ROMANIAN ACADEMY

STOMATOLOGY EDU JOURNAL

VOLUME 3 ISSUE 3-4 AUTUMN 2016

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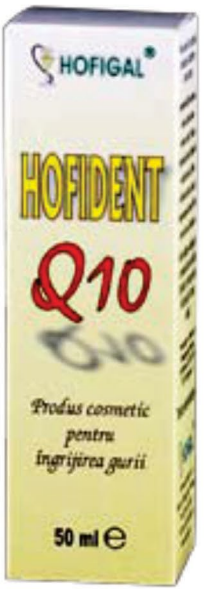

Hofident Q10

Product presentation: Solution for oral hygiene.

Composition (INCI): aqua/water, alcohol, *Capsella Bursa Pastoris* extract, *Plantago Lanceolata* extract, *Chamomilla Recutita* extract, *Achillea Millefolium* extract, *Aesculus Hippocastanum* extract, *Mentha Piperita* extract, Ubiquinone.

Action: The product has antiseptic, healing, hemostatic, anti-inflammatory aetion, it acts as a antioxidant, detoxifier, deodorant. It is strongly recommended in gingivitis, stomatitis, thrush, compression pain causedby dental prostheses, after tooth extraction, in case of nipple lesion, bleeding gums, mouth and gum ulcers.

Recommendations: It delays dental plaque formation, it prevents bad odour and provides daily mouth hygiene.

HofImun® FORTE

Product presentation:
Chewable tablets to stimulate the immune system

Composition: Each chewable tablet contains raspberry fruit extract *(Rubii idaei fructus)*, Echinacea extract *(Echinacea purpurea)*, concentrated extract of licorice root *(Glycyrrhiza radix)*, magnesium ascorbate and excipients.

Action: It stimulates the immune system, it is antiinflammatory, antiviral, antiseptic, it fluidifies the bronchial and pharyngeal secretions, antioxidant, cardioprotective, vasoprotective, it has antineoplastic antileukimic action, (due to the ellagic acid), it contributes to wound healing, fortifies and remineralizes (it regulates the potassium balance), it has antiulcer effects and is an overall body tonic.

Recommendations: to supplement the diet with nutrients and bioactive substances in: acute and chronic infections of the upper airways (angina, pharyngitis, laryngitis, bronchitis), prophylactic during periods with increased risk of infection with influenza viruses, it has sweating effects in fever, in recurrent herpes episodes of mucocutaneous rash, frequent urinary tract infections, inflammatory urogenital processes; immunodepression after radiotherapy or chemotherapy, bacterial skin infections, psoriasis, neurodermitis, chronic cardiovascular diseases associated with hypercholesterolemia, adjuvant in the diet indicated in the treatment of gastroduodenal ulcers, tonic during periods of physical and mental strain, exhaustion.

Bucoprotect gel

Product presentation: Gel for oral hygiene.

Composition (INCI): aqua, *capsella bursa pastoris*, *calendula officinalis, achillea milefolium, hippophae rhamnoides, olea europea, hypericum perforatum,* carbomer, triethanolamine, collagen, *foeniculum vulgare, mentha piperita, citrus amara.*

Action: Antiseptic, anti-inflammatory, healing, stimulates the inside lining of the mouth and gums trophicity, reduces pain caused by specific oral diseases (gingivitis, stomatitis, lesions of the prosthesis, thrush, periodontitis).

Recommendations: Fights against bad breath (halitosis).

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stomaeduj

Volume 3, Issue 3-4,
Pages 117-258, Autumn, 2016

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ISSN 2360 – 2406 (Print)
ISSN 2502 – 0285 (Online)
ISSN – L 2360 – 2406

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At least once a week I get an e-mail inviting me to become editor/reviewer or author of a scientific journal. They all are open access journals, which means that their content is available without restrictions or fees through the internet. This concept goes back to the Budapest Open Access Initiative (2002)[1], which stated the following: " its free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself"[1].

The basic idea behind is that knowledge should be publicly accessible and no barriers such as subscription fees should prevent the dissemination of knowledge. This is a very noble and idealistic thought which has been perverted by many mechanisms. A famous American economist has once stated "There is nothing but a free meal!" This means that someone has to pay for it! In the classical world the publisher pays for the production cost, which includes the peer review system, which is usually done for free by voluntary reviewers, who are usually managed by an academic who acts as Editor for a symbolic honorarium. The financial source for such an allowance is usually the subscription fee. The negative side is that big publishers offer to University libraries only packages, which usually include many Journals that the university does not want. Knowing this, one can say that in the traditional way the academic and the scientific institutions widely support the worldwide dissemination of knowledge. So it is understandable that Universities usually like the open access approach.

However, the world is not just black and white. In the open access world there has been a reversal of financing practices. There the author must pay for the publication, which favors wealthy authors. The University of Florida (UF) has just launched an initiative to support UF members to publish in open access journals, which costs the UF 120'000$/year. It is substantially less than the cost of the traditional libraries. Furthermore, in the US grants traditionally pay for publication costs. But open access has also created "predator journals" where, with murky methods and shady or absent reviews, some publishers make fortunes on the back of the authors. Some of these Journals require submission fees, some ask for high publication fees, once the paper is accepted and some save by doing very sloppy reviews or none at all. The experiment of John Bohannon[2] clearly shows how dangerous this route may be. John Bohannon decided to create a fake paper with such grave errors that a competent reviewer should easily detect and thus recommend its rejection: "The Paper took this form: Molecule X from lichen species Y inhibits the growth of cancer cell Z. To substitute those variables I created a database of molecules, lichens, and cancer cell lines and wrote a computer program to generate hundreds of unique papers. Other than those differences, the scientific content of each paper is identical."[1] He then created fictitious authors and institutions mainly in the developing world by permuting names and inventing institutions. To camouflage his good English, he had Google translate it into French and then

back into English, based on a recommendation of some Harvard molecular biologists colleagues who had mock-reviewed the paper. Then these fake manuscripts were submitted at a rate of 10 per week to a multitude of journals. A few publishers requested a fee to be paid up front. Those were excluded from the process, which means that the remaining used the standard model: fee for publication after acceptance. If a journal rejected the paper it was also excluded from further actions. If the paper came back and the journal asked for revisions, the author complied. If it was accepted, the author withdrew the paper with the comment that an "embarrassing mistake" was found.

"By the time the Science went to press, 157 of the journals had accepted the paper and 98 had rejected it. Of the remaining 49 journals, 29 seem to be derelict: websites abandoned by their creators. Editors from the other 20 had e-mailed the fictitious corresponding authors stating that the paper is still under review; those too, are excluded from this analysis. ... Of the 255 papers that underwent the entire editing process to acceptance or rejection, about 60% of the final decisions occurred with no sign of peer review. ... Of the 106 journals that discernibly performed a review, 70% ultimately accepted the paper. Most reviews focused exclusively on the papers layout, formatting, and language"[1]

Even if some open access journals rejected these fake papers and J. Bohannon was criticized for not having a control group, this is bad news for the credibility of the scientific community. Therefore scientists should only submit to Journals they know, where the Editor is a known personality in their research field and where they know that a sound peer review process is performed, which is a laborious task.[3]

Dear Readers, I am proud to be Editor of a Journal that takes peer review very seriously!

Sincerely yours,

J-F Roulet

Editor-in-Chief

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https://doi.org/10.25241/stomaeduj.2016.3(3-4).edit.1

Centric Relation: Didactic or Practical?

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Is centric relation only a didactic tool for the dental student and novice dentist, and if not so, why is it such an enigma or obscure belief?

Centric relation is defined as the most posterior relationship of the mandible to the maxillae where the anatomy of healthy muscles and joints can comfortably guide the mandible into a closed position prior to any tooth contact. It is a reproducible relationship with a hinge-type of opening and closing. It is often used to mount diagnostic casts on an articulator for the purpose of discovering the location of the premature contacts which minutely deflect the jaw forward and/or laterally. Most people have premature contacts on centric relation closures without experiencing any problems. Proprioceptive nerves surrounding the roots of all natural teeth send signals to the temporomandibular joints which enable the mandible to avoid closing onto the deflective tooth contacts, thus avoiding problems which might develop from bruxing on them (sensitivity, fremitus, TMD, facets, etc.). With the totally edentulous patient centric relation is used to help determine the desirable vertical and horizontal relationship for the complete denture maximum intercuspal position (MIP).

Dr. Woelfel has studied, observed and used centric relation for sixty-six years and he firmly believes that no one (dentulous or edentulous) experiences problems when provided with centric relation occlusion (CR = MIP). In fact, both retention and stability usually improve with complete dentures when the two positions coincide.

How to best obtain and record centric relation on dentulous patients: the mandible should first be deprogrammed or tripodized (each temporomandibular joint plus an incisor stop or anterior guide). With the patient's head tipped backwards, explain and rehearse the entire procedure of closing the retruded jaw firmly onto a leaf gauge or sliding forward and then backward into centric relation several times on the sliding guide. Be sure that the patient maintains the final closed centric relation position on the leaf gauge or sliding guide while you prepare and make the registration.

How to best record centric relation on edentulous patients: Using a large mirror, have the patient watch closely as they move their jaw forward and backward several times with your thumb gently on their chin. Tell them when their jaw is in the correct backward position. You should feel the mandible pop back into centric after the patient has protruded and then retrudes. Explain that this is the "back" position that you want to record. Have the patient practice opening and closing a few more times in the "back" position before recording it. The centric relation registration should be made with the mandible

opened about 2 millimeters from the established vertical dimension, using a fluid material like quick-set plaster or polyvinylsiloxane. You should never use the word "bite" when recording centric relation because people are so used to protruding their jaw when they incise or bite something off. Avoid the commonly used method "put your tongue back in your throat and close up" method. It is quite easy to protrude your jaw with your tongue back in the throat and this procedure usually displaces the mandibular trial base or occlusion rim.

Good luck recording centric jaw relation now that you can appreciate how valuable and important a position it is. Centric relation is relatively easy to locate and record on the majority of patients. Utilizing it should add to the success of your practice.

J.B. Woelfel
Emeritus Editor-in-Chief

https://doi.org/10.25241/stomaeduj.2016.3(3-4).edit.2

The joy of reading, the effort to get information and the wish to educate oneself

Marian-Vladimir Constantinescu
DDS, PhD, Professor
Editor-in-Chief

Dear Readers,

Confucius said: "By nature, men are nearly alike; by practice, they get to be wide apart".

In the socialist countries beyond the Iron Curtain, the communist education system stated that it was compulsory to attend ten grades, since in this way people were easier to control as Henry Peter Brougham said: "Education makes a people easy to lead, but difficult to drive; easy to government, but impossible to enslave".

Problems arose when one started to look, in the specialized libraries, for information, references and the necessary documentation to write a graduation paper or a doctoral degree. If you were lucky you were likely to find some magazines or books, but not during the last years of that utopian regime in Romania, a regime which was an economic failure and which, moving towards its end, had come to the conclusion that education is expensive, therefore would invariably guide us towards ignorance.

Index Medicus allowed you to get information on the existing citations about the subject that you had selected. To add to your documentation you could go to the American Library where you could borrow books coming from the very libraries of the American universities. Moreover, upon request, I managed to receive a series of videotapes from the University of Michigan on modeling in wax and clinical and instrumental occlusal analysis. These videotapes were presented in a scientific session for the faculty teaching staff and practitioners in Bucharest.

Also in order to supplement your documentation you could contact the author asking him to send you some reprints. If you did that, and also if you were a patron of the American Library, you would be targeted by the secret services because you had relations with foreigners and you had to suffer the consequences as I had to.

"Education is the most powerful weapon which you can use to change the world", said Nelson Mandela. Perhaps for this reason access to training courses by renowned foreign specialists was practically impossible. Exceptionally, we managed to invite Prof. Jean Romerowski, dental anatomy professor at the University Paris VII as a participant in a United Nations Development Programme (UNDP) assistance program. So, for a week, Prof. Romerowski initiated us into the occlusal analysis methodology at the Clinic for Dental Prosthetics in Bucharest. Also as part of that UNDP assistance program we managed to equip the first metal-ceramic laboratory and together with Prof. Lucian Ene we managed to take part in the congresses organized by the International Academy of Gnathology - European Section, in Paris and Lausanne. While attending these congresses I met the famous Dr. Paul B. Feinmann from Geneva, President of these scientific events and personal dentist of several film celebrities. He was so generous as to keep me updated on the latest developments related to dental occlusion.

"The goal of education is the advancement of knowledge and the dissemination of truth" said the late president John F. Kennedy. The evolution of knowledge after the fall of the Berlin Wall and implicitly of all the communist regimes that slavishly followed the Kremlin ideology involves other issues as

well. These countries were faced with Benjamin Disraeli's statement: "Upon the education of the people of this country, the fate of this country depends". Now access to databases on the Internet is unprecedented, unlimited. You must have acquired the research methodology and have the ability to select your bibliographic sources. Difficulties occurred when you wanted to read a treatise which could cost as much as your monthly salary paid by the state, as a practitioner or educator; when you wanted to participate in some congress or hands-on refresher course.

Initially, there were problems with getting your visa, then there came the costs of airfare, hotel accommodation and the participation fee. Even if some professional societies or associations would exempt their colleagues from the former communist countries from the payment of the participation fee or asked for a lower fee, such as a student or pensioner fee, the financial burden of participating in a congress in Europe was felt for over half a year.

We found ourselves in the position of inviting the great professionals and professors of dentistry to our country. The Romanian Society of Stomatology, founded in 1923, organized the FDI World Congress in Bucharest in 1970. During this event a decision was adopted to introduce the FDI tooth notation system. The Romanian Society of Stomatology extended invitations to a number of professionals to deliver conferences during this event to. Here are some of those who generously accepted to do it: Dr. Paul B. Feinmann from Geneva, prof. Sami Sandhaus from Lausanne, prof. Julian B Woelfel from Ohio University, CO, USA and others as well.

During the Dracula Tour I managed to strike a close friendship with Prof. Woelfel and his family. So, Prof. Dumitru David and myself are privileged to receive from Prof. Woelfel a presentation copy of each and every edition of his remarkable treatise on Dental Anatomy. To my surprise I have recently received an advanced copy of Woelfel's Dental Anatomy - ninth edition to be issued in 2017 by Wolters Kluwer Publisher!

At first our associations could only cover the accommodation costs as well the social program. Then we also started covering economy class plane tickets. There were exceptional circumstances when some lecturers asked for 10,000 euro for a one-day lecture and a hands-on event and some professional associations managed to meet their request.

Indeed "Education is the best provision for the journey to old age." as Aristotle said. This may be the reason why the EU has adopted a program of lifelong learning (LLP). The objective of this EU program is to contribute by promoting lifelong learning, to the development of the EU as an advanced knowledge society with sustainable economic growth with more jobs and greater social cohesion.

LLP is a challenge for our prestigious journal editors to be actively involved in raising awareness and educate our readers so they can continuously improve their quality of care.

Sincerely yours,
M-V Constantinescu
Editor-in-Chief

https://doi.org/10.25241/stomaeduj.2016.3(3-4).edit.3

EACMFS 2016, The 23rd Congress of the European Association for Cranio Maxillo-Facial Surgery
Date: 13 - 16 September 2016
Location: London, UK
Event types: Conference, Course, Exhibition
Visit event website: http://eacmfscongress.org/

CAE Canadian Academy of Edodontics - 52nd Annual General Meeting
Date: 13 - 17 September 2016
Location: Winnipeg, Canada
Event types: Conference, Exhibition
Visit event website: www.caendo.ca

AAOMS 98th Annual Meeting, Scientific Sessions and Exhibition
Date: 18 - 23 September 2016
Location: Las Vegas, NV, SUA
Event types: Conference, Exhibition
Visit event website: https://aaoms.confex.com/aaoms/am1609/webprogram/start.html

IADR PER Congress
Annual Meeting of the British, Continental European, Irish, Israeli, and Scandinavian Divisions of IADR
Date: 20 - 22 September 2016
Location: Jerusalem, Israel
Event types: Conference, Exhibition
Visit event website: http://www.iadr.org/i4a/pages/index.cfm?pageid=4518#.VoUbo_mLTIU

2016 Fachdental Leipzig
Date: 23 - 24 September 2016
Location: Leipzig, Germany
Event types: Conference, Exhibition
Visit event website: www.messe-stuttgart.de/fachdental-leipzig/

2016 Dental Expo Moscow - 40th Moscow International Dental Forum & Exhibition
Date: 26 - 29 September 2016
Location: Moscow, Russia
Event types: Conference, Exhibition
Visit event website: www.dental-expo.com/eng.html

2016 EAO - European Association of Osseointegration Congress
Date: 29 September - 01 October 2016
Location: Paris, France
Event types: Conference, Course, Exhibition
Visit event website: www.eao-congress.com

2016 UNAS International Dental Congress
Date: 05 - 08 October 2016
Location: Bucharest, Romania
Event types: Conference, Exhibition
Visit event website: http://www.unas.ro/unas/content/

2016 Slovak Dental Days - 17th International Specialised Exhibition of Dental and Dentotechnical Devices, Tools and Materials co-located events
Date: 06 - 07 October 2016
Location: Bratislava, Slovakia
Event types: Conference, Exhibition
Visit event website: www.incheba.sk/en/event-calendar.html?page_id=137#CUREVENT

Dental World
Date: 13 - 15 October 2016
Location: Budapest, Hungary
Event types: Conference, Exhibition
Visit event website: http://10times.com/dental-world

2016 ADA - American Dental Association Annual Meeting
Date: 20 - 22 October 2016
Location: Denver, CO, USA
Event types: Conference, Exhibition
Visit event website: www.ada.org/en/meeting/attendee-information/future-meetings/

15th Euro Congress on Dental & Oral Health
Date: 24 - 26 October 2016
Location: Rome, Italy
Event types: Conference, Exhibition
Visit event website: http://www.dentalcongress.com/europe/scientific-program/

AAID - American Academy of Implant Dentistry, 65th Annual Meeting
Date: 26 - 29 October 2016
Location: New Orleans, LA, USA
Event types: Conference, Course, Exhibition
Visit event website: www.aaid.com

2016 AMSPPR NORD ARDEAL Dental Medicine Congress
Date: 03 - 05 November 2016
Location: Bucharest, Romania
Event types: Conference
Visit event website: http://www.amsppran.ro/doc/noiembrie_2016.pdf

2nd International Conference and Expo on Biomechanics and Implant Design
Date: 07 - 08 November 2016
Location: Las Vegas, NV, USA
Event types: Conference, Course, Exhibition
Visit event website: http://biomechanics-implantdesign.conferenceseries.com/scientific-program/

SIE International Congress 2016
Date: 10 - 12 November 2016
Location: Rome, Italy
Event types: Conference, Course, Exhibition
Visit event website: http://endodontics.it/

25th Annual Meeting of the Portuguese Dental Association
Date: 10 - 12 November 2016
Location: Oporto, Portugal
Event types: Conference, Exhibition
Visit event website: https://www.omd.pt/en/congress/2016/scientific-programme

Dental-Expo Samara 2016
Date: 10 - 12 November 2016
Location: Samara, Russia
Event types: Conference, Exhibition
Visit event website: http://www.dental-expo.com/eng/samara.html

3rd PanDental Society Conference
Date: 11 - 12 November 2016
Location: Birmingham, UK
Event types: Conference, Exhibition
Visit event website: http://www.pandental.co.uk/programme/bsp_programme.php

Id Infotage Dental Frankfurt 2016
Date: 11 - 12 November 2016
Location: Frankfurt/Main, Germany
Event types: Conference, Exhibition
Visit event website: http://www.infotage-dental.de/id_f_home_de

5th Mediterranean Orthodontic Congress - MOIP
Date: 11 - 13 November 2016
Location: Limassol, Cyprus
Event types: Conference
Visit event website: http://www.moip2016.com

17th World Congress on Oral Care and Dental Hygiene
Date: 14 - 16 November 2016
Location: Orlando, FL, USA
Event types: Conference, Course, Exhibition
Visit event website: http://oralcare.conferenceseries.com/scientific-program/

BDIA Certificate : Introduction to Dentistry Exams
Date: 16 November 2016
Location: London, UK
Event types: Conference, Exhibition
Visit event website: https://www.bdia.org.uk/examinations.html

18th Asia-Pacific Dental and Oral Care Congress
Date: 21 - 23 November 2016
Location: Melbourne, Australia
Event types: Conference, Course, Exhibition
Visit event website: http://dentalcare.conferenceseries.com/scientific-program/

ADF 2016 Conference
Date: 22 - 26 November 2016
Location: Paris, France
Event types: Conference, Course, Exhibition
Visit event website: http://www.adf.asso.fr/en/meeting

Finnish Dental Congress
Date: 24 - 26 November 2016
Location: Helsinki, Finland
Event types: Conference, Exhibition
Visit event website: http://hammaslaakaripaivat.messukeskushelsinki.fi/?lang=en

GNYDM - Greater New York Dental Meeting 2016
Date: 25 – 30 November 2016
Location: Helsinki, Finland
Event types: Conference, Exhibition
Visit event website: http://www.nxtbook.com/nxtbooks/gnydm/programguide2016/

2016 Dental Implant Conference
Date: 01 - 03 December 2016
Location: Chicago, IL, SUA
Event types: Conference, Exhibition
Visit event website: https://aaoms.confex.com/aaoms/im1612/meetingapp.cgi

18th International Conference on Oral Health and Maxillofacial Surgery
Date: 05 - 06 December 2016
Location: Madrid, Spain
Event types: Conference, Course, Exhibition
Visit event website: http://oral-maxillofacialsurgery.conferenceseries.com/scientific-program/

Midwinter Meeting 2016
Date: 08 December 2016
Location: London, UK
Event types: Conference, Course, Exhibition
Visit event website: https://www.bdia.org.uk/midwinter-meeting-2016.html

19th American Dental Congress
Date: 08 - 10 December 2016
Location: Phoenix, AZ, USA
Event types: Conference, Course, Exhibition
Visit event website: http://www.dentalcongress.com/america/scientific-program/

PREVENTION OF DENTAL CARIES THROUGH THE EFFECTIVE USE OF FLUORIDE – THE PUBLIC HEALTH APPROACH

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Received: July 15, 2016
Revised: August 03, 2016
Accepted: August 17, 2016
Published: August 19, 2016

Cite this article:
Petersen PE. Prevention of dental caries through the effective use of fluoride – the public health approach. Stoma Edu J. 2016;3(3-4):130-140.

ABSTRACT **DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.1**

Background: The World Health Organization (WHO) emphasizes that dental caries is a severe public health problem across the world. The current global and regional patterns of dental caries reflect distinct risk profiles of countries which relate to the structure of the society, living conditions, lifestyles, and the existence of preventive oral health programmes. Research conducted in high income countries documents that systematic use of fluoride reduces the burden of dental caries; such research is scarce in low and middle income countries.
Objectives: This article reviews the evidence on effective use of fluoride, highlights the public health approach to fluoridation, and clarifies how automatic fluoridation contributes to breaking social inequities in dental caries.
Data collection: Scientific publications on fluoride administration stored in PubMed/Medline and caries data from the WHO databank.
Outcome: Dental caries identified from national surveys or country relevant data; extraction of scientific reports is based on their public health relevance.
Conclusions: The article outlines the history of fluoridation programmes and describes the sound evidence on automatic fluoridation through water, salt and milk, or from the use of high quality fluoridated toothpastes (1000-1500 ppm F). The experiences from the implementation of programmes in various countries are discussed and the potential for breaking the social inequalities in the burden of dental caries is clarified. Finally, the role of WHO in the development and implementation of fluoridation schemes is explained; WHO technical assistance in the outcome evaluation and assessment of fluoride exposure is enlightened.
Keywords: burden of dental caries, social inequalities, population-based disease prevention, automatic fluoridation, WHO.

1. Introduction

Dental caries continues to pose an important public health problem across the world.
The World Health Organization (WHO) emphasizes that the disease affects about 60–90% of schoolchildren and the vast majority of adults; moreover, dental caries contributes to an extensive loss of natural teeth in older people globally[1,2]. Meanwhile, in most westernized high income countries, dental health has improved over the past three decades in parallel to the introduction of prevention-oriented oral health systems. A decline in the prevalence and the severity of dental caries is particularly observed in children and younger adults in countries having established public health programmes using fluoride for dental caries prevention, coupled with changing living conditions, healthier lifestyles, and improved self-care practices. In Eastern Europe and Central Asia dental caries levels are high and with health systems in transition the exposure of the population to fluoride for disease prevention has diminished dramatically. In low and middle income countries of Asia, Latin America, and certain areas of Africa, the prevalence of dental caries is growing considerably. The lack of preventive programmes is further complicated by the fact that these countries have a shortage of oral health personnel and the capacity of oral health systems is mostly limited to treatment of symptoms or emergency care. In children and adults suffering from severe tooth decay, teeth are often left untreated or they are extracted to relieve oral pain or discomfort. In the future, tooth loss and impaired quality of life are therefore expected to increase as a public health problem in many developing

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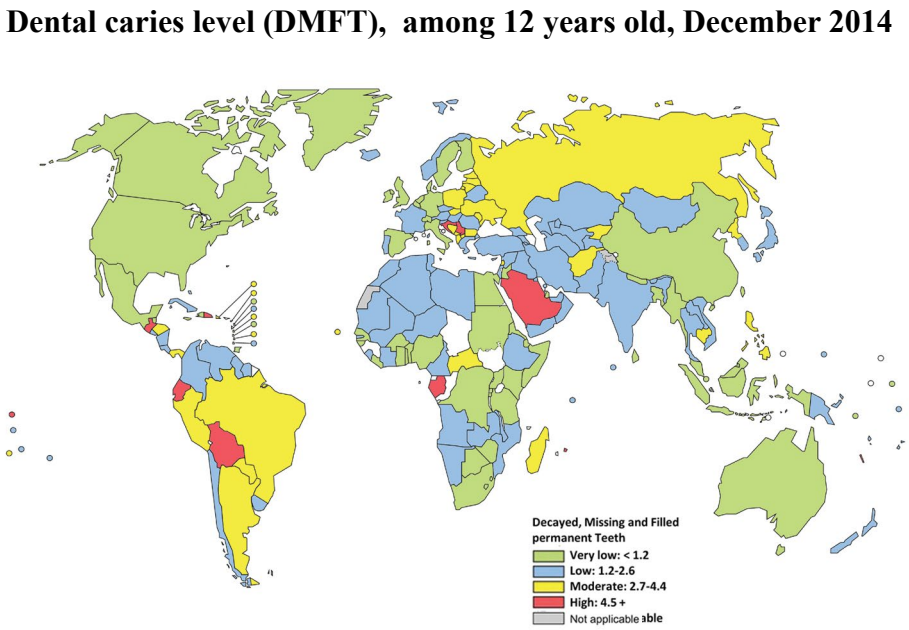

Figure 1. Levels of dental caries experience among 12-year-old across the world as measured by the DMFT index according to the WHO Global Oral Health Data Bank[3]

countries unless prevention is introduced. Figs. 1-2 summarize the epidemiological information depicting the burden of dental caries across the world. The figures show the country scores of Decayed, Missing due to caries, and Filled index at ages 12 and 35-44-years[1,3]. Fig. 3 demonstrates the high DMFT index among older people within the six WHO regions. The number of teeth missing due to caries is remarkably prominent. The current global and regional patterns of dental caries largely reflect distinct risk profiles of countries which relate to structure of society, living conditions, lifestyles, and the existence of preventive oral health systems[4]. The socio-behavioural risk factors in dental caries are found universally and they play significant roles in children, adults as well as older people. The disease level is relatively high among the underprivileged population groups, i.e. people with a low education background, poor living conditions, people with poor dietary habits and high consumption of sugars, and people with limited tradition of dental care[5]. Unless serious efforts are made to tackle the social inequity by modifying risk factors and by establishing effective caries prevention programmes, the level of dental caries in disadvantaged populations and countries will unduly increase[4]. Evidently, substantial population groups in low and middle income countries have not yet obtained the health benefit from fluoride in community prevention programmes. The reasons for not having been able to implement such prevention programmes varies in nature ranging from lack of national policy and systems for oral health to low awareness of the importance of oral health.

The purpose of this article is to review the evidence for using fluoride for prevention of dental caries and to summarize the public health benefit from usage of automatic fluoridation as recommended by WHO. In addition, the intention is to discuss one of the major public health advantages of automatic fluoridation in that the approach may break the prevailing oral health diversities between population groups.

2. Existing fluoridation programmes

Few low and middle income countries have large-scale fluoridation programmes in operation. Some countries in Latin America have introduced water and salt fluoridation, and remarkable caries reduction has been observed in the populations of those countries. However, effective exposure to fluoride is still fairly limited in other regions. In the African region, for example, salt fluoridation has been implemented in Madagascar with the support of UNICEF and WHO. In Asia, Thailand introduced high-quality fluoride-containing toothpaste and milk fluoridation in school programmes[6-8]; in parallel, WHO facilitated the implementation of salt fluoridation in Laos and Viet Nam. While the use of fluoride-containing toothpaste is becoming more common in low and middle income countries, its use is not the norm even among those who brush their teeth twice a day, and it is more likely to be used in urban rather than in rural communities[9,10]. Locally produced fluoride-containing toothpastes often have insufficient levels of fluoride. Two important events have analyzed the use of fluoride in Asia. In 2006, a WHO symposium reviewed the Chinese experiences from fluoridation programmes[11] and a workshop on the effective use of fluoride in Asia was held in Thailand in March 2011, which analyzed the opportunities and barriers in establishing sustainable fluoride programmes[7,8].

Most industrialized countries have demonstrated a substantial decline of dental caries among children and growing proportions of adults tend

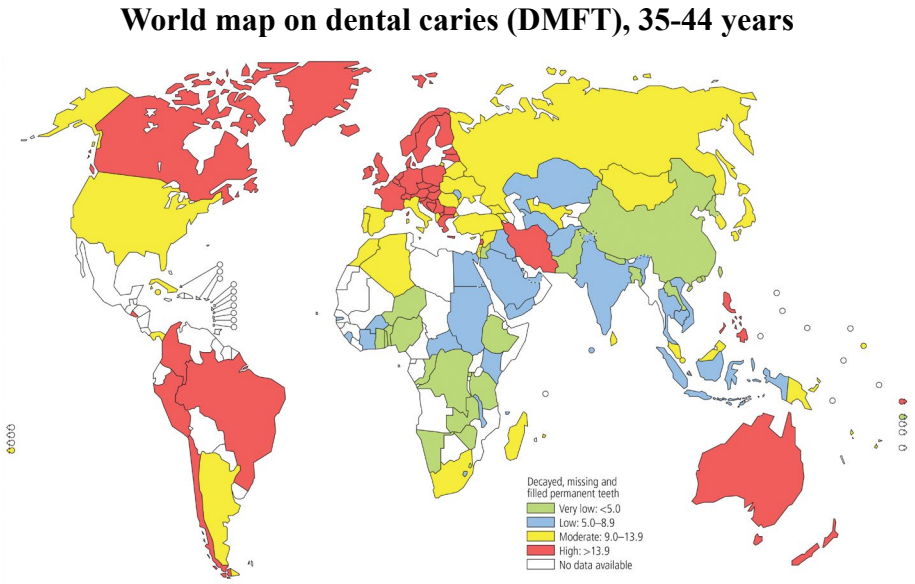

Figure 2. Levels of dental caries in 35-44-year-olds in countries as measured by the DMFT index, WHO Global Oral Health Data Bank[3]

to preserve their natural teeth. Several years ago high income countries in Europe, USA, New Zealand, and Australia[12] introduced several years ago comprehensive fluoride administration programmes based on water fluoridation, salt fluoridation, or milk fluoridation. The Scandinavian countries and Japan introduced systematic use of effective fluoridated toothpaste and this appears to be significant population-directed prevention as tooth brushing with fluoridated toothpastes is highly frequent.

2.1. Effective use of fluoride

Fluoride is a key agent in reducing the prevalence of dental caries, which it achieves in at least three ways[12, 13]:

- by encouraging repair (re-mineralization) of early damage to enamel caused by acid produced by the breakdown of sugars by plaque bacteria;
- by improving the chemical structure of the enamel, making it more resistant to acid attack; and
- by reducing the ability of the plaque bacteria to produce acid.

WHO[1] emphasizes that the prevalence and incidence of dental caries can be controlled by the joint action of communities, professionals and individuals. In many low and middle income countries, however, access to oral health services is limited, while in high income countries significant numbers of the underprivileged population groups are underserved. For these reasons, professionally applied fluorides such as fluoride varnish or fluoride gel are considered less relevant to public health programmes. Thus, according to WHO[14] the public health approaches to effective use of fluoride include:

- water fluoridation
- salt fluoridation
- milk fluoridation; and
- development of affordable fluoride-containing toothpastes.

Government agencies and the private industry sector in charge of operation of water facilities, salt processing plants, dairies and toothpaste manufacturers have a very important role to collaborate on the development and implementation of community dental caries prevention programmes in which water, salt or milk alone or in combination with toothpaste are considered as vehicles for making fluoride available to the population.

3. Research on population-based prevention through fluoride

Research on the effects of fluoride on oral health started slightly over 100 years ago[15]. During the first third of the century research focused on studying causes of mottled enamel. The next twelve to fifteen years researchers studied the relationship between fluoride, dental caries and enamel fluorosis. In the second half of the 20th century research aimed at adding fluoride to community water supplies and later to salt for human consumption; it gradually shifted to the development and evaluation of fluoride-containing toothpastes and mouth rinses and, to studying the use of milk as a vehicle for fluoride as a possible public health alternative to water or salt fluoridation. More recently, efforts have been made to summarize these extensive data sets through systematic reviews, such as those conducted on water fluoridation by the University of York National Health Service Centre for Reviews and Dissemination[16,17], on fluoride ingestion and bone fractures[18] and on fluoride toothpaste[19] and mouth rinses[20] by the Cochrane Collaboration Oral Health Group.

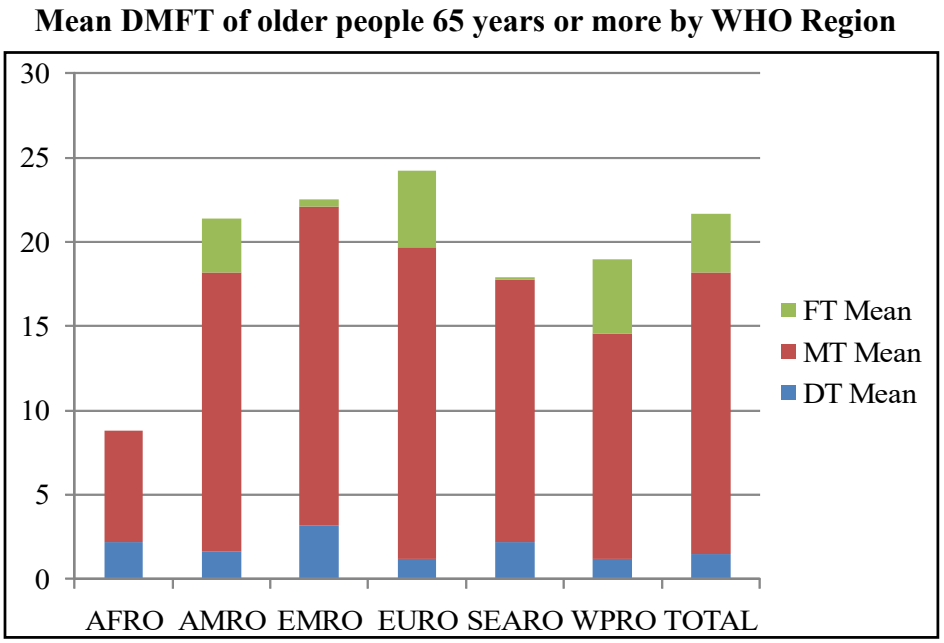

Figure 3. Dental caries experience (DMFT) among older people (65+ years) across WHO regions of the world, as measured by the DMFT index, WHO Global Oral Health Data Bank[3] (AFRO= Africa, AMRO= Americas, EMRO= Eastern-Mediterranean, EURO= Europe, SEARO= South East Asia, WPRO= Western Pacific)

3.1. Water fluoridation

The history of water fluoridation can be divided into three periods[21]. The first period from 1901 to 1933 focused on investigating causes of mottled enamel (Colorado brown stain, first reported by Frederick McKay). The second period between 1933 and 1945 attempted to study the relationship that might exist between fluoride concentrations, fluorosis and dental caries, and established that moderate levels of fluoride prevent dental caries. The third period, from 1945 to the present focused on adding fluoride to community water supplies. In 1945, the first controlled experiment of water fluoridation was initiated by H. Trendley Dean in the city of Grand Rapids, Michigan United States of America[22]. Five years later, Dean reported that there were significant reductions in dental caries. These results were complemented by Arnold et al. in 1953[23]. Other major fluoridation programmes followed the first community programme for water fluoridation instituted at Grand Rapids; in the USA in Newburgh in 1945[24], and in Evanston, Illinois in 1946[25]; in Canada in Brantford and Ontario in 1945[26]; in the Netherlands in 1953[27]; in New Zealand in 1954[28]; in the United Kingdom in 1955[29-31], and in the German Democratic Republic in 1959[32]. The outcomes of these programmes were published mainly in the 1950s and 1960s. As a result, many community water fluoridation programmes were introduced in the largest cities of the USA, including Indianapolis (1951), San Francisco (1952), Philadelphia (1954), Chicago (1956), New York (1965), Dallas (1966), and Detroit (1967). The average cost of water fluoridation in the USA has been estimated at the level of 1US$ per person per year[33]. Worldwide, extensive fluoridation programmes have also been introduced in Australia, Brazil, Chile, Colombia, Canada, Hong Kong Special Administrative Region of China, Ireland, Israel, Malaysia, New Zealand, Singapore, the United Kingdom, and elsewhere. More recently, new programmes have been introduced in large conurbations in the south and west of the USA, including Los Angeles (in 1999), Las Vegas (in 2000), Sacramento (in 2000), and San Antonio (in 2002).

Systematic reviews consistently conclude that water fluoridation reduces the prevalence of dental caries, i.e. the percentage of the population with decayed, missing and filled primary teeth (dmft)/Decayed, Missing due to caries, and Filled permanent Teeth (DMFT) > 0 and reduces the incidence of dental caries. There is no credible evidence that water fluoridation is associated with any adverse health effects. Water fluoridation has benefits in addition to those associated with the use of fluoride toothpastes alone.

In order to properly implement water fluoridation programmes a central water distribution system is indispensable. In addition, the full support of the top health authorities and of the government is essential; some countries have secured laws, decrees or regulations. Adequate budget for the initiation and maintenance of programmes is indispensable to ensure sustainability.

3.2. Salt fluoridation

One of the objections to water fluoridation is that it limits consumers' choice. If the public water supply is fluoridated, a consumer has few practical alternatives other than to purchase bottled drinking-water that does not contain

Table 1. Dental caries severity in selected countries before implemention of automatic fluoridation for prevention of dental caries[3]

Country	Automatic Fluoridation			DMFT 12-years	Year of implementation
	Water	Salt	Milk		
Brazil	X			2.8	1953
Bulgaria			X	3.1	1988
Canada[1]	X			2.1	1945
Chile[2]	X			2.6	1996
Chile Codegua			X	3.23 dmft@6years of age	1994
Colombia		X		2.3	1997
Costa Rica		X		2.5	1987
Cuba		X		1.5	2000
Czech Republic		X		2.5	1994
France		X		1.2	1986
Germany		X		0.7	1991
Honk Kong	X			0.8	1961
Ireland	X			1.1	1957
Israel	X			1.66	1970
Jamaica		X		1.1	1987
South Korea	X			2.08	1978
New Zealand	X			1.4	1954
Macedonia			X	3.03	2009
Malaysia	X			1.6	1957
Mexico		X		2.0	1989
Russian Federation			X	2.9	1994
Singapore	X			1.0	1958
Switzerland		X		0.86	1955
Thailand			X	1.9	2000
United Kingdom	X			0.7	2003
St Helens, UK			X		1993
United States	X			1.16	1945
Uruguay		X		2.5	1992

[1] Ontario
[2] Metropolitan area

fluoride. One of the attractions of fluoridated salt is that it can be sold alongside a non-fluoridated alternative. Salt is consumed by virtually all populations, the amount consumed is constant, and an overdose is virtually excluded. In countries of the Americas decrees, regulations or standards emanated from health authorities require that salt for human consumption be fluoridated. Salt fluoridation has been used successfully for over 55 years. The fluoride addition is inexpensive and techniques for addition in various settings have been developed and these are accessible to small and large processors. When most salt for human consumption is fluoridated, the effectiveness of salt fluoridation approximates that of water fluoridation. Fluoridated salt is available in certain countries that do not have identified programmes. The first studies on the effects on the incidence and prevalence of dental caries of fluoride added to alimentary salt were carried out from around 1965 to 1985 in Colombia, Hungary and Switzerland, with rather similar results to those observed after the introduction of water fluoridation[34,35]. These studies also explain that fluoridated salt reaches the consumer through several channels, including domestic salt, meals at schools, large kitchens,

and in bread. In Colombia, Costa Rica, Jamaica, and the Canton of Vaud in Switzerland, most, if not all, of these channels are used; in France and Germany the focus is on fluoridating domestic salt. Jamaica provides another interesting setting, because all salt destined for human consumption in the country has been fluoridated since 1987. Significant development has occurred in the Americas where Colombia, Costa Rica, Jamaica, Mexico and Uruguay have more than 20 years of documented community experience with population coverage up to 98%[36-38].

Around the world, the concentration of fluoride in salt used ranges from 200 mg/kg to 350 mg/kg, with an optimal concentration of around 250 mg/kg[39,40]. In studies conducted in Hungary the concentration of 350 ppm F was used in all test towns. Caries reduction of 53% to 68% was observed in both temporary and permanent dentitions after 15 years of salt fluoridation[41]. If salt ingestion was reduced concentration of fluoride in salt could be increased to provide the corresponding amount of fluoride to maintain comparable cariostatic effect.

One concern expressed misleadingly is that the promotion of the dental benefits of fluoridated salt would be unacceptable and contradictory to public health messages that encourage the reduction of consumption of salt and thus decrease the risk of hypertension. However, populations are not encouraged to consume more salt but limit themselves to a minimal consumption to improve their dental health; rather, the "automatic" or passive effect of fluoridated salt is accepted. In other words, people do not need to change their usual behaviour to benefit. Indeed, reduced consumption of salt could and should be encouraged and, where this is successful, the concentration of fluoride in salt could simply be increased appropriately.

Iodization of salt has been successfully used to prevent iodine deficiency diseases and is now being promoted in all parts of the world. It is emphasized by WHO that iodization and fluoridation of salt should be combined[40]. Coordination between health agencies, salt producers, marketers, distributors, and the community, with inclusion of appropriate epidemiological surveillance systems, is recommended for effective implementation. The cost of implementing a salt fluoridation program varies with the type of equipment available at the processing plant, the method for adding the fluoride compound, cost of the fluoride compound, necessary training of personnel, quality control equipment, and supplies. The cost of the equipment and other inherent costs for initiating a salt fluoridation programme depend on the size of the processing plants and the amount of salt to be processed. Estimates based on programmes implemented in the Americas indicate that the cost per person per year is approximately US $0.06[34].

3.3. Milk fluoridation

The fluoridation of milk is another example of an attempt by public health administrators to provide the benefits of fluoride without requiring the consumers to take on particular responsibilities or change their behaviour. The potential of milk as an alternative vehicle for fluoride –primarily to children - was first identified in Switzerland in 1962. Further experience was reported from programmes implemented in Scotland[42], and in Hungary[43]. Various channels have been used, including programmes distributing milk in kindergartens[44], and schools[45,46], and powdered milk and milk-cereal distributed as part of the National Complementary Feeding Programme in Chile[47]. The results of these programmes as well as other ones targeted at children have been summarized by WHO[48]. All studies have emphasized that it is important to start the programme in early childhood to ensure an optimal effect on the deciduous teeth, and to maintain the consumption of milk for at least 180 days per year. Interesting initiatives such as sending school milk home on a Friday evening for consumption over the weekend have been reported in China, where milk consumption has been maintained for more than 300 days per year[49]. To date no milk fluoridation programmes have been targeted at and evaluated in adult populations. Still today, WHO is involved in comprehensive milk fluoridation programmes in several countries such as Thailand and Bulgaria. In Bulgaria, the first community based scheme was introduced in 1988 including some 15,000 children and it reached more than 30,000 children in 2003. WHO reported recently the experience gained from milk fluoridation in Bulgaria[50]; this programme was evaluated through the application of a most advanced study design based on longitudinal surveys and time trend analysis. Fluoridated milk delivered daily in schools in Bulgaria resulted in substantially lower caries development compared with children in schools receiving milk without added fluoride.

The enrollment of children in milk fluoridation programmes increased substantially as programmes were introduced in four other countries. More recently there has been further expansion, particularly in Thailand and Chile. In Thailand about 1 million children are now covered by the national programme. In conclusion, fluoridation of milk can be recommended as a caries preventive measure in children, where the fluoride concentration in drinking water is suboptimal, caries experience in children is significant, and there is an existing school milk programme[48]. Generally, the additional cost of providing fluoridated milk, compared with non-fluoridated milk, is approximately two to three US dollars per child per year[34].

3.4. Fluoride-containing toothpaste

Toothpaste is probably the most widespread and significant vehicle used for fluoride. Introduced in the late 1960s and early 1970s, their rapid increase in market share was remarkable. The consensus

view from high income countries was that the introduction of fluoride-containing toothpastes was the single factor most responsible for the massive reduction in dental caries seen in many countries during the 1970s and 1980s[51]. Furthermore, of the various vehicles for fluoride, toothpaste has been the most rigorously evaluated. Marinho et al.[19] included 74 randomized, controlled clinical trials of good quality in their systematic review of fluoride toothpastes. WHO considers a toothpaste containing 1000-1500 ppm F to be an effective toothpaste; meanwhile, in some low and middle income countries fluoridated toothpaste may contain less fluoride such as 400-500 ppm which is ineffective for the prevention of dental caries.

Accordingly, people should be encouraged to brush their teeth daily with effective fluoride-containing toothpaste, i.e. fluoride recommended at the level of 1000-1500 ppm. It is worth noting that "topical" fluorides such as toothpaste can also have a "systemic" effect when they are inadvertently ingested by young children. Dispensing a pea-sized amount of toothpaste, encouraging parents to supervise tooth brushing by their young children, or the use of toothpastes containing less fluoride by young children are approaches to ameliorating this problem. Countries may recommend toothpastes with low concentration of fluoride, i.e. 500 ppm or less specifically for such young age groups (1-3 years of age).

An important limitation is that the population value of these toothpastes depends upon the behaviour of the individual and the family in purchasing and regularly using the products. Studies of children[52-55] and adults[4,56] have shown that use toothpaste containing fluoride are not uniform and is less likely among underprivileged population groups. In addition, ethnicity plays a significant role in oral hygiene habits[57]. The fall in the incidence of dental caries after the introduction of fluoride into toothpaste formulations, although seen in all social classes, is particularly found in the wealthy social classes; social-class inequality persists in countries with advanced or less advanced oral health systems[4].

In response to the social inequities found in many parts of the world that are known to impact oral health with consequent disproportional occurrence of dental caries, the WHO Oral Health Programme continue to promote the development and use of "affordable" fluoride-containing toothpaste[58]. "Affordable" toothpaste is one that is available at a price that allows people on a low income to purchase it. Vital elements in the cost of production are the choice and availability of raw materials. Critically, the abrasive agent and the fluoride source should be compatible over time. Precipitated calcium carbonate is the abrasive agent of choice because of its low cost and ready availability in developing countries. It is experienced companies which can manufacture effective toothpastes that are also of a low cost. However, it remains to be seen whether the marketing of such toothpastes will increase demand and use among low-income groups. In order to encourage use it might be in the interest of countries to exempt these effective fluoride toothpastes from the duties and taxation that are imposed on cosmetics[1,34,59].

4. WHO policy on the use of fluoride for the prevention of dental caries

The WHO policy on the effective use of fluoride is reflected in four World Health Assembly Resolutions: WHA22.30 (1969) and WHA28.64 (1975) on fluoridation and dental health; WHA 31.50 (1978) on fluoride for prevention of dental caries, and the most recent WHA60.17 (2007): *"Oral Health: Action Plan for Promotion and Integrated Disease Prevention"*. The 2007 Resolution urges Member States to ensure that populations benefit from appropriate use of fluoride[14] and the statement reads as follows:

(4) for those countries without access to optimal levels of fluoride, and which have not yet established systematic fluoridation programmes, to consider the development and implementation of fluoridation programmes, giving priority to equitable strategies such as the automatic administration of fluoride, for example, in drinking-water, salt or milk, and to the provision of affordable fluoride toothpaste;

Today about 450 million people benefit from fluoride[4]. The WHO Oral Health Programme continues to emphasize the importance of public health approaches to the effective use of fluorides for the prevention of dental caries and the Programme is involved with support, guidance, and practical assistance to several countries. **Table 1** summarizes the baseline data on dental caries severity at 12 years of age reported to the WHO Global Oral Health Data Bank [CAPP][3] from countries that have implemented automatic fluoridation programmes (water, salt or milk). It is recognized that fluoride-containing toothpaste may be available in these countries although, data on demand and regularity of use in all countries are not available.

4.1. WHO guidance

Where the incidence and prevalence of dental caries in the community is high to moderate, or where there are firm indications that the incidence of caries is increasing, an additional source of fluoride (water, salt or milk) should be considered. Water fluoridation using fluoride at a concentration of 0.5–1 mg/l is the method of choice if the country (or area of the country) has a moderate level of economic and technological development. A central water system, a municipal water supply reaching a large population, trained water engineers, and a favorable public opinion are essential factors[14,34,59].

WHO has issued a publication on inadequate or excess fluoride prepared within the context of preventing disease through healthy environments; this document focuses on the sources of exposure

to fluoride and health effects[60]. Dental enamel fluorosis should be monitored periodically to detect increases in or higher-than-acceptable levels of fluorosis. Action, such as adjusting intake of fluoride from water, salt, milk or other sources, should be taken when the prevalence of fluorosis is found to be excessive. It is highly recommended to calculate the community fluorosis index (CFI) using data generated from examinations of renal excretion undertaken by calibrated examiners as part of epidemiological studies to assess whether occurrence of unsightly fluorosis constitutes a public health problem warranting increasing consideration. WHO produced in 2014 a manual on the assessment of renal fluoride excretion in community prevention programmes for oral health[61]. This manual informs on practical procedures in measuring exposure to fluoride from existing fluoridation programmes. It complements the WHO "Oral Health Surveys – Basic Methods 2013"[62] which provides guidelines for obtaining epidemiological information about the population level of dental caries and the prevalence of enamel fluorosis. Salt fluoridation may be relevant to countries where the technical facilities for water fluoridation are not available. It is required that salt production and distribution can be controlled.

Salt fluoridation is an effective alternative that has the advantage of allowing consumer choice; this may be important in certain countries or cultures. An overview of some practical aspects relating to the implementation of salt fluoridation programmes has been published[39,40].

Milk fluoridation is particularly used for promoting oral health in children. WHO published a comprehensive manual[48] on milk fluoridation which highlights the rationality of milk as a vehicle for the administration of fluoride; the manual details the biological basis, the opportunities for integration with other national or community programmes on diet and nutrition, development of community and school health programmes, challenges in practical implementation, and monitoring and evaluation of programmes. The evidence on the use of milk fluoridation is outlined in this manual and further supported by country experiences. A global report has revealed that the school is a unique platform for fluoride administration, particularly when programmes are organized according to the WHO Health Promoting Schools Project[63,64].

WHO convened an Expert Committee in 1993 to provide authoritative information about the role of fluoride in the promotion of oral health throughout the world[59]. In 2016, a similar group of experts published an update of the research on fluoride and oral health and the findings are reported in a special issue of the journal *Community Dental Health*[34]. It reviews the effect of fluoride from biological, clinical and public health perspectives. The document focuses on the presence of fluoride in the environment; fluoride metabolism and excretion; fluoride in teeth and bone; biomarkers of fluoride exposure; dental caries prevention and enamel fluorosis; fluoridated drinking water, salt and milk; topical use of fluoride, and fluoride-containing toothpaste. Based on the modern conception of evidence for public health the report emphasizes the effectiveness and appropriateness of different fluoride application forms in communities and specifies the practical impact of implementation of combined administration of fluoride. In addition, this publication summarizes the experiences from the use of fluoride around the globe. Such update information is highly relevant to countries which are in process of introducing fluoride programmes or to those countries engaged in adjustment of programmes.

5. The need for further research

Continuous research is vital to advance the use of fluoride for oral health in countries. It is important to maintain and foster a programme of public health research that might seek to:

- update our information on the cost-effectiveness and cost-benefit of water, salt and milk fluoridation against a background of the now widespread use of fluoride-containing toothpastes;
- continue to develop and update our knowledge of the health effects of ingested fluoride;
- further develop affordable techniques for the removal of fluoride from the public water supply in communities where natural concentrations of fluoride are above the guideline value of 1.5 mg/l set by WHO[65];
- better understand the public perception of dental enamel fluorosis and, increment efforts to educate the community so that it is well understood that enamel fluorosis is not a disease and that mild forms are preferable to the devastating effects of dental caries; and
- evaluate the effects of the introduction of affordable fluoride-containing toothpastes on purchase and use by the public.

Research on the prevention of dental caries through the use of fluoride is urgently needed in low and middle income countries.

It is well recognized from research undertaken in high income countries that population wide automatic fluoridation measures are most effective and equitable strategies for the prevention of dental caries; however, it remains to clarify to what extent the implementation of fluoridation programmes is possible in low and middle income countries and whether similar health results may be obtained. In addition, the social inequalities in dental caries prevalence are substantial in all countries and further evidence is needed on how to break the gap between rich and poor population groups through effective use of fluoride.

Acknowledgments

The author declares no conflict of interest related to this study. There are no conflicts of interest and no financial interests to be disclosed.

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Questions

Given a global perspective, are the problems related to dental caries are largely solved now?

❑a. Dental caries continues to be a major public health problem to countries across the world and is now increasing rapidly in developing countries;
❑b. Because of dentistry, dental caries is now a limited problem to people around the globe;
❑c. Essentially, we have no effective strategies to tackle the burden of dental caries among people;
❑d. The burden of dental caries is more or less of same magnitude in Eastern Europe as in Western Europe.

Is fluoride is of great benefit to avoid dental caries?

❑a. Yes, years of research have shown high scientific evidence of fluoride for the prevention of dental caries;
❑b. Fluoride is harmful to the health of people and should be avoided;
❑c. It is helpful that we have information on the internet on the negative impact of fluoride;
❑d. People will suffer from dental caries no matter what.

What is the recommendation made by WHO in relation to fluoride?

❑a. The use of fluoride should be restricted because it is unhealthy;
❑b. The use of fluoride is a cost-effective approach for public health;
❑c. The use of fluoride-containing toothpaste is good but the fluoride concentration does not matter;
❑d. Children and pregnant women should avoid fluoride for the prevention of dental caries.

Do we have to accept social inequalities in dental caries?

❑a. In dentistry we have no effective means to reduce the health gap between poor and wealthy people;
❑b. Automatic fluoridation (water, salt or milk) is a most equitable approach which is recommendable in public health;
❑c. Social inequality is not of concern to dentistry; we should just take proper care of our patients;
❑d. If poor or low educated people just cleaned their teeth properly, they would have a dental status comparable to the standard of wealthy and highly educated people.

MOTIVATIONS FOR STUDYING DENTISTRY AND DENTAL COLLEGE PREFERENCE AMONG RAS AL KHAIMAH COLLEGE OF DENTAL SCIENCES (RAKCODS) STUDENTS

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Received: January 05, 2016
Revised: February 29, 2016
Accepted: March 15, 2016
Published: March 18, 2016

Cite this article:
Alkhabuli JOS, Khamis AH. Motivations for studying dentistry and dental college preference among Ras Al Khaimah College of Dental Sciences (RAKCODS) students. Stoma Edu J. 2016;3(3-4):141-149.

ABSTRACT

DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.2

Objectives: The objectives of this study were to find out the reasons for choosing dentistry as a future career and the factors for preferring Ras Al Khaimah College of Dental Sciences students over other dental colleagues in UAE.
Methods: A cross sectional questionnaire comprised of 19 items related to the dental career and 6 items related to RAKCODS preference factors were sent electronically to the 1st year (2014-2015) and 2nd year (2013-2014) RAKCODS students. The responses on the students' motivation were collected using three-point ordinal scales. The data were analyzed using SPSS, v16 program. T-test and Chi-Square test were used to measure the level of differences.
Results: The overall response rate was 67.0% (n=110). The mean age was 18.9 years. Females represented 63.6% and males 36.4% of the respondents. The important motives were "interest to treat people and improve their oral health" by 73.6%, "dental practice is a combination of hand skills and knowledge" by 66.4%, "dental profession provides option to be self-employed" by 61.8% and "dentistry has high-level income of practice" by 60%. Females showed significant difference to males in treatment of people and oral health care motive (p=0.022). Dentistry has high income and pays better were important factors for males more than for females (p=0.033 and p< 0.001) respectively. The curriculum comparable to international standard and the fascinating facilities were the most significant preference factors of RAKCODS.
Conclusion: The motives towards a dental career were mainly to improve peoples' oral health, have high income and to be a self-employed professional. Curriculum and facilities were the most attracting factor of RAKCODS.
Keywords: professional practice, dental, career choice, students, United Arab Emirates.

1. Background

Ras Al-Khaimah (RAK) is one of the seven emirates that comprise the United Arab Emirates (UAE) of 300.000 inhabitants[1]. The RAK College of Dental Sciences (RAKCODS) was established in 2007 as one of the four constituent professional Colleges of the RAK Medical and Health Sciences University (RAKMHSU). It was the third dental college to be established in UAE and it is fully accredited by the higher ministry of education and scientific research.
The college started with 13 students on board in a humble building and with not enough facilities in 2007. Since its inception, there has been gradual increase in the number of admitted students. In the academic year 2012-2013, the college moved into a state of the art building, and modern facilities that can accommodate up to 80 students per academic year.
Since then, there has been a sharp increase in the number of students seeking admission to RAKCODS. A total of 38 qualified dental surgeons have graduated from RAKCODS so far.
The UAE society is a diverse community living in a very peaceful environment. The varied ethnicity has echoed in the different backgrounds of the students making up the academic community, with different levels of educations, personal characters

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and motivations towards prospective professions.

Dentistry is a well-respected and reputable profession in societies all over the world. Several factors may govern or modulate the decision of pursuing this field. Traditionally, several factors have been recognized that may influence one's decision to choose dentistry as a future career including oral health promotion, assisting and working in societies, availability and ease of employment, financial security, prestige, provision of enough time off for family life, desire to work in health care and making a good income[2-6].

Interestingly, variation in social background, race, gender and country have been found to influence career selection as well[7-10]. In the United States of America for example, it has been reported that African-American students were more inclined to serve the community, while the Caucasian-American students' motivation to graduate as a dentist was related to fulfilling family commitments[11]. In a study by Khami and his colleagues[12], social status and security were ranked amongst the highest by the students. Many students consider the dental profession as prestigious. In a study involving more than 400 students prestige topped the other factors scoring 44.4% and helping other people came second: 43.6%[13].

A substantial percentage of people in many communities cannot afford dental treatment. Government clinics are usually congested and limited to emergency and basic dental services. Thus, many authors explored altruism and empathy towards the population's oral health status as motives among the students, however, many reports failed to show a great impact of these factors on the choice of a dental career, particularly among male students.

Several publications have demonstrated that gender differences are some of the driving forces of the career. Females appeared to be more motivated to promote oral health and care than males[9,14]. In a piece of research involving four dental colleges in South Africa, Lallo and his group[15], found racial differences as one of the motivations amongst the surveyed students, mainly in terms of finance, post-graduation practice, community services and financial debts.

Freire and colleagues[6], in a cross-sectional study used a self-administered questionnaire to investigate ambitions and motives to choose a dental career of all first-year students enrolled in the 1993–95 and 2006–08 periods in one of the Brazilian dental.

The report found significant differences in the freshmen's motivations and various professional perspectives overtime. The study revealed diverse personal views over the influencing factors in pursuing a dental career among students.

2. Aim of the study

The objectives of this study were to investigate the driving motives and influential factors of RAKCODS students towards choosing dentistry as their future career, and whether there were any specific reasons for preferring RAKCODS over other dental colleges in UAE.

3. Methods

The research proposal was approved by the research and ethics committee of RAKMHSU, reference number (RAKMHSU-REC-1-2015-F-D). A self-administered questionnaire with three sections (A, B and C) was constructed using previously reports published in the literature. The first section (A) covered demographic information including age, gender, nationality and high school curriculum. The second part (B) included 19 items inquiring about the potential influential factors in choosing a dental career. The third section (C) consisted of six questions probing the reasons for preferring RAKCODS as a college to pursue a dental career. Responses on students' motivation were collected using three-point ordinal scales "important, less important, not important".

A total of 164 registered students were included in the survey. They were students who had just finished their first academic year 2013-2014 and newly admitted students for the academic year 2014-2015. The questionnaire was pretested on 40 students. A correction of ambiguity was performed on all items and prepared for the online survey. The students were approached via their university email ID and a message was sent to the respective students explaining the online questionnaire, its voluntary nature, the need for honesty in answering the questions and the need for acceptance to participate in the research. A clear statement was written in the message denoting that a response to the questionnaire would be considered as their consent. The online-link to the questionnaire was emailed to the respective academic year students and activated for three weeks. Three reminder emails were sent to the students with a one week interval requesting completion of the questionnaire. The survey allows only one answer to be selected for each variable and the system only accepts the fully answered questionnaires. By the end of the third week the questionnaire link was deactivated and the data were saved as an Excel file.

Questionnaire

Dear Dental students,
Welcome to the college of dental sciences, RAKMHSU. We are conducting a survey, right the beginning of the academic year on the reasons that made you to select dentistry as your future profession.
Your name is not required but your age, gender and the curriculum that you have chosen to obtain your high school certificate are important.
Please be honest while answering the following questions.

Section A:

- Gender: M F
- Age: ……. years
- Nationality:……
- High school Curriculum:
  - British
  - American
  - Indian
  - Pakistan
  - Arabic
  - Persian
  - Australian
  - Others

Section B:

Which of the following factors made you choose Dentistry as your future career?

S. No.	Factor	Important	Less Important	Not important
1	On recommendation of a friend/ relative			
2	Because one of my parents is a dentist			
3	It's easy for dentists to find work employment			
4	Dentistry pays better than other job options available to me			
5	Dental profession provides option to be self-employed			
6	I have keen interest to treat/help people to improve their oral health			
7	Dentistry has high-level income of practice			
8	Dentistry provides short cut to health care specialty			
9	Developed interest from my family dentist			
10	A career in dentistry offers job security			
11	Dentists have a flexible work schedule			
12	Dental career provides enough time to be with family			
13	Dental practice is a combination of hand skills and knowledge			
14	There is not much "on call" work for dentists			
15	Motivation by marketing/dental professionals during high school			
16	Dentistry is a prestigious profession			
17	Worked in other dental related fields and now I want to be a dentist			
18	Dentists do not need to deal with life threatening conditions			
19	Failure to be admitted to other programs, like Medicine			

Section C:

Why did you choose RAKMHSU to pursue Dentistry?

20	Because RAK is my home (convenience)			
21	Tuition fees are less than other dental colleges			
22	I could not get admission in other dental colleges in UAE			
23	I was transferred from other dental colleges in UAE			
24	RAKCODS curriculum is comparable to international standard			
25	RAKCODS has fascinating building and very good facilities			

*RAKMHSU: Ras Alkhaimah Medical and Health Sciences University

**Please notice, answering this questionnaire is your consent to participate in the survey.*

4. Results

Before analyzing the results, the column in the data Excel file indicating the students' emails was deleted, to keep the data anonymous. As there is no loss of data or unanswered questions among all subjects, the data will be projected mainly in percentages.

Out of 164 students 110 completed the online questionnaire with a response rate of 67.0% and a mean age of 18.9 (range 16-25). 63.6% of the participants were females and 36.4% were males. With regard to the curricula they studied; 61 (55.5%) of the students completed Arabic high school curriculum and 27 (24%) completed British curriculum (Table 1). The respondents' ethnicity was uneven with the majority from Bahrain 20 (18.0%) followed by Syrian and Iraqi 16 (14.4%) and 15 (13.5%) respectively (Fig. 1).

Fig. 2 shows the respondents' reasons for choosing dentistry as a career and level of importance. Of these, "Have interest to treat people & improve their oral health" (73.6%), "Dental practice is a combination of hand skills and knowledge" (66.4%), "Dental profession provides option to be self-employed" (61.8) and "Dentistry has high-level income of practice" (60.0%) were the predominant influences. A high percentage of the respondents thought the dental profession provides a flexible work schedule and adequate time to spend with the family (52.7%) and (56.4%) respectively. Half of the respondents thought dentistry is a prestigious profession. In 30% of the respondents the dental career was chosen on a recommendation by friends or relatives. Many students (42.7%) thought pursuing dentistry would make the process of hunting a job much easier. A high percentage (47.3%) assumed that dentistry offers a short cut to the health care profession without need for further studies. A low percentage of respondents (18.2%) were admitted to dentistry as a second option after failing to obtain other programs. The motivation programs offered by the college marketing professionals during school time were important for 21.8% of the respondents. Only (4.5%) of the students were influenced by their dentist parents in choosing the dental career.

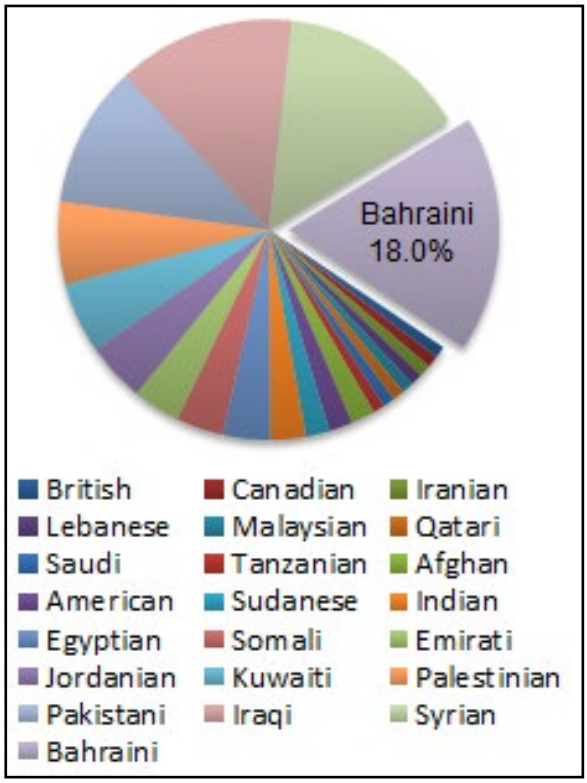

Figure 1. Nationalities of the respondents

Table 1. Showing the frequency and percentages of students and the studied curricula at high school level

Curriculum	n (%)
American	12 (10.9%)
Arabic	61 (55.5%)
British	27 (24.5%)
Canadian	2 (1.8%)
British and American	1 (0.9%)
Indian	3 (2.7%)
International Baccalaureate	1 (0.9%)
Kuwaiti	1 (0.9%)
Persian	2 (1.8%)

Table 2 shows the ranking of factors that influenced the respondents to prefer RAKCODS over other dental colleges. Almost half of the students preferred the college because of the resemblance between the curriculum and the international standard followed by the fascinating building and availability of the facilities. Relatively low tuition fees were ranked as the third reason for choosing RAKCODS. About (21%) of the respondents accepted RAKCODS, as they could not secure a seat in the other dental colleges (rank 4).

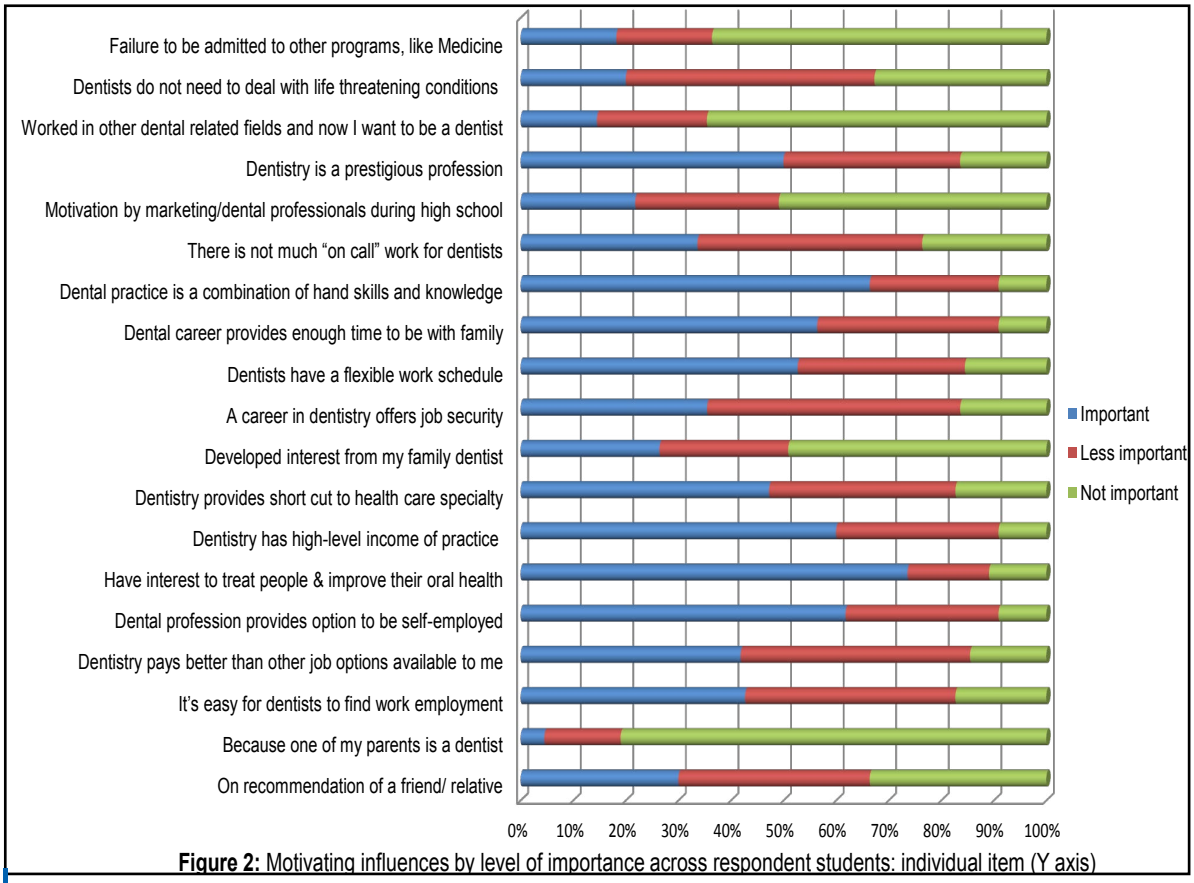

Figure 2: Motivating influences by level of importance across respondent students: individual item (Y axis)

Figure 2. Motivating influences by level of importance across respondent students: individual item (Y axis) and proportion of students selecting each item (X axis) (n =110)

Table 2. Respondents' reasons for choosing RAKCODS as institute to study dentistry

Factors	%	Rank
RAKCODS curriculum is comparable to international standard	48.2	First
RAKCODS has fascinating building and very good facilities	47.3	Second
Tuition fees are less than other dental colleges	27.3	Third
I could not get admission in other dental colleges in UAE	20.9	Fourth
Because RAK is my home (convenience)	10.0	Fifth
I was transferred from other dental colleges in UAE	3.6	Sixth

4.1. Statistical analysis

The variables in (Fig. 2) were given score 2 for important, 1 for less important and 0 for not important in a range between (0-38).

The score of dental career motivation factors was normally distributed with a mean of (20.14) and SD (6.433). This provides us with an idea about how likely our students were to consider being logic and confident in choosing the career as an important factor. From high possible expected score of 38 points, the students on average score 20 ±1.2 as confidence Interval of their score factors. With respect to confidence as an important factor, we expected the highest possible score, namely 38 points, yet the average score the students got was 20 ±1.2. This would locate the level of this chosen variable as an important factor in choosing this profession somewhere between 50%-56%. Generally, this indicates that the factor they chose was not based on logical assumption.

Gender as well was not a factor which was systematically chosen for the dental career. 70 female students had a score of (20.86) and SD (6.7), while the 40 males had a score of (21.6) and SD (6.0) and p-value (0.549).

The students were grouped into freshly registered students, namely the (16-20) year old group and late registered students, namely above (20) years of age and tested against the score of factors; the study revealed that the mean of score of the 99 fresh students was (21.3), SD (6.2), while for the elder (late) group (11 students) the score was (19.9), SD (8.5) and *p*-value 0.507.

The high school curriculum variable was recorded as Arabic-based curricula and others. Again, the study showed no difference between the score of factors to choose dentistry as a career. About 62 students selecting the Arabic curricula made an average of score (21.45), SD (6.5), while 48 students coming from other background curricula made an average of (20.6), SD (6.3) with *p*-value 0.448.

However, the variables were also directly correlated with the gender using Chi-Square Test. The test yielded three significant correlations (Table 3). Treatment and improvement of peoples' oral health was considered as an important factor by female respondents more than males (p=0.022). On the other hand, the male respondents indicated that dentistry has high income and pays better than other jobs, so these were considered as important factors by higher percentages than females (p=0.033 and p< 0.001) respectively.

Table 3. The dental career factors demonstrating significant gender differences

Variable	Gender (%)	Chi-Square Test
Have interest to treat people & improve their oral health	Female (81.4) Male (60.0)	p=0.022
Dentistry has high-level income of practice	Female (51.4) Male (75.0)	p=0.033
Dentistry pays better than other job options available to me	Female (28.6) Male (65.0)	p< 0.001

5. Discussion

Online questionnaires have many advantages, such as ease of distribution, lack of human errors in entering data, control of the research timing and instant generation of results. However, they have a reasonably low response rate. The current study reveals a response rate of 67%, which is relatively superior to many published articles, which used paper based questionnaires[5,16]. The response percentage was calculated out of the total number of officially registered students holding a University ID number. Nevertheless, according to the college attendance register, a small percentage of the first year students (<6%) had never attended any classes, at least up to the time of deactivation of the online questionnaire link and this would reduce the response rate to some extent. It is worth mentioning that in this study there were no missing data, double answered questions or incomplete responses. In fact responses with those discrepancies were rejected by the system and not included in the total number of respondents.

It is probably a misleading approach to include all academic years of a program in a survey probing motivations for the choice of a dental career. This would probably provide deceptive outcomes. A factor that would make a student enroll in dentistry today might change over subsequent academic years. It is not unusual for a candidate to develop a different attitude towards the profession in his/her later years of study. This is quite evident in a previous study that included all students from year one to year five[13].

The current study included two academic years: year one (fresh students) and year two (just finished year one). The two classes form 50% of the total number of RAKCODS students. In the present study the number of female (63.6%) students exceeded the males (36.4%). This trend has been noticed in many countries including Brazil[6], United States[9] and Denmark[10], and stirred debate about feminization of dentistry[18]. The top three main motivations of the participants towards enrolling in the dental career were "treatment of people and improvement of their oral health (73.6%)", "dental practice is a combination of hand skills and knowledge (66.4%)" and "dental profession provides option to be self-employed (61.8%)". Interestingly, the females demonstrated higher motivation towards community services compared to the males. Helping people and improving of oral health (Altruistic motives) variable were rated as the most important factor by the female students and revealed a statistically significant difference (p=0.022). This finding is in agreement with several previous reports[9,10,18]. Dentistry is a profession which inspires knowledge and hand skills; therefore, it is of no surprise to see considerable participants opting for dentistry as their future career. On the contrary, Brand and others[7] explored the motives of the first year dental students in the University of Sydney, but noticed that skills, science and knowledge were the least important motives among the surveyed

students. The authors stated that there were many inconsistencies in their findings reflecting subjective rather than objective criteria selection by the students.

The dental profession stands as a specialized field and enables fresh graduates to establish their own dental practice, thus the high valued concept of self-employment. In addition to the current study, many others[18-21] found similar motive strength among the respondents.

A dental career is very attractive occupation and well-known for its high revenues. A substantial number of male students expressed their motives to study dentistry for financial gain and revealed a statistically significant difference when compared to female students (p=0.033). This finding is in agreement with a similar regional study[13]. Furthermore, dental practice is not the only well-paid profession. However, in contrast to female respondents, more than half of the male students who preferred dentistry as their future career believed that the dental profession would pay far better than any other potential jobs (p< 0.001). In the Middle East culture, males are responsible for most of family expenditures whereas females are invariably dependent and this probably reflects the low financial concerns expressed by females as a priority for job preference. It appears that, when it comes to career decision males are likely to be motivated by working conditions and financial gain while females by altruistic and human factors, a view that is shared by other reports as well[13,22].

A private dental practice has the merit of time flexibility. This would make practitioners able to adjust their working schedule and find sufficient time to be with their families. Du Toit et al.[3], reported that "leaving time for family life" was the first and strongest motivation for the surveyed students in the United States, Taiwan, Singapore, South Africa and Australia. In our study, more than half of the respondents, particularly the females considered this factor as crucial in taking a dental career decision.

Another factor that might have influenced the students in their career choice was prestige. Dentists provide an essential oral health care service. Furthermore, the patients' oral welfare and much of their total well-being is in the dentists' hands; thus the profession occupies a highly respected position within the community. Over 50% of the respondents rated prestige as an important factor for their career choice. This is in accordance with several previous reports[2,3,23]. Nevertheless, others found that prestige was the least important motive[24,25]. This probably reflects the range of social differences. In many countries including USA and UK the title "Doctor" is reserved for medical professionals or for those holding a PhD degree, while in the Middle East, the title is also used for dentists and this probably inspires motivation towards a dental career.

In UAE there are four accredited dental colleges providing undergraduate programs, each has its own curriculum, admission criteria and fees structure. This diversity may induce preferences among applicants for dental colleges. Therefore, the second part of the survey sought answers to questions related to RAKCODS (Table 2).

Probably this is the first study in the region to include another element of motivation in a survey querying for dental career, the "INSTITUTE". In 2011, the RAKCODS curriculum was completely revamped. Several new courses were added, clinical training credit hours were increased and the final year ends up with the submission of mandatory research project. Moreover, in Sep 2012 the college launched a new building complex with state of the art facilities. The survey revealed that 48% of the respondents chose RAKCODS because of the curriculum structure that meets their own country requirement and matches international standards. Many of the RAKCODS students are expats and approval of the curriculum by the authorities of their countries is essential for the recognition of the BDS degree. A similar percentage of students (47%) were attracted by the fascinating building and associated facilities. The new students invariably visit the RAKCODS site and take a tour with their families before officially enrolling in the program to ensure satisfaction.

The other issue that might influence the students' admission or choice of a discipline is tuition. RAKCODS tuition remains the most reasonable compared to other dental colleges in UAE. About 27% of the respondents might have considered RAKCODS for a dental career because of tuition. It appears that about 20 % of the surveyed students failed to get admission in other dental colleges, so that was the reason they chose RAKCODS. One fact remains unresolved in UAE with regard to admission to Universities. Students studying the British curriculum usually get their IGSC grades in mid-August and by mid-July all dental colleges would have filled their allocated seats, leaving those IGSC students with no chances for admission until the next academic year.

6. Conclusion

The present study describes the diverse demographic background of the RAKCODS students. The motivations seemed to be associated with the socioeconomic aspects of dentistry. The main motives were the interest to treat and improve people's oral health, dentistry is a knowledge and skill-based profession, dentistry generates a potential high income and dentistry provides self-employment, and it is a career that provides adequate time to be with one's families. There were statistically significant differences in motivation between males and females with financial factors more influential for males, and altruistic factors for females. With regard to the factors that may have influenced the choice of RAKCODS as the "INSTITUTE" for a dental career, the curriculum and fascinating facilities were the most attracting factors.

Acknowledgments

The authors declares no conflict of interest related to this study. There are no conflicts of interest and no financial interests to be disclosed.

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Questions

Mainly, the female students are highly motivated to study dentistry to:

❑a. Improve their income;
❑b. Be a self-employed practitioner;
❑c. Treat and improve peoples' oral health;
❑d. Have a flexible working schedule.

The majority of students have chosen RAKCODS to study dentistry because:

❑a. The curriculum matches the international standard;
❑b. Tuition fees are affordable;
❑c. Could not get admission to another dental colleges;
❑d. Easy to commute to the college.

Which of the following is second most preferred high school curriculum by RAKCODS students?

❑a. The Australian curriculum;
❑b. The American curriculum;
❑c. The Persian curriculum;
❑d. The British curriculum.

In contrast to female students, what is the main male students' motivation to study dentistry?

❑a. "There is not much on call work" for dentists;
❑b. A dental job pays better than other jobs;
❑c. Their parents are dentists;
❑d. It is easy to get a job.

HALITOSIS WITH FIXED ORTHODONTIC APPLIANCE VS REMOVABLE ORTHODONTIC ALIGNERS: A PILOT STUDY

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Received: March 22, 2016
Revised: April 20, 2016
Accepted: May 04, 2016
Published: May 06, 2016

Cite this article:
Levrini L, Posimo D, Tieghi G, Gualandi G, Caprioglio A. Halitosis with fixed orthodontic appliance vs removable orthodontic aligners: a pilot study. Stoma Edu J. 2016; 3(3-4):150-155.

ABSTRACT **DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.3**

Introduction: Halitosis is a widespread condition and is a big handicap for the patients. Most adults suffer from bad breath, an estimated 10-30 percent of the USA population, and this may lead to personal discomfort and social disagreement. Furthermore, some authors estimate that approximately 50% of the middle-aged and older individuals emit socially unacceptable breath, especially in the morning, which can be attributed to physiological causes.
Methodology: For the purposes of this study 10 patients with aligners (aligners grup - AG) and 10 patients with fixed orthodontic appliance (fixed group - FG) were selected. This experiment aims to detect the presence of halitosis with a gaschromatograph (OralChroma™). The machine analyzes the air sample and provides results in 8 minutes by creating a graphic that shows the amount of 3 volatile sulfur compounds.
Results: The values measured by the gascromatograph show a significant difference between the two groups. We also considered the average values of both groups. The averages confirm the difference between AG and FG group (FG average > AG average) in all three values.
Conclusion: This study is only a pilot study and should be expanded in order to produce more consistent results, but we can already assert that the possibility to remove the oral device certainly provides a better outcome for oral hygiene procedures and, consequently, improves the halitosis condition. In conclusion we can consider oral hygiene and halitosis as important factors in order to decide what kind of orthodontic device is better suited for the single patient.
Keywords: halitosis, orthodontic appliance, clear aligners, volatile sulfur compounds (VSC), gaschromatograph.

1. Introduction

Halitosis is a widespread condition and is a big handicap for the patients. Most adults suffer from bad breath, an estimated 10-30 percent of the USA population, and this may lead to personal discomfort and social disagreement[1]. Furthermore, some authors estimate that approximately 50% of the middle-aged and older individuals emit socially unacceptable breath, especially in the morning; this can be attributed to physiological causes[2]. Halitosis, which means foul breath, might be related to physiologic and/or pathologic reasons[3] such as ear nose-throat diseases (chronic sinusitis, tonsillitis), gastrointestinal system diseases, diabetes mellitus, and acute rheumatic fever. Also, more frequently, halitosis can be related to intraoral factors, including especially gram-negative anaerobic microorganisms on the dental plaque, in the periodontal pockets, in the saliva, and on the dorsum of the tongue[4]. Besides these causes we should consider orthodontic treatment too. With the presence of fixed orthodontic appliances, efficiency when performing dental hygiene procedures decreased

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in a stastically significant way (p=0,003), which led to a statistically significant increase of the plaque and tongue coating indexes, and confirmed the suspected positive correlation between halitosis and fixed orthodontic appliances[5]. The brackets and ligatures have a negative effect on natural cleaning by creating retention areas for plaque, making the mechanical cleaning of the teeth and gingiva by the tongue and lips more difficult, and increasing the viscosity of the saliva[6-8]. It has been stated that the accumulation of plaque and the increase in bacterial count[9] and tongue coating[10] are clearly also involved in the formation of halitosis. There are also plenty of studies about the effect of orthodontic treatment on the periodontium[11,12]. Determining the bracket system that causes the less destructive biologic effect has gained importance today. In this perspective, studies have been conducted on self-ligating brackets (SLB), with conflicting opinions. The absence of ligatures should provide fewer retentive sites than other bracket ligation types[13] but, on the other hand, this theoretical advantage may be eliminated in reality because SLB consist in opening and closing mechanisms that may provide additional plaque retention sites[14,15]. Instead, with aligner devices, oral hygiene habits were very good[16]. The use of removable orthodontic appliances, particularly invisible aligners, allows adequate oral hygiene and can reduce the risk of dental and periodontal complications such as white spot lesions, caries and periodontitis[17]. About the correlation between halitosis and orthodontic aligner treatment, it has been shown that this kind of treatment (Invisalign®) is characterized by only minimal impairment of overall oral health and the associated quality of life. Neither halitosis, nor oral dryness, nor high plaque or gingival index measurements were observed[4]. This is a very interesting study but it does not compare orthodontic aligners and fixed orthodontic appliances, as predisposing conditions to halitosis. The aim of the present study is to evaluate the presence of volatile sulfur compounds (VSCs) in patients with orthodontic aligner compared to patients with orthodontic fixed appliance. The VSC consisting of hydrogen sulfide, dimethyl sulfide, and especially methyl mercaptan released through the proteolytic degradation of saliva, exfoliated epithelium, food debris, gingival crevicolar fluid, plaque, postnasal drip, sulfur-containing amino acids, and peptides in the blood by the anaerobic microorganisms found in the oral cavity are effective on the formation of halitosis[18]. The null hypothesis is that there are no differences in oral volatile sulfur compounds (VSC) emissions between patients with fixed orthodontic appliances and orthodontic aligners.

2. Materials and Methods

2.1. Study Sample

Fixed Orthodontic and Invisalign® patients were selected consecutively with the following characteristics: age between 18 and 39 years old, good general health, non-smokers, absence of systemic diseases, absence of gastro esophageal reflux, no eating disorders (DAC) and not pregnant. The fixed orthodontic treatment we intended was a superior and inferior multi-brackets system at least from first molar to first molar, instead, the Invisalign treatment consisted of superior and inferior aligner devices. Both treatments have to be started since, at least, three months subjects were involved in the study. We considered the following characteristics as exclusion criteria: individuals with systemic diseases, medical treatments, cuts, sores, lesions of the mucosa and wounds, bearers of crowns, veneers or bridges on the upper incisors and active carious lesions. We also left out individuals who declared to not brush their teeth at least three times a day, to not use dental floss and/or dental picks and, in Invisalign® cases, to not clean aligners with their personal toothbrush and toothpaste (with RDA less than 100) at least two times a week and to not put them in immersion solution of sodium sulfate carbonate at least once a week[19,20]. Among these patients10 patients with aligners (aligners group – AG) and - 10 patients with fixed orthodontic appliance (fixed group – FG) were selected. The study was carried out in accordance with the principles of the Declaration of Helsinki and in compliance with Good Clinical Practice. The study protocol was reviewed and approved by the University of Insubria Research Centre Cranio Facial Disease and Medicine Institutional Ethical Committee. Before taking part in the study each patient was required to sign an informed consent form to which a detailed description of the study protocol was attached. These individuals were asked to come for the orthodontic control, at least an hour after performing the oral hygiene procedures, and for VSC measurements.

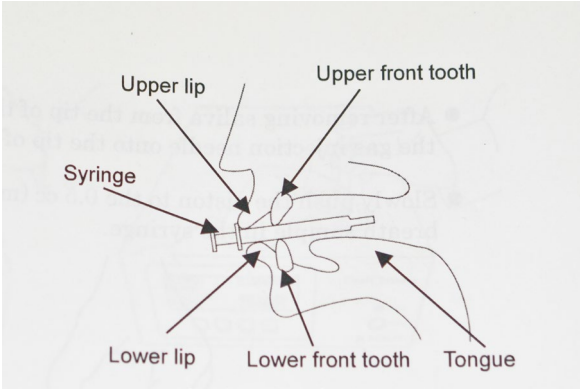
2.2. Methodology

This experiment aims to detect the presence of halitosis with a gaschromatograph OralChroma™ (Fig. 1).

Figure 1. Gaschromatograph OralChroma™

The patient must keep a sterile disposable 1 ml syringe in the oral cavity for 60 seconds, with his mouth closed and without contaminating it with saliva (Fig. 2 a-c). After 60 seconds, the patient must open and close the syringe plunger 2 times,

without letting saliva inside (Fig. 3). After this operation, the clinician takes the syringe with the plunger open, empties it up to 0.5 ml, mounts the needle (supplied with the OralChroma™) and quickly inserts it into the machine's slot and pushes the piston of the syringe to put the air into the machine that starts analyzing the sample of breath. The volatile sulfur compounds that are analyzed to identify the presence or absence of halitosis are: hydrogen sulphide H2S, methyl mercaptan CH3SH and dimethylsulfide (CH3)2S (Fig. 4).



2a.

2c.

2b.

Figure 2 a-c. The patient must keep a sterile disposable 1 ml syringe in the oral cavity for 60 seconds

The machine analyzes the air sample and provides results in 8 minutes by creating a graphic that shows the amount of 3 volatile sulfur compounds. The results are reported in ppb or ng / 10ml. The unit chosen to present the results of this study is the ppb. To make a diagnosis of halitosis it is sufficient to have one of the three volatile sulfur compounds at a level higher than the threshold, that is different for each of the three gases. In particular: 112 ppb/10 ml H2S Hydrogen sulfide, 26 ppb/10 ml CH3SH methyl mercaptan and 8 ppb (CH3) 2S dimethylsulfide.

2.3. Data Evaluation

The data obtained were collected in Excel sheets and analyzed by an analysis software. A statistical test for independent samples, Mann-Whitney test, and a statistical significance test used in the analysis of contingency tables, Fisher's exact test, was used to compare the two groups, a value difference of $p < 0.05$ was considered statistically significant. The graphic system choosen to show the data is a box plot.

Figure 3. After 60 seconds, the patient must open and close the syringe plunger 2 times, without letting saliva inside

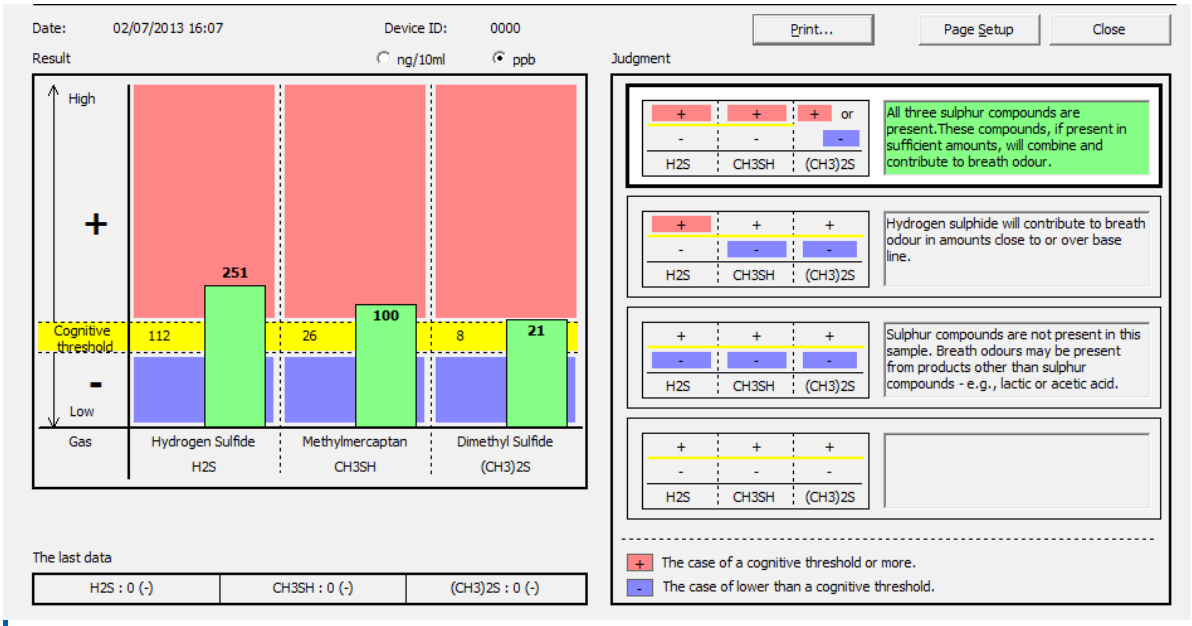


Figure 4. Example of chart showing the levels of the three VSC

3. Results

The values measured by the gascromatograph show a significant difference between the two groups. The minimum value for each gas in both groups is 0, while the maximum values are:

- AG group: 76 (H2S), 17 (CH3SH) and 3 ((CH3)2S). They are all under the threshold.
- FG group: 491 (H2S), 45 (CH3SH) and 44 ((CH3)2S). In this case all the values are over the threshold. We also considered the mean of both groups. Means confirm the difference between AG and FG group (FG mean > AG mean) in all three values (Tab. 1). The standard deviation study shows that AG values are nearer to average than FG values (Tab. 2).

Table 1. Mean for each gas

AG			FG		
H_2S	CH_3SH	$(CH_3)_2S$	H_2S	CH_3SH	$(CH_3)_2S$
11,2	1,7	0,3	123,7	7	7,7

Table 2. Standard deviation for each gas

AG			FG		
H_2S	CH_3SH	$(CH_3)_2S$	H_2S	CH_3SH	$(CH_3)_2S$
24,0	5,4	0,9	179,2	14,5	14,2

4. Discussion

This study evaluates the presence of volatile sulfur compounds (VSCs) in patients with orthodontic aligners compared to patients with orthodontic fixed appliances. In the aligner group, the three gases evaluated by OralChroma were below the threshold in the 10 patients participating in this study. Instead, in the fixed orthodontics appliance group, there were considerable differences between the patients. Five subjects in this group were over the threshold for at least one gas value and this is sufficient to consider these individuals as halitosis carriers, but two of this group were over the threshold for two gas values. The other five subjects, instead, were under the threshold for all of the three gas values measured in this study. The literature is poor on studies that compare the presence of halitosis between two types of orthodontic appliances, but they treat separately the halitosis problem and the two appliances considered in this study. The Rosenberg's study[2] shows that approximately 50% of the middle-aged and older individuals emit socially unacceptable breath. Zurfluh et al., instead, studied halitosis in the presence of fixed orthodontic appliances and in this case the percentage increases. One of the causes must be sought in the decrease of dental hygiene performance that leads to an increase of the plaque and tongue coating indexes. Lara-Carillo et al. demonstrated that brackets and ligatures have a negative effect on natural cleaning because they create retention areas for plaque and increase the viscosity of the saliva. For the same reason they make the mechanical cleaning of the teeth and the gingiva, performed by tongue and lips, also more difficult. Furthermore, for Pellegrini et al. an increase of plaque index causes an increase in the bacterial count, which clearly is involved in the formation of halitosis[9]. Starting from these considerations, many studies have been conducted by several authors[6,7,13] about self-ligating brackets (SLB), because the absence of ligatures was supposed to provide fewer retention areas than in other bracket ligation types, but the opening/closing mechanisms may provide, on the contrary, additional plaque retention

areas[11,14]. Alternatively, Schaefer et al. showed that removable orthodontic appliances, particularly invisible aligners, allow a more adequate oral hygiene[16]. About the correlation between halitosis and orthodontic aligners treatment it is shown that this kind of treatment did not lead to an increase of plaque and bacterial count, thus neither halitosis, nor oral dryness, nor high plaque or gingival index measurements were observed.

5. Conclusion

The study shows similar results in both groups, but the aligners group shows better results because none of the subjects have high level of volatile sulfur compounds or, better yet, they are all below the threshold for the three values considered. In the second group, instead, there are some differences among the patients because of their different level of oral hygiene, which can cause important changes in the VSC analysis. The presence of brackets, ligatures and archwires is a big increasing factor for halitosis. Indeed, they cannot be removed by the subject during oral hygiene procedures therefore plaque retention is surely higher than in the aligners group, where the appliance can be removed and oral hygiene can be performed as any subject without orthodontic appliances would do[17]. This study is only a pilot study and should be expanded in order to produce more consistent results, but we can already assert that the possibility to remove the oral device certainly provides a better outcome for oral hygiene procedures and, consequently, improves the halitosis condition. In conclusion we can consider oral hygiene and halitosis as important factors in order to decide what kind of orthodontic device is better suited for the single patient.

Acknowledgments

The authors declares no conflict of interest related to this study. There are no conflicts of interest and no financial interests to be disclosed.

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Questions

Which are the VSC?

❑a. VSC (volatile sulfur compounds) are hydrogen sulphide H2S, methyl mercaptan CH3SH and dimethylsulfide (CH3)2S;
❑b. VSC are sulfur dioxide SO2, methyl mercaptan CH3SH and dimethylsulfide (CH3)2S;
❑c. VSC are hydrogen sulphide H2S, dimethyl mercaptan (CH3)2SH and dimethylsulfide (CH3)2S;
❑d. VSC are hydrogen sulphide H2S, methyl mercaptan CH3SH and methylsulfide CH3S.

Which kind of instrument was used to measure the VSC?

❑a. A gascromatograph was used to measure the VSC;
❑b. A halimeter was used to measure the VSC;
❑c. A spectrophotometer was used to measure the VSC;
❑d. Salivar strips were used to measure the VSC.

Are VSC levels higher in the orthodontic fixed group (FG) or in the aligner group (AG)?

❑a. The FG shows higher level of VSC;
❑b. The AG shows higher level of VSC;
❑c. FG and AG show the same VSC level;
❑d. The FG shows lower level of VSC.

How can the measurement of halitosis be useful in orthodontic treatment?

❑a. The measurement of halitosis cannot be used for making an appropriate orthodontic treatment choice;
❑b. Halitosis is an important factor in order to decide what kind of orthodontic device is better suited for a single patient;
❑c. The measurement of halitosis is useful to improve the oral hygiene of the patient;
❑d. Halitosis does not appear during orthodontic treatment.

THE USE OF 3D VIRTUAL PLANNING AND 3D PRINTING FOR THE TREATMENT OF FACIAL ASYMMETRY: A CASE REPORT

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Received: September 07, 2016
Revised: September 22, 2016
Accepted: October 15, 2016
Published: October 18, 2016

Cite this article:
Shaheen E, Politis C. The use of 3D virtual planning and 3D printing for the treatment of facial asymmetry: a case report. Stoma Edu J. 2016;3(3-4):156-161.

ABSTRACT **DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.4**

Introduction: Facial asymmetry is a three-dimensional problem and is common in humans. Depending on the severity of the condition and the cause, several treatment modalities are proposed. In this study, we report on our workflow treating facial mandibular asymmetries without malocclusion.
Methodology: CT scans were used for preoperative planning and postoperative evaluation. 3D planning using the mirroring technique was presented and afterwards a simulated extension was 3D printed and used during the surgery for accurate harvesting and placement of the bone graft.
Results: The surgical actual outcome when compared to the simulation revealed good approximation with a mean of 0.29 (± 1.73) mm.
Conclusion: The proposed method can be considered promising for the treatment of facial mandibular asymmetry without affecting the occlusion. However, a larger scale prospective study should be conducted to confirm these findings.
Keywords: facial asymmetry, 3D virtual planning, 3D printing.

1. Introduction

People with facial asymmetry are commonly seen in the general population. The developmental type of facial asymmetry is idiopathic and non-syndromic in nature[1]. Facial asymmetry may cause esthetic, malocclusion or other problems to the patients.

Different treatment modalities of facial asymmetry have been proposed including orthodontic appliances for mild asymmetry in children[2]. For more severe asymmetries, involving dental, skeletal and soft tissue components, a combination of orthodontic and orthognathic management are recommended. Orthognathic surgery can be accompanied by mandibular angle reduction, genioplasty, bony augmentation, etc[1].

The aim of this study was to present the use of 3D virtual planning and printing as surgical assistance to the treatment of facial mandibular asymmetry with autogenous appositional bone graft.

2. Materials and Methods

A patient was presented with complaints of facial asymmetry to the department of Oral and maxillofacial surgery, University hospitals of Leuven, Belgium. The patient had no complaints regarding functional occlusion, only esthetic. After clinical and radiographic examination, the patient was diagnosed with neutral occlusion within normal skeletal and dental midlines, good transverse ratio, end-to-end in the front with a chin deviation to the left.

The procedure recommended for this patient was treatment of mandibular asymmetry with autogenous bone graft. Indication for this patient was purely esthetic.

Ethical approval was obtained from the Ethical Review Board of the University Hospitals Leuven (S57587).

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2.1. Preoperative planning

Preoperative imaging was performed with a 128-slice spiral multi-slice computer tomography (MSCT) scanner (Siemens Somatom Definition Flash, Germany: 120 kV, 161 mAS, slice thickness 0.75 mm). The Digital Imaging and Communications in Medicine (DICOM) images of the patient were imported into the Simplant O&O software (Materialise Dental, Leuven, Belgium) and the mandible, maxilla, skull and soft tissue were segmented via thresholding (Fig. 1a).

A mirroring procedure of the mandible was implemented around the midsagittal plane as defined by Gateno et al. (3)(Fig. 1b). The left side was mirrored to the right and the right was mirrored to the left (Fig. 1c and 1d). As shown in figure 1, the mirroring from left to right wasn't feasible since the mandibular alveolar nerve would be exposed, therefore, only the mirroring of the right to the left was considered. This option concerns an augmentation procedure (Fig. 1c). Afterwards the original mandible was subtracted from the mirrored mandible at the left side (Fig. 1e) and exported as STereoLithography (STL) file then 3D printed in polymer material using Objet Connex 350 (Stratasys, Eden Prairie, Minnesota, USA) with slice thickness of 0.03 mm.

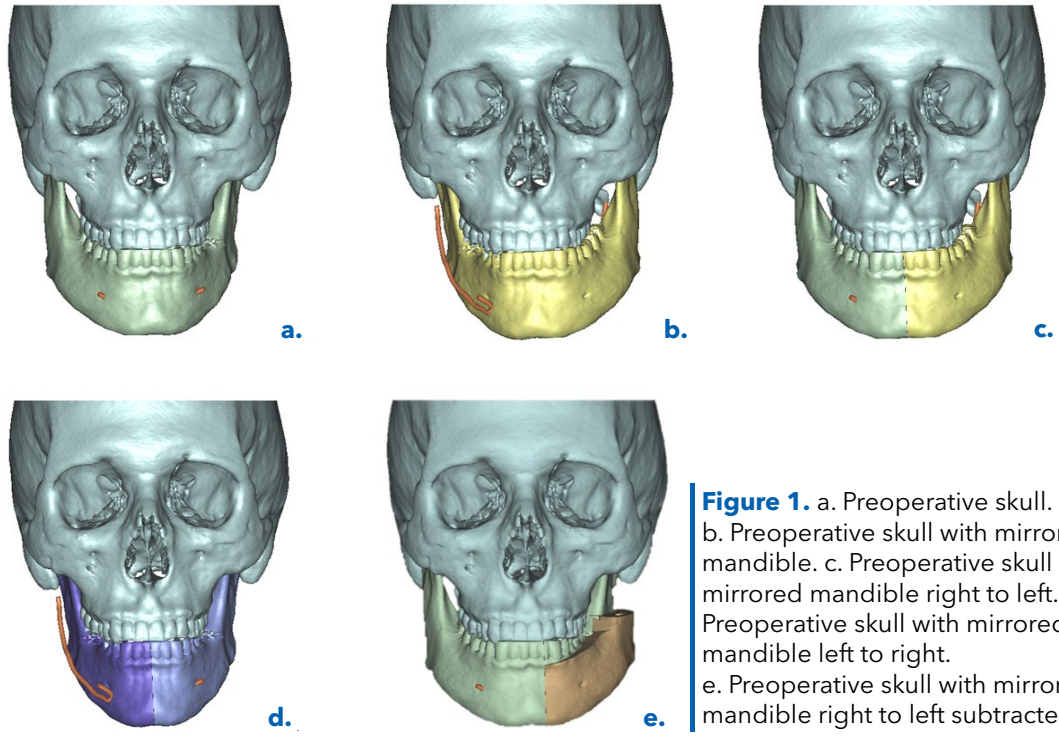

Figure 1. a. Preoperative skull. b. Preoperative skull with mirrored mandible. c. Preoperative skull with mirrored mandible right to left. d. Preoperative skull with mirrored mandible left to right. e. Preoperative skull with mirrored mandible right to left subtracted

This subtracted object served as a surgical guide for the bone graft size and shape during the operation (Fig. 2). This object was sterilized prior to the operation.

The results of the mirroring and the expected soft tissue simulation were shown to the patient prior to the operation (Fig. 7 a, b). The patient accepted these simulations and the fact that the postoperative results may differ from the simulations.

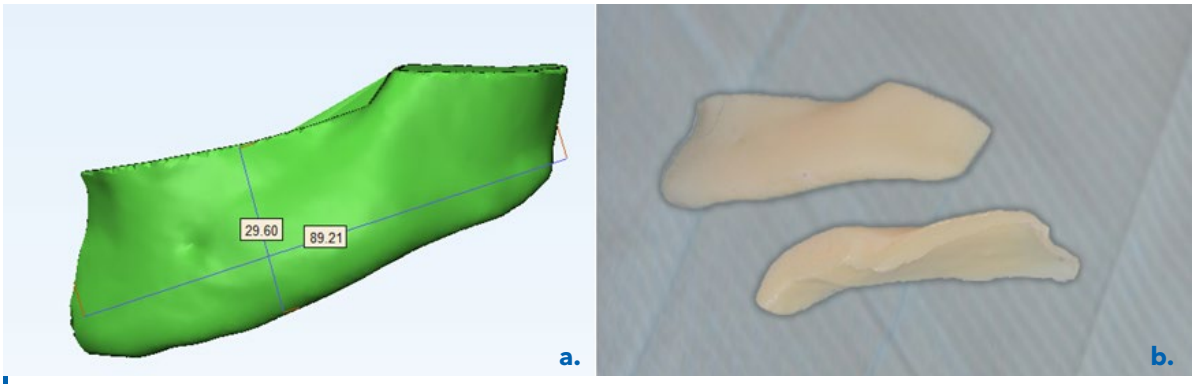

Figure 2. a. The surgical guide in STL format (dimensions: 29.6mm x 89.2mm). b. The same object in the operation room after 3D printing and sterilization

2.2. Operation

The 3D printed surgical template was used during the bone harvesting of the anterior iliac crest where a rectangular piece of bone larger than the template was harvested, using the template to define the bone cuts. Thereafter the single-piece bone graft was manually trimmed using the template as target model, which was afterwards grafted on the body of the left side of the mandible. The surgeon built up the mandible with the bone and fixated the different pieces with 6 mini screws (KLS Martin, Germany) of lengths 7 and 9 mm.

2.3. Postoperative evaluation

Postoperative CT was taken one month after the operation with the same settings as for the preoperative scan. The data was evaluated in the Amira software (FEI, USA). The preoperative and postoperative DICOM images were imported and the postoperative images were superimposed on the preoperative images via voxel based registration with mutual information[4–6] (Fig. 3).

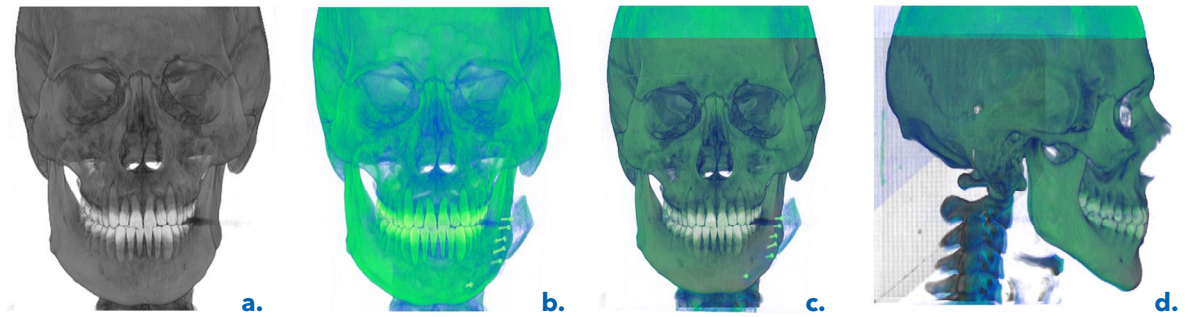

Figure 3. a. Preoperative skull (gray). b. Postoperative skull (green). c. Postoperative skull registered onto the preoperative skull frontal view, and d. lateral view

The preoperative extension was imported into the Amira project to visualize the changes between the simulated extension and the postoperative outcome (Fig. 4).

The postoperative bone was segmented and the extension was separately segmented then exported as STL files for further analysis.

A part comparison analysis between the postoperative extension and the simulated extension was done in the 3-matic software (Materialise, Leuven, Belgium) where the Euclidean distances between the surfaces were calculated (Fig. 5).

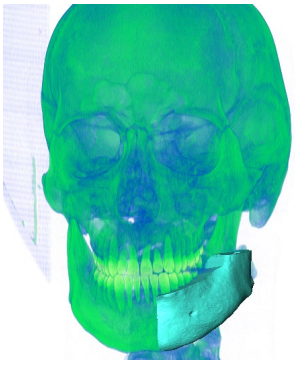

Figure 4. The simulated preoperative extension overlaid on the postoperative outcome after registration

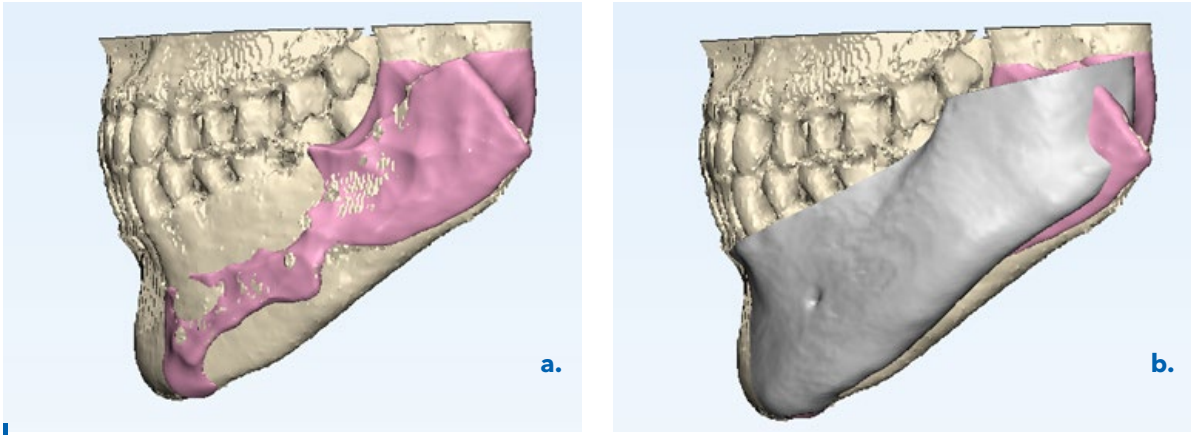

Figure 5. a. The postoperative mandible with the postoperative segmented extension. b. The postoperative mandible and extension with the preoperative simulated extension

3. Results

The visual evaluation of the simulated and actual extensions revealed a good approximate in terms of shape and position. For the quantitative analysis, at the bone level via the part comparison, revealed a mean of 0.29 mm and standard deviation of 1.73 mm. Fig. 6 shows the results of the part comparison with the simulated extension overlaid on the postoperative extension and the color coded map ranging in mm. Extreme differences (5 mm) were found at the region of mandibular angle while differences at the mandibular body region ranged between 0 and 3 mm.

Fig. 8 shows the extra-oral clinical images taken for this patient preoperatively (left) and 6 months postoperatively (right).

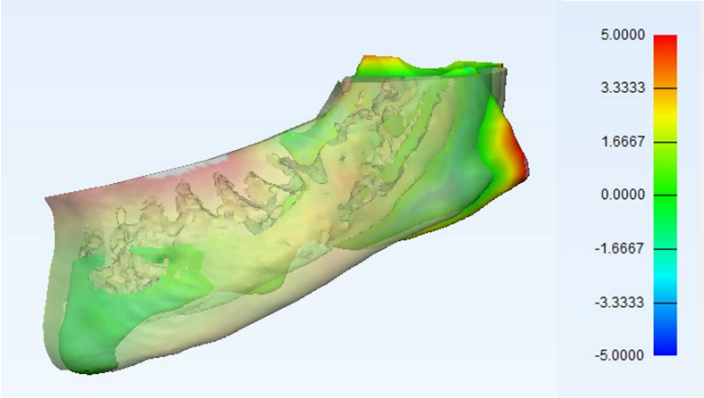

Figure 6. Color coded map for the part comparison analysis between the simulated and actual extensions

4. Discussion

In this study we presented a case with facial mandibular asymmetry. As the patient's complaints and diagnosis were only esthetic with no functional problems, the recommended treatment was autogenous apposition bone graft. Even though other non-resorbable graft materials could equally be used by the same method, the patient opted for an autogenous graft material. The use of 3D planning and printing was investigated where the mirroring technique around the midsagittal plane was applied to simulate the symmetry of the mandible both sides. A 3D printed extension was used during the surgery as a guide for harvesting and grafting for accurate positioning.

For the quantitative postoperative evaluation for the bone in relation to the simulation revealed mean error of 0.29 mm (±1.73 mm). Maximum differences were found at the mandibular angle part. This can be due to the difficulty of reshaping the bone in this region.

Since it is recommended to evaluate the soft tissue minimum 6 months postoperatively (7), quantitative evaluation one month postoperatively was not possible, but visually it was in line with the preoperative prediction (Fig. 7).

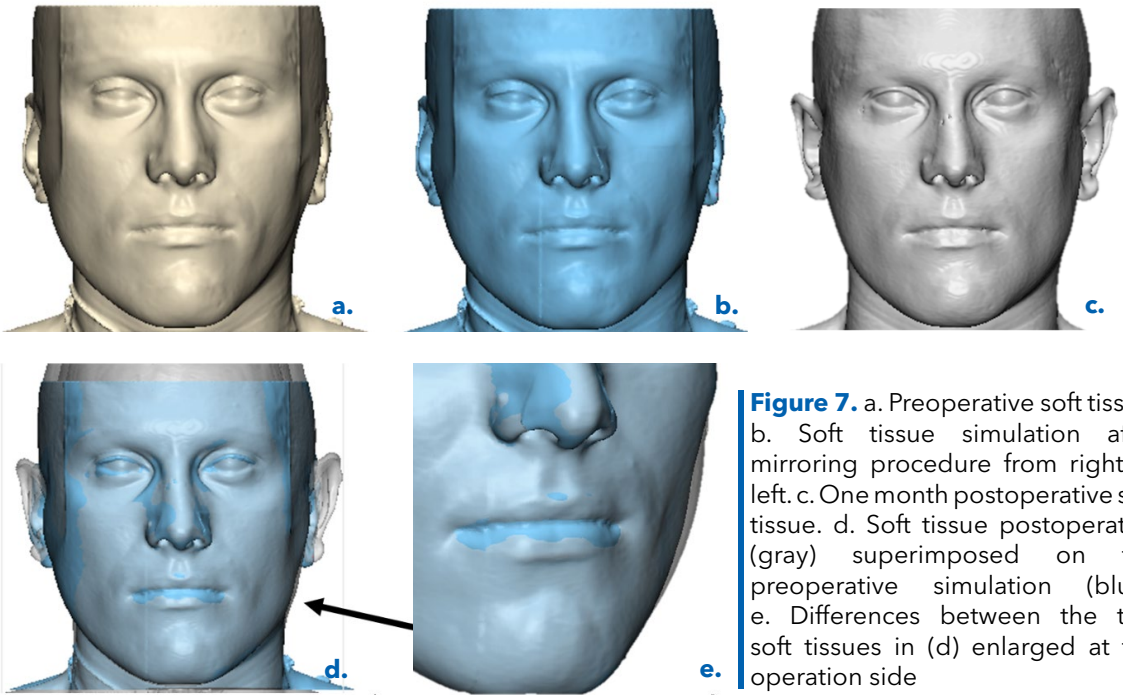

Figure 7. a. Preoperative soft tissue. b. Soft tissue simulation after mirroring procedure from right to left. c. One month postoperative soft tissue. d. Soft tissue postoperative (gray) superimposed on the preoperative simulation (blue). e. Differences between the two soft tissues in (d) enlarged at the operation side

This limitation can be solved in future studies by taking regularly 3D photographs and thus no extra radiation dose to the patient[8]. However, after clinical evaluation of the patient 6 months postoperative, the surgical outcome was clinically accepted and the patient was satisfied with the results (Fig. 8).

Figure 5. The extra oral non-smiling clinical images of the patient preoperatively (left) and 6 months postoperatively (right)

5. Conclusions

Based on the findings presented in this case, the treatment of mandibular asymmetry using autogenous appositional bone graft can be recommended. The use of 3D planning based on the mirroring technique and the 3D printing of the extension was proven to be valuable for more accurate harvesting and grafting during the surgery as shown in the results. However, a larger scale prospective study should be conducted to support these outcomes.

Authors Contributions

ES and CP contributed equally to the concept and protocol. ES contributed to the data gathering and analysis. ES and CP contributed to the interpretation and critical manuscript writing and revision.

Acknowledgments

The authors declares no conflict of interest related to this study. There are no conflicts of interest and no financial interests to be disclosed.

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Questions

Which software was used for the mirroring technique?

❑a. Amira;
❑b. Simplant O&O;
❑c. 3-matic;
❑d. Proplan.

Which type of registration was used to superimpose the postoperative images to the preoperative images?

❑a. Point based registration;
❑b. Surface based registration;
❑c. Voxel based registration;
❑d. Surface best fit.

What type of analysis was used to compare the simulated and postoperative extension?

❑a. Part comparison surface based;
❑b. Part comparison volumetric based;
❑c. Point to point comparison;
❑d. Linear measurements.

What were the complaints of the patient?

❑a. Esthetic;
❑b. Malocclusion;
❑c. Esthetic and malocclusion;
❑d. Skeletal class II.

REMOVING SMEAR LAYER DURING ENDODONTIC TREATMENT BY DIFFERENT TECHNIQUES - AN IN VITRO STUDY. A CLINICAL CASE - ENDODONTIC TREATMENT WITH ER:YAG LASER

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Received: October 10, 2016
Revised: October 31, 2016
Accepted: November 21, 2016
Published: November 23, 2016

Cite this article:
Sahar-Helft S, Stabholtz A. Removing smear layer during endodontic treatment by different techniques - an in vitro study. A clinical case - Endodontic treatment with Er:YAG Laser. Stoma Edu J. 2016;3(3-4):162-167.

ABSTRACT

DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.5

Introduction: Cleaning and shaping the root canal system during endodontic treatment produces a smear layer and hard tissue debris. Removing smear layer through irrigation is a critical adjunct.
Objectives: The aim of this study was[1] to evaluate in vitro the effect of irrigation techniques, irrigation with syringe-needle and laser-activated irrigation with 17% EDTA in root canals and[2] to demonstrate the effect of laser activated irrigation in a patient case.
Materials and Methods: Sixty extracted teeth were divided into three equal groups; Group 1: treated only with ProTaper™ F3 Ni-Ti files. Group 2: positive-pressure irrigation: 17% EDTA was used for 60-second irrigation, with a syringe. Group 3: Er:YAG laser-activated irrigation with 17% EDTA irrigation was used for 60 second, Laser flat tip was inserted in the upper coronal third of the root canal.
Results: Scanning electron microscopy showed that the smear layer is removed most efficiently using laser-activated irrigation with a 17% EDTA.
Conclusion: Smear-layer removal was most effective when the root canals were irrigated using Er:YAG laser at low energy with 17% EDTA solution. This effect was not observed with the positive-pressure techniques. A clinical case demonstrate the effect of using Er:YAG laser activated 17% EDTA inside root canal.
Keywords: endodontic, root canal irrigants, Er-YAG laser, scanning electron microscope, smear layer.

1. Introduction

Root canal treatment is performed to prevent or treat apical periodontitis. Effective endodontic treatment includes cleaning and shaping complex three-dimensional microstructure in which irregular structures such as isthmuses, apical deltas, and lateral canals may be present. The shaping phase aims to enlarge the canal. However creates a smear layer along the root canal walls[1]. The smear layer consists of a superficial layer on the surface of the root canal wall approximately 1-2μ thick and a deeper layer packed into the dentinal tubules to a depth of up to 40μ[2]. It contains inorganic and organic substances, including microorganisms and necrotic debris[3]. In addition to the possibility that the smear layer may be infected, it can also protect the bacteria already present in the dentinal tubules by obstructing intra-canal disinfection agents[4]. Pashley[5] considered that a smear layer containing bacteria or bacterial products might provide a reservoir of irritants. Thus, complete removal of the smear layer would be consistent with the elimination of irritants from the root canal system[6]. Peters et al. clearly[7] demonstrated that more than 35% of the surface area of the canals remained unchanged following instrumentation of the root canal using four Ni-Ti preparation techniques.
Mechanical instrumentation is always combined with irrigation in order to clean the areas that cannot be reached by instruments, to remove the smear layer, and to promote disinfection. Irrigation of the root canal is traditionally performed using a syringe-needle combination. However, the penetration of the irrigant in the apical third is limited[8-9]. Activation of the irrigation solution is suggested to improve their distribution in the canal system and increase irrigation effectiveness. Recent

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advances in dental research have incorporated laser technology as an novel modality for use in endodontic therapy[10].

In 1917, Albert Einstein wrote: "a special kind of light could be created under the right conditions - a light nobody had seen before. The light would be a single color, it would not scatter the way normal light does and it would be very intense". This kind of light would later be called laser. The use of laser at different wavelengths has been proposed to supplement conventional endodontic cleaning procedures[11-14]. Lasers pulsed infrared have been shown to cause cavitation-bubbles and pressure waves within the root canal space when combined with irrigants[15-16]. The cleaning effect of LAI (Laser Activated Irrigation) is based on cavitation: when a pulsed erbium laser is emitting in a root canal brimful of irrigant, strong absorption of the laser energy by the irrigant results in the formation of vapor bubbles at the fiber tip. These vapor bubbles expand during the pulse and then collapse soon after termination of the laser pulse[17]. Erbium lasers are effective in activating irrigating solutions: the absorption coefficients for water at 2,940 nm (Er:YAG laser) and at 2,790 nm (Er;Cr:YSGG laser) are 12,000 and 6,000 respectively[18] and cause formation of vapor bubbles at the fiber tip. For LAI to be effective, high absorption of laser energy into the irrigating liquid is necessary.

The aim of this study was (1) to evaluate in vitro the effect of irrigation techniques, irrigation with syringe-needle and laser-activated irrigation with 17% EDTA in root canals and (2) to demonstrate the effect of laser activated irrigation in a ppatient case.

2. Materials and methods

2.1. Tooth Samples

Sixty single-rooted human teeth extracted for periodontal reasons were used. (Ethics committee approval, Hadassah Hospital (No 0118-14-HMO). Root canal preparation was carried out using ProTaper™ (Dentsply Maillefer, Baillaigues, Switzerland) F3 Ni-Ti files with 2.5% NaOCl irrigation. The apices of all teeth were sealed with Super-EBA (Harry J. Bosworth Co., Skokie, IL, USA) to prevent irrigant leakage.

The teeth were randomly divided into three groups. Group 1 was treated with ProTaper™ F3 Ni-Ti files as described above, and served as a negative control. Group 2 was treated with ProTaper™ F3 Ni-Ti files, at the end of mechanical procedure, root canal was irrigated with 10 ml of 17% EDTA using a syringe with a 27-G needle (Navitip) for 60 seconds. Group 3 was treated with ProTaper™ F3 Ni-Ti files, at the end of mechanical procedure, root canal was subjected to LAI with Er:YAG laser at a wavelength of 2940 nm (LiteTouch™, Light Instruments,Yokneam, Israel) equipped with a 17 mm 400-µm plan-ended sapphire tip. Radiation was set to 0.5 W, 50 mJ, 10 HZ for 60 seconds. The water spray of the laser was closed. An irrigation solution of 17% EDTA was injected during radiation. The laser tip was inserted 3 mm in the upper coronal third of the root canal.

After the various treatments, two longitudinal cuts were made with a high speed bur and the teeth were split in half.

2.2. Scanning Electron Microscopy (SEM)

All samples were dried and mounted on stubs and then coated with Au/Pd using a Polaron SC7640 Sputter Coater (Polaron, Hertfordshire, UK). The effects of the irrigation treatments on the smear layer were examined by SEM at a magnification of 10,000X of the root canal. The samples were examined using FEI Sirion High Resolution SEM and FEI Magellan Ultra-High Resolution SEM (FEI, Eindhoven, The Netherlands).

3. Results

3.1. Examination of Surface Morphology

Fig. 1 shows SEM micrographs of the dentin wall at 10,000 magnification of the root canal present smear layer covered the root canal surface after endodontic preparation. In the second group, irrigation with 17% EDTA through a syringe for 60 seconds removed only part of the smear layer, at the apical part smear layer is present no dental tubules can be seen (Fig. 2).

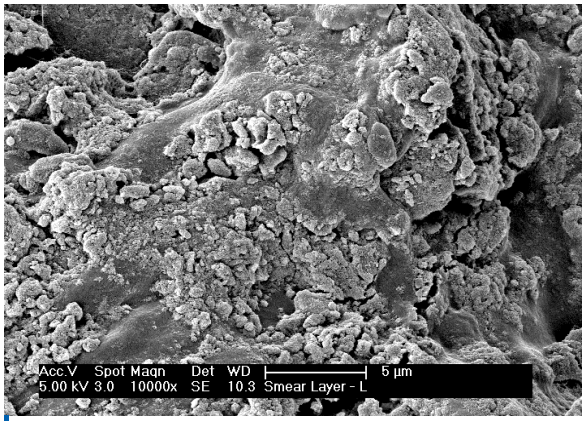


Figure 1. SEM X 10,000 picture presents smear layer after cleaning and shaping the root canal system during endodontic treatment

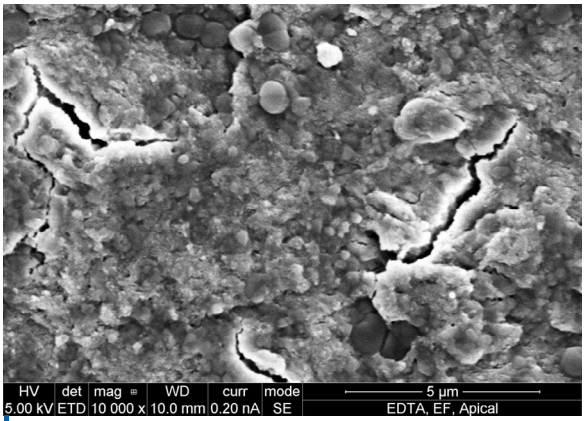


Figure 2. SEM X 10,000 picture presents smear layer at the apical part after irrigation with 10 ml of 17% EDTA using a syringe for 60 seconds

In group 3. Er:YAG LAI with 17% EDTA showed the best smear-layer removal from the entire root canal surface, including apical area with open dentinal tubules (Fig. 3).

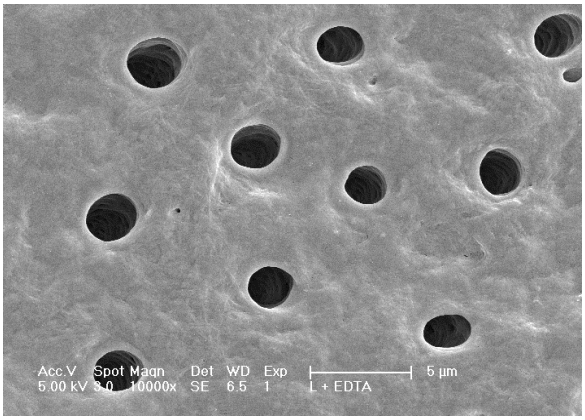


Figure 3. SEM X 10,000 picture presents clean root canal wall with open dentinal tubules after Er:YAG laser with 17% EDTA for 60 seconds

The best effect on smear-layer removal and tubules were open in all parts of the canal was present when we used 17% EDTA with Er:YAG LAI.

4. Discussion

This ex vivo study was designed to evaluate the effectiveness of using a 17% EDTA irrigation solution with laser irradiation compared to conventional syringe irrigation. Intact teeth were used to simulate the clinical situation as closely as possible. The maximum irrigation time was 1 minute of 10 ml to minimize detrimental effects on the dentin surface. Prolonged application of the EDTA solution might increase Ca2+ removal from the root dentin. Spangberg[25] showed that EDTA solution removes the smear layer within 1 minute of reaching the canal surface. In our study, exposure to 17% EDTA was limited to 1 minute to prevent potential changes in the dentin's microhardness, permeability, and solubility characteristics[26].

The generation of shockwaves by dental lasers inside the root canals can play an important role in smear layer removal[19-24]. Similarly, smear layer removal can be achieved when water is activated in root canals using erbium lasers (Er,Cr:YSGG or Er:YAG)[19,23.24],causing the formation of vapor bubbles that expand and implode[19,21,22,24]. Apparently, there is no difference in the efficacy of both wavelengths in terms of smear layer removal In our study we used the laser light here at subablative settings, which does not damage the root canal wall. (we tested before the EDX at this energy).

The position of the laser tip inside the root canal is important. when using the laser fibers in the root canal, as apical extrusion of the irrigant after laser activation has been described[20]. A previous study by George et al.[20] showed that there was twice as much dye penetration through the apical constriction with the fiber tip at 4 mm than at 5 mm. Therefore, in our vitro study, we insert the laser tip at upper part of the root canal, to avoid the irrigation extrusion.

The standard irrigation technique during endodontic treatment employs a syringe and needle. Its effectiveness is unpredictable in the apical part of the canal, since the solution is only effective 1.5 mm beyond the needle tip[27,28, 31,32]. The depth of needle penetration depends on the size and morphology of the canal[28]. The results of the present study confirm that 17% EDTA irrigation with a syringe does not affect the apical segment of the root and the smear layer remains intact on this important part of the root surface.

5. Conclusion

Smear-layer removal was most effective when the root canals were irrigated using Er:YAG laser at low energy with 17% EDTA solution.

6. A Clinical case - Endodontic treatment with Er: YAG laser

A clinical case of a male, 42 years old suffers from diabetes .

The clinical examination demonstrated maxillary lateral incisor tooth no 12# with metal ceramic crown. The sinus - tract was present in the apical area. There was no pain to percussion, pocket depth was normal.

According to the patient story the sinus-tract was there for over 2 years.

The radiographic examination reveled a large radiolocency at the apical part of the lateral incisor tooth. (Fig. 4). The crown was removed and endodontic retreatment was started .

During cleaning and shaping the root canal system with inter-appointment intracanal medicaments such as : Calcium hydroxide, 3mix (it is mixing of 3 antibiotic: Metronidazole, Minocycline, and Ciprofloxacin), and with Ledermix, the Sinus-tract


a.


b.

Figure 4. a. Radiograph and b. Photograph demonstrated maxillary lateral incisor tooth #12 with radiolucency and sinus-tract at the apical area

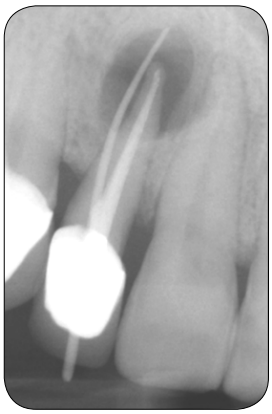
a.


b.

Figure 5. a. LAI with Er:YAG laser. Radiation was set to 0.5 W, 50 mJ, 10 HZ for 60 seconds. b. Rubber-dam on tooth #12 with laser safir tip

persisted. We decided to treat this patient with Laser Activated Irridation, using the Er:YAG laser (LiteTouch™, Light Instruments,Yokneam, Israel) at energy, 0.5 W, 50 mJ, 10 HZ for 60 seconds with 17% EDTA as an irrigation solution. (Fig.5)

The final obturation was accomplished at the same appointment. Approximately 2 years later, the radiograph demonstrates that radiolucency ceased and the periapical tissues heal normally. (Fig. 6) and there is no evidence of the sinus-tract.


a.


b.

Figure 6. Radiograph tooth #12
a. Before endodontic treatment, with radiolucency and sinus-tract at the apical area
b. 2 years folow up, after LAI with Er:YAG laser

Acknowledgments
The authors declare no conflict of interest related to this study. There are no conflicts of interest and no financial interests to be disclosed.

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From 2000 till today Dr. Sharonit Sahar-Helft has been researching the laser fields and she has published a lot of articles and book chapters. Since 2006 till today Dr Sharonit Sahar-Helft has been Istael's representative at the World Federation Laser Dentistry (WFLD). Since 2013 till today: Head of Israel society for laser in dentistry (ISLD). 2013-2016: Chairperson of the organizing committee of Israel laser in dentistry.
2014-2016: Responsible for the external relations and correspondence of the WFLD Europe division.
Responsible for laser research and cooperation between Israel conferences and other countries.
Currently, Dr. Sharonit Sahar-Helft also works in private practice, limited to endodontics.

Questions

The smear layer is packed into the dentin tubules at a depth of:

❑a. 1. Less than 40μ;
❑b. Up to 40μ;
❑c. 1-2μ;
❑d. Only at the infected areas on the root canal.

To remove the smear layer after endodontic preparation you have to:

❑a. Clean the root canal wall with bigger file in order to remove the smear layer;
❑b. Use irrigation solution like 17% EDTA in order to remove the smear layer;
❑c. Use all kinds of lasers to remove smear layer;
❑d. Use LAI (Laser Activated Irrigation) Er:YAG laser with 17% EDTA to remove smear layer.

Lasers pulsed infrared cause cavitation-bubbles and pressure waves within the root canal space when combined with irrigants. Which laser you will prefer:

❑a. CO2 laser;
❑b. Er:YAG laser;
❑c. Diode laser;
❑d. Blue laser.

The position of the laser tip inside the root canal is important: chose the correct answer:

❑a. The irrigation solution can penetrate through the apical constriction when the laser tip was close to the apical area;
❑b. To have efficient effect the laser tip should be insert till the apical area;
❑c. You should use the laser tip as much as it penetrates into the root canal;
❑d. You should initiate the laser tip before treatment.

WHO IS THE FACIAL SPECIALIST? HYALURONIC ACID FILLERS: OPTIMISATION OF AESTHETIC DENTISTRY AND PATIENT LOYALTY

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Received July: 23, 2016
Revised: August 15, 2016
Accepted: September 05, 2016
Published: September 07, 2016

Cite this article:
Zupi A. Who is the facial specialist? Hyaluronic acid fillers: optimisation of aesthetic dentistry and patient loyalty. Stoma Edu J. 2016;3(3-4):168-177.

ABSTRACT

The hyaluronic acid is the most used filler for the correction of facial wrinkles. The filler procedure is relatively painless and virtually free of complications and side effects. It requires deep knowledge of the face anatomy and its tissues, understanding of the skin physiology, excellent knowledge of injection techniques, ability to empathise with the patient and aesthetic sensibility. Dentists are the most facilitated specialists in this field. They have great knowledge of facial anatomy with its skeletal, muscular, vascular and nervous structure and, in addition, they master, better than anyone else, the injection technique.
Face and smile are indivisible units. No facial aesthetic treatment would be completely satisfactory if it did not involve the care of the teeth and smile. The clinical approach proposed here aims to gain the tools to integrate the examination of the soft tissue of the face, with their anatomic and functional characteristics, in the dentists' routine. Through this approach we can decode, simplify and make possible the harmony, complex and unique, of the faces of our patients. The final aim is to increase the services and the therapeutic options offered with the integration of perioral soft tissue treatment protocol to common approach to classic dentistry.
Keywords: esthetic, dental, dermal fillers, hyaluronic acid.

DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.6

1. Introduction

The analysis that each one of us performs in the clinic routine highlights the aspects that we know we can improve with the old or new techniques at our disposal. When we look at someone's face, we focus on some details based on our profession, our passion and sometimes, our desires. A hairstylist will be driven to observe the quality of a haircut, for instance. In the same way, a make-up artist will evaluate the way in which someone is wearing make up. Instinctively, she will think what product that person used and how good it is and if it suits the subject. A stylist will notice the accessory and clothes a person is wearing. He might even judge the taste of that person.
A dentist, who loves his job, will always focus his attention to someone's smile and mouth. He will start thinking of a treatment for that person. Moreover, the facial analysis performed by the prosthodontics is different from the one performed by the dentist and different from what the maxillofacial or plastic surgeon analyse. Still different, it is the analysis performed by dermatologists or medical aesthetics. This confirms the phrase: "what we see depends mainly on what we look for"[1]. Our eyes look for what we desire and they only see what we are able to understand. John Lubbock said that. He was a banker, liberal politician, philanthropist and scientist. He was influential in the nineteenth-century's debates concerning evolutionary theory[2]. This quote is very appropriate for our case, because "what we see depends on what we can offer to the patient".
To improve the aspect of a person, dentists are always able to evaluate the quality of the teeth alignment and eventually propose almost invisible dental treatments. Also, decayed or damaged teeth can be cured or replaced. Whitening treatments are always more efficient and less aggressive on the teeth. It is time for the dentist to start working on the frame of the smile too, which makes it healthy and beautiful. The patient often implicitly requires this. Sometimes, however, the patient makes this request explicitly. So, as dentists, we cannot say no! It is a duty and also an opportunity for us.
Patients, more often now, ask for rejuvenation injection procedures for their face. At the end of the nineties, the majority of patients who asked for an aesthetic treatment preferred surgical procedures (more than 55%)[3]. Now, this balance is completely inverted. In 2015, slightly less than 90% of patients in the United States strongly preferred

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Figure 1. Simulation of the treatment on the same patient (A) by different specialists. Traditional dental treatment without HA fillers (B). Treatment with HA fillers without any dental intervention (C). Combined treatment of aesthetic dentistry and HA filler. (D). N.B. Images (A) and (D) are real, images (B) and (C) have been created by the combination of the first two.
Modified from: Costa E (ed). Estetica dei tessuti orali e periorali in odontoiatria. Parma, Italy: Acta Medica Edizioni; 2014. Courtesy of the author

injectable or minimally invasive procedures[4]. The percentage increases for facial rejuvenation: more than nine million people, only in the United States, have chosen facial filler and botulinum[4]. The facial rejuvenation procedures with dermal filler (together with botulinum) represent the area of higher growth in cosmetic treatments. In the United States alone, in 2015, patients have paid over 1.6 billions of dollars for facial fillers[4].
The increase in demand of this kind of treatment also increased the number of practitioners who offer this service. This meant that a lot of new figures entered this area of expertise that were not traditionally involved in it. The dermal filler procedure in general, and facial filler in particular, initially neglected by plastic surgeon because it was considered minor, has now become a land to conquer by many specialists. Dermatologists *in primis*; followed by gynaecologists, anaesthesiologists and so on: clinicians and nonclinicians[5]. And last, dentists, who finally decided to enter this area. However, still today, with differences from country to country, dentists hesitate to join this area.
The most of us in the dental industry are quite ignorant of what these procedures even are, the theories behind them, the way they are delivered and the benefits for the patients. The aim of this paper is to gain the tools to integrate the examination of the soft tissue of the face, with their anatomic and functional characteristics, in the clinical routine, following a simple and well-tested protocol. In this way, dentists will be able to extend their view of the characteristics of a smile and a face and to propose innovative therapeutic solutions, which will meet the patient's request and expectations.

2. Hyaluronic acid: what it is, where and how it works

The hyaluronic acid (HA) is the most used filler for the correction of wrinkles, skin imperfections and the remodelling of the face[6,7]. HA is a substance normally found in the skin and it gives its characteristics of resistance and maintenance of the form[8]. With age, the physiological production of HA decreases and the skin loses elasticity and tone; this is what determines the creation of expression lines and wrinkles[6,7,9].
The HA is a glycosaminoglycan, which consists of regular repeating non-sulfated disaccharide units of glucuronic acid and N-acetylglucosamine [8]. Binding to many water molecules, the HA gives hydration, elasticity and softness of the tissues, protecting them from excessive solicitations[6,7,9]. The concentration of HA in the connective tissue of the skin gets gradually reduced with time. For this reason, a mature skin appears less elastic and hydrated compared to younger skins. Although it is a normal physiologic phenomenon, many people want to fight the advancing age, therefore prevent wrinkles and other skin imperfections.
HA fillers were developed at the end of the eighties[10]. They represent an efficient minimally invasive solution for the imperfections of the face mainly caused by the aging of the skin, but also "congenital"[7]. The infiltrations can be performed alone or as a completion of a plastic surgery operation such as lifting. With the injection of HA intradermal the filling of the wrinkles and the increase of the volume of the face is achieved.
There are different types of HA filler with different characteristics. The HA does not have side effects, it does not require an allergy test, gives a natural modelling to the treated area and it gets gradually absorbed in a few months (from four to twenty-four months)[6,7,9,11]. The time of reabsorption depends on different factors. The most important ones are the type of skin, the treated area, tobacco use, eating habits, overexposure to UV rays (both natural and artificial) the quantity and the density of the injected filler[7,11].
HA fillers are injected intradermally with pre-measured syringes and thin needles (from 20 to 30 gauge).

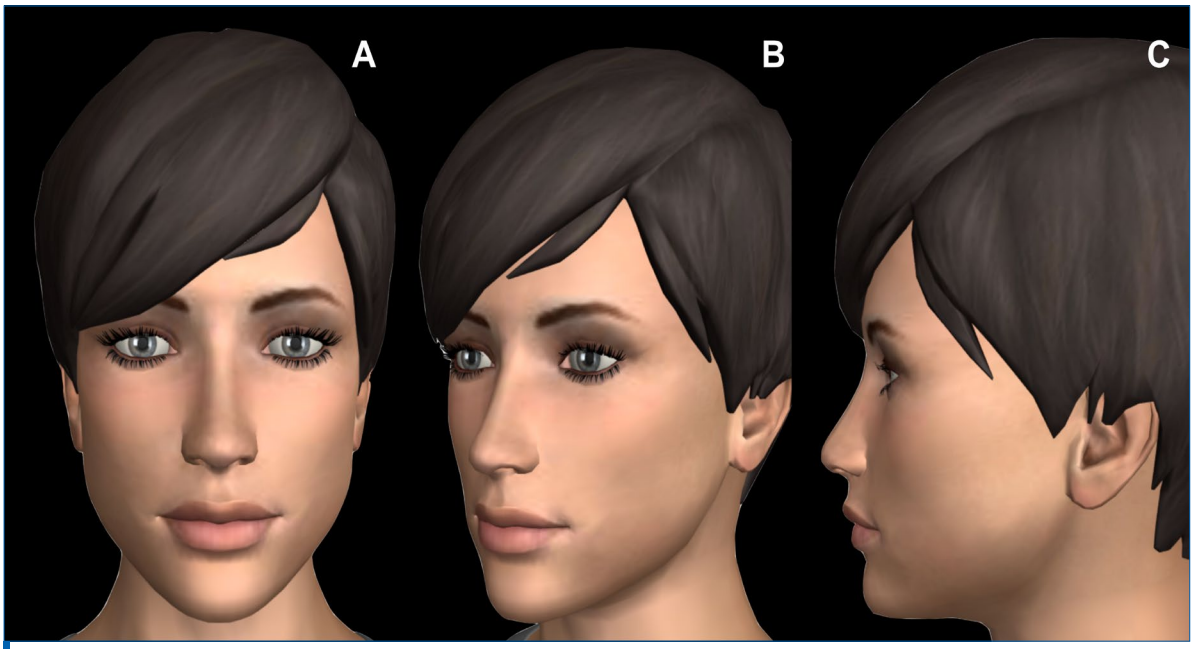

Figure 2. Facial proportion analysis. Soft tissue examination is performed in the three projections: frontal (A), oblique (B) and lateral view (C). The patient should be evaluated standing up with his head in a natural head position, with the eyes staring at a point to the horizon on the same plane of his or her eyes.
Drawn by Aldo Zupi using ZygoteBody™ 3D Anatomy Viewer. Zygote Media Group Inc., American Forks, UT

Contraindications are rare: skin diseases, infections or viruses (e.g. herpes labialis) in progress, autoimmune diseases of the skin and collagenopathies[12]. Although there is no evidence of contraindication, it is safer not to administer HA fillers during pregnancy and breastfeeding[12].

3. Who is the facial filler specialist?

The first objection raised from the dentist (about filler procedure) is always the same: "can the injection technique be done in a dental clinic?" or "wouldn't it be better if specialists such as dermatologists and plastic surgeons did the facial filler?"
Surely, from an historical point of view, dermatologists and plastic surgeons have been the first to focus and take care of people's faces and use therapies (more or less invasive) for the maintenance and the recovery of the health and beauty of the patients. In the last years, minimally invasive procedures (such as fillers) started to spread around and different professional categories such as anaesthesiologists, medical aestheticians, ophthalmologists, internists and so on, started to be interested and so they also begun to use facial fillers in their every day practice. In some cases, the filler practice left the medical area to cross into the paramedical area (in the best case scenario). It is not rare that non-medical staff performs procedures such as filler, botulinum, sclerotherapy, and mesotherapy[5,13].
Usually, the training for these procedures is only focused on the technical aspects. Teaching focuses on just a few concepts. They are surely important, but, perhaps, not enough to create the facial filler specialist. Many facial filler courses are focused on "where", "how much" and "how" to inject. They offer a very quick refresh of our facial anatomy knowledge and of its critical and dangerous areas. The whole aging physiology is discussed rapidly in a couple of sentences. This is enough to gain all the necessary techniques for the surgical procedure. However, they give the necessary anatomical and functional knowledge for granted.
A dentist, any dentist, has spent his whole professional training (from the first day at university) studying and mastering the anatomy and physiology of the oral and perioral area. They have studied and mastered all the aspects and they know the characteristics better than any other medical specialist. In addition, the dentist is the only specialist who spends every day of his profession working on this area, dealing with its singularities and the changes that happen with time. If this were not enough, everything is subject to the aesthetic judgement of the patient every single day.
Therefore, dentists have to accept the ugly truth of being the 'real' specialists of the oral and perioral region (or rather from the chin to the cheekbones) and that their very specific scientific background and their daily work is not comparable to that of any other specialist's. No dermatologist, plastic surgeon or other, will be as competent and confident as the dentist.
With increasing frequency, patients ask us, or our colleagues, for a generic improvement of their physical conditions (Fig. 1A). In these cases, usually, the approach is different depending on the specialist. If the interlocutor is a traditional dentist, the operation will be limited to the teeth

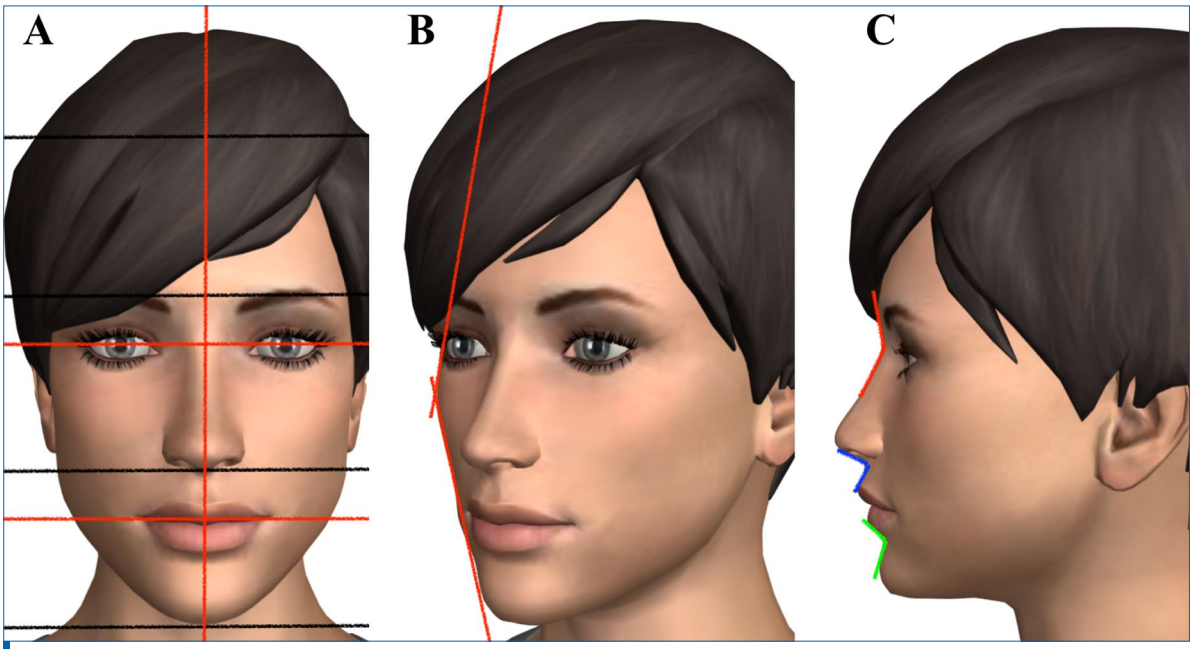

Figure 3. Facial proportion analyses. Frontal view (A). The face is divided into three thirds (black lines): the upper third (in between the hairline and the line which links the upper points of the eyebrows); the middle third (in between the line which links the upper points of the eyebrows and the inter-alar line); and the lower third (from the inter-alar line to the chin). The three thirds should have similar dimensions. More several planes (red lines) should be used as reference points to evaluate the shape (bitemporal, bizygomatic, and inter-commissural line), and the vertical symmetry (vertical median line, intercantal line, and inter-commissural line). Oblique view (B). The face is focused at about 45° to highlight the angle formed by the buttress of the zygomatic bone on the external profile (red lines). From the internal profile, we will examine the look of the temporal area, of the periorbital area, of the cheek and the definition of mandibular angle. Profile view (C). Several angles can be analysed: the fronto-nasal (red); the naso-labial (blu), it shows if the tip of the nose is facing down and it gives us information on the form of the upper lip; the labio-mental (green) it describes the direction of the labio-mental sulcus and allows us to evaluate the form of the lower lip.
Drawn by Aldo Zupi using ZygoteBody™ 3D Anatomy Viewer. Zygote Media Group Inc., American Forks, UT

and mouth. A traditional dentist sees the patient exclusively as a mouth with teeth and gum. Nothing else. He will most certainly do an excellent job. The patient will definitely be satisfied (Fig. 1B). If the patient went to an aesthetic doctor or plastic surgeon, the evaluation would be very different. Any other doctor, not an odontologist, would not evaluate the mouth. Teeth would be excluded from any kind of evaluation immediately. The exam would concentrate on the skin and face. In this case, too, the plastic surgeon would do a great job and the patient will be satisfied (Fig. 1C). What is the difference you can give to the patient? The difference is a complete exam of the face and the smile and a global and harmonious solution (Fig. 1D).

Face and smile are indivisible units. No aesthetic treatment would be completely satisfactory if it did not involve the care of the teeth and smile. Surely, two or three different specialists can do this separately: dentist and aesthetic doctor; or dentist, aesthetic doctor and plastic surgeon. This is how it used to happen, until now. However, a new kind of dentist with aesthetic sensibility, can finally become the specialist who treats face and smile in a coherent and harmonious way. To be able to do so, a correct and targeted assessment of the patient and serious dermal filler training is required.

4. Patient's assessment

The traditional dentistry approach to the solution of cases with aesthetics problems basically consists in the assessment of the beauty of the face based on the personal work experience of each dentist. The main element to assess it is the smile. For the construction of a correct aesthetic plan the face has to be considered in its entirety and it is necessary to have a detailed knowledge of anatomic and functional characteristic of the soft tissue of the face and therapeutically available options for the soft tissue treatment, with a particular reference to possibilities and limits of not surgical techniques[14].

In the approach to the facial aesthetic rehabilitation, we need to start from the evaluation of several facial parameters: face's form; aspect and position of soft tissue (nose, lips, chin, etc.) and supporting structures (bones, cartilages, and teeth); muscles' activity; and aging, meaning the way in which these tissues aged or will age[14]. Leaving out any of these aspects can only take us to a partial aesthetic success without a harmony of the whole face[14].

Table 1. Facial analysis. Main elements to evaluate during skin analysis

1. Colour.
2. Phototype.
3. Texture.
4. Elasticity.
5. Thickness.
6. Type of skin (dry, oily, mixed, sensitive, dehydrate) and sebaceous and sweat secretion.
7. Presence od stains (ipo- or hyperpigmentation).
8. Presence of injuries or neoformations (scars, inflammation, keratosis, fibroids, dermatitis, etc.).
9. Presence and distribution of nevous.
10. Presence of wrinkles (distribution and depth).

Table 2. Glogau's aesthetic and anatomic analysis of the aging skin

Type I		No wrinkles. Patient age 20-30. Early photo aging (mild pigmentary changes, no keratosis); minimal acne scarring; need minimal or no make-up.
Type II		Wrinkles in motion. Patient age 30-40. Early to moderate photo aging (early senile lentigines visible, keratoses palpable but not visible, parallel smile lines beginning to appear); mild acne scarring; need some foundation.
Type III		Wrinkles at rest. Patient age 50-60. Advanced photo aging (obvious dyschromia, visible keratosis, discoloration with telangiectasia, wrinkle present even when not moving); acne scarring present that make-up does not cover; need heavier foundation.
Type IV		Only wrinkles. 60 or older. Severe photo aging (yellow-grey skin colour, prior skin malignancies, wrinkles throughout, cutis laxa of different origin); severe acne scarring; cannot wear make-up because it cracks.

The integration of perioral soft tissue treatment examination to classic dentistry approach allows and simplifies the comprehension of the complex and unique harmony of the faces of our patients[14]. Costa and Di Gioia[14] have proposed a simple but complete and exhaustive facial analysis protocol. It is the collection of all the information we gained by observing the patient during a clinical examination and by examining photos and videos of the face. This analysis consists in three phases: (A) analysis of facial proportions; (B) skin analysis; and (C) analysis of the expressive quality of a face[14].

5. Analysis of facial proportion

Analysis of facial proportions must consider soft tissue (skin, muscles, subcutaneous fat, intraoral soft tissue) and hard tissue (bone and dental support, dento-alveolar relationship). One must gather as much information as possible about the form, the proportions and the symmetries of the face must be gathered. According to Yarbus' studies[15], when we observe a face, our eyes focus on areas of the face known as Region of Interest. They are the areas of maximum curvature of the face, where the transition between these different areas happens. It is necessary to concentrate our attention on these areas.

We practice the soft tissue examination in the three projections: frontal, oblique and lateral view (Fig. 2). In the same projections we will perform a series of aesthetic photos of the face. The patient should be evaluated standing up with his head in a natural position meaning with the eyes staring at a point in the horizon on the same plane as his or

Table 3. Characteristics of the dermal filler with hyaluronic acid procedure

Duration of the procedure.	From five to fifteen minutes.
Necessity of post-treatment observation.	Until one hour from the treatment. It does not require particular environment (it can be done in the waiting room).
Type of treatment.	Local infiltration (hyaluronic acid) absolutely biocompatible.
Necessity of post-treatment medications.	No medication. Useful post-treatment check to evaluate the result and eventual 'touch up'.
Inability period or post-treatment convalescence.	None. It is possible to resume activities immediately after the operation (lunch-time treatment).
Post-treatment outcome.	None. The injection does not create any scars and the complete absorption of the hyaluronic acid does not create outcome. Complications are very rare (usually self-limiting).

her eyes. The best point of view is given when the head posture respects the parallelism between the Frankfurt plane and the horizon. We will be looking for the same posture of the head in all the other projections as well.

In the frontal view we will divide the face in three thirds: *the upper third*, in between the hairline and the line which links the upper points of the eyebrows; *the middle third*, in between the line which links the upper points of the eyebrows and the inter-alar line; and *the lower third*, from the inter-alar line to the chin (Fig. 3A). We can now evaluate the proportions between the three thirds, which should have similar dimensions.

In the frontal view we also identify several lines, which will be used as reference points (Fig. 3A). Some of them (bitemporal, bipupillar, bizygomatic, bigonial) can be used to evaluate the shape of the face. The form of the face can vary a lot from one patient to other. This is an important parameter to take into account as the patient's request could modify the form of his or her face. Sometimes, the patient will ask to soften the curves of the face or to emphasise some characteristics. We will have to verify the parallelism between these lines and the inter-commissural line. An eventual lack of parallelism between the inter-commissural line and the horizontal lines of the face should also consider an accurate dental occlusion evaluation.

Using the frontal view again, the symmetry of the face can be analysed. Let us draw the vertical plane (a median line of the face passing through the centre of the glabella and the centre of the upper lip philtrum); let us examine the deviations, the asymmetries, the deviation of the tip, and dorsum of the nose (Fig. 3A). With the comparative analyses of the two hemifaces, it is possible to immediately detect eventual asymmetries without being influenced by the mimic.

The second projection is the oblique one (Fig. 3B). In the oblique view we can focus on the face at about 45° to highlight the angle formed by the buttress of the zygomatic bone on the external profile, which with young women is projected upwards: it is also known as malar projection angle, it becomes more evident with age as it gets smaller and the zygomatic buttress gets lower. From the oblique projection, we will examine the look of the temporal and periorbital area, of the cheek and mandibular angle. These areas, too, lose tone and tend to fall with time. Moreover, we can observe the form and the dimensions of the nose and its relationship with the philtrum.

The third projection is the profile (Fig. 3C). The division of the face in three thirds, as in the frontal view, gives us information concerning the facial height, especially about the lower third of the face. On the profile we analyse several angles: *the fronto-nasal angle* (115°-130°); *the naso-labial angle* (85°-105°), it shows if the tip of the nose is facing down and it gives us information on the form of the upper lip; *the labio-mental angle* (110°-130°), which describes the direction of the labio-mental sulcus and allows us to evaluate the form of the lower lip[14].

A profile is defined as concave (common in the elder patients or edentulous patients) if the angle formed at the intersection of the line drawn from the glabella to the sub nasal point with the line from the sub nasal point to the cutaneous pogonion is bigger than 180° or convex if the corner is smaller than 180°. This angle gradually changes with age. It becomes increasingly wide until it reaches figures such as 200° in edentulous older patients. Once the proportions of the face have been studied as a whole and we have an idea of the unbalanced areas, we can observe the aesthetic regions of the face, following a useful medical division of these parts (Fig. 4); we can now examine each of these areas and each area's relation to the others, to identify the ones, which may need intervention. The lips and the perioral region represent the main areas of aesthetic intervention for the dentist. Therefore, very deep knowledge of its biological and anatomic characteristics of it is required. We will evaluate form, dimension, volume, tone and symmetry of the upper and inferior lip. We will observe the relationship between the upper and inferior lip (ideally it varies from 1:2 in favour of the lower lip's height). It is necessary to respect these characteristics even after the corrections, on both intra and extra-oral level, to preserve a natural look. The lip and perioral region is subdivided into at least ten sub-regions with very different characteristics from one another, which require different ways of therapeutic approach (Fig. 5).

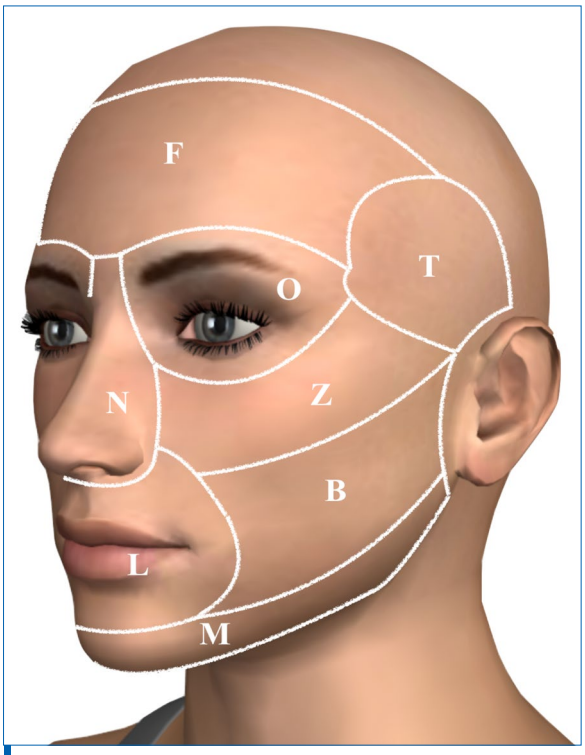

Figure 4. Aesthetic regions of the face. The main aesthetic regions of the face are: the frontal region (F), the temporal region (T), the orbital region (O), the zygomatic region (Z), the buccal region (B), the nasal region (N), the mandibular (M), and the lip and perioral region (L).
Drawn by Aldo Zupi using ZygoteBody™ 3D Anatomy Viewer. Zygote Media Group Inc., American Forks, UT

Each one of these areas has particular anatomic features: skin, subcutaneous tissues, muscles, fat, movements and mimic. The therapeutic options will be different for each different area. In addition, we need to consider the changes associated to aging and this allows us to understand how important it is to know the face anatomy before any intervention.
Careful attention must be paid to the exterior margin of the vermilion. It is surrounded by a thin line and slightly detected skin called the lip white roll (Fig. 5). It is very noticeable in young lips, which highlights the red border of the lip. The presence of this area is one of the secrets best kept by plastic surgeons. Its presence and its use allow as to obtain excellent aesthetic results with no invasive treatment.

6. Skin analysis
The next step is the skin analysis: a glowing and well-maintained skin improves the beauty of a face and a smile. We need to be able to do an initial screening of the status of the skin and eventually we need to be able to spot injuries or diseases, which will be evaluated by the dermatologist. It is important to asses the skin surface. We will examine as many elements as possible (Tab. 1). Hair, eyebrows, eyelashes, and make up are considered characteristics, which are perceived as parts of a person's personality. When the main physiological parameters of function get closer to 'normality' the skin will look bright, light, compact, well hydrated, soft, elastic and smooth.
An important parameter to evaluate in the analysis of the skin is the texture (also called webbing or skin profile). The skin texture is formed of the set of lines, which fused together on the skin surface surround quadrangular or rhomboid areas with primary and secondary lines. It is very hard to observe this in children and babies with a naked eye. With age, these lines become less frequent, deeper and messy. The skin texture can be evaluated through macrophotography according to Beagley and Gibson[16] or through profilometry[17] and it is conditioned by the form and function of the structures, which cover it.
The skin examination is obviously completed with the observation of wrinkles. A good reference for this evaluation is the classification of Glogau[18], which links age, wrinkles and texture quality (Tab. 2). To be able to understand the difference between the wrinkles and the rationale of their treatment it is necessary to remember the structure of the skin. The skin of the face is a layered structure. The main layers are the epidermis and the dermis. Below them there is the adipose tissue. The depth of these layers gradually varies depending on the area of the body and face examined. It is very thin in the periocular region; it becomes thicker on the cheeks, it gets thinner again on the mandibular region to then become once again thicker in the perioral region. The epidermis is subdivided in a keratinized superficial portion with the cellular elements at the end of its life cycle and in a deeper portion with vital cellular elements. In the deepest zones of this layer the melanocytes have been localised, which explains the difficulties in treating the skin spots. Below the epidermis, the dermis and the connective tissue can be found, also with variable thickness. The dermis is the layer where the HA is positioned. Here is where the increase in volume happens, which has an impact on the layers above achieving a filling or smoothing of the wrinkle.

7. Analysis of the expressive quality of the face
A last evaluation is the quality of the facial expression. This evaluation has to happen with the analysis of the static and dynamic mimic activity. Each face is unique because of some important characteristics: the mimic, the skeletal muscle activity of the face and the neck, the head posture, the look, and the smile (the heart of the face).

8. Surgical procedure: how and where
The filler procedure is extremely simple and it only requires easy injections technique knowledge. Dentists are the best specialists in this field. A dentist, generally, performs dozens of injections everyday; probably thousands every year. For a dentist, an injection is a very familiar act.
The layer where the filler injection happens is,

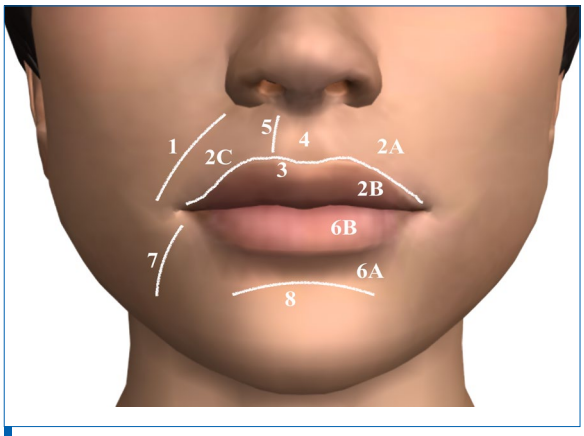

Figure 5. Aesthetic sub regions of the lip and perioral region. The perioral region is subdivided in at least ten sub regions with very different characteristics from one another and which require different therapeutic approaches. The main aesthetic sub regions of the lip are: the naso-labial fold (1), the white upper lip (2A), the red upper lip or upper vermillion (2B), the lip white roll (2C), Cupid's bow (3), the philtrum (4), philtrum's pillar (5), the white lower lip (6A), the red lower lip or the lower vermillion (6B), the labio-mandibular fold or puppet fold (7), and the labio-mental fold (8). Each one of these areas has particular anatomic characteristics: skin, subcutaneous tissues, muscles, fat, movements and mimic. The therapeutic options will be different for each different area.
Drawn by Aldo Zupi using ZygoteBody™ 3D Anatomy Viewer. Zygote Media Group Inc., American Forks, UT

in the majority of the cases, the dermis. Within the dermis, the specialist can choose to use the superficial portion just below the epidermis, or a deeper portion, above the subcutaneous fat. The dermis has variable thickness depending on the anatomic area, the age and the degree of aging. The same happens in the epidermis. The skin can have minimum thickness in areas such as the periorbital one where it does not go over a millimetre or it can get to a few centimetres in areas such as the back or in areas subject to constant friction. However, there are general parameters that can be applied safely in all situations.
The depths in which we act can be divided in two layers: a superficial layer, generally 1-2 millimetres deep, and a deeper layer, usually never superior to 5 millimetres. The injection depth depends on the depth of the flaw. Small superficial wrinkles must be treated with superficial injections and with small quantities of material. If the line is deeper, the injection will need to be deeper too, as the quantity of skin to lift is bigger and wider. Even deeper is the area of injection for deep and not elastic wrinkles. A larger amount of material is required and the surface of the tissue to lift is wider. This is the first rule to follow to choose the right depth where to operate. The second rule is just as simple. Each area of the face has skin of constant thickness and, therefore the dermis can be found at a known depth.
We can easily subdivide three areas in which the skin is usually thin. In these areas, we will hardly go at a depth greater than 1-2 mm. This applies especially to the so-called "white roll" of the lip. It is an important area because it will almost always be treated in our patients. To areas with thin skin oppose areas with thick skin. In these areas, generally, we inject at least at 2-3 mm of depth and in some cases even deeper. It is important to remember that almost the whole perioral region has a relatively thick skin and sometimes, when facing deep and "ancient" wrinkles, it is necessary to go very deep. We must always associate the concept of stickiness or density or reticulation of the HA used to the concept of depth. This way, the tissues will be "lifted" more naturally.
How should the HA filler be placed? A dentist is used to inject anaesthetics or other drugs. The technique is exactly the same. Once, the needle has been inserted and we have reached the desired depth, we will inject the quantity of filler we believe is right. The general rule is to usually under dose the injection. A correction, in fact, is always possible. On the other hand, the "subtraction", even if possible, is a lot more complicated.
Anyway, we will inject the quantity of HA desired in small spots along the wrinkle or the line we want to increase. The distance between spots is not very important. We can add material where and when we want if necessary and, if required, we could use the same site of injection. This way, with small and aimed corrections, we will achieve to fill or lift a wrinkle. The "spot technique" allows an extremely precise correction. However, it requires, patience and precision.
For those … in a hurry, the linear technique consists in the injection of a "strip" of HA at the bottom of the wrinkle or along the line we want to increase. The technique is very simple. You will need to penetrate in the skin at an angle of about 45° for the necessary depth. As we know, the depth can be of just a few millimetres (1 or 2) or even half a centimetre or more. Once we have reached the desired depth, we will move the needle until it is parallel to the skin. We will proceed along the line we want to fill up for the whole length of the needle. At this point we can start to inject the filler and, at the same time, we retract the needle. In this way, we release a strip of HA like the trail of a plane or of a boat, which will fill the line or wrinkle. Like in the "spot technique", we can go back to the same area as many times as we think it is necessary, lengthening or increasing the volume of the strip.
Below, are briefly mentioned the techniques usually used for the common imperfections of the face are briefly mentioned (labial wrinkles, thin lips, malar region and crow's feet).
The labial wrinkles are formed around the mouth and generally have a vertical movement. They are usually the result of mimic and aging. This imperfection is usually known as "barcode". Different factors, such as smoking can speed

up the formation and increase the entity. The HA efficiently fills these wrinkles up and can get rid of the imperfection. The filling can happen for each single wrinkle or treat the whole white upper lip with a technique called "fan".
Thin lips are a congenital imperfection, genetically determined. They are usually very unpopular among women, as today's standard of beauty expects full lips. Dermal fillers allow an appropriate correction. The HA, makes the lips fleshier, via the infiltration of the correct quantity. The infiltration happens at different depths depending on the treated area and the volumes are gradually "redesigned". Thin lips are complex to correct and it is best to make this corrections in several steps. The HA is fully resorbable; this eliminates the fear of error for "excess". Anyway it is always advisable the search for a natural effect and not the "Hollywood" effect.
Less pronounced cheekbones, or anyway the physiological reduction of their volume, flattens the look of the face giving an older appearance. The infiltration of HA allows, in a relatively easy way, to increase the volume of the middle third making the face "sharper" and younger. This area, however, requires the use of a more dense or reticulated HA filler and its placement in layers "unusually" deeper. The so-called crow's feet are a common imperfection in both men and women. Even though they add 'depth and interest' to the eyes and look, they are not very much loved, especially by women. The correction is quite complex because of the extreme thinness of the skin which can determinate the creation of visible "cords" (anyway reversible). In addition, the continued contraction of the muscular mimic decreases the effect of the correction. Therefore, the ideal treatment would be a combination of botulinum toxin and dermal filler. The HA must be injected very superficially and in extremely "controlled" quantities along the main lines. In this case, too, we have to follow the golden rule of not exceeding and eventually subdividing the treatment in several steps.
It should not be forgotten that the injections of HA are not absolutely painless. In same areas, such as the lips, the majority of patients who had fillers feel a sense of burning or discomfort during the procedure. To avoid it, it is advisable to anesthetise the area, which is going to be treated. It is possible to do so with topical anaesthetic cream (usually with lidocaine) or with an injection in the oral vestibule (usually with mepivacaine without vasoconstrictor).

9. Conclusion

The treatment of face imperfections with HA filler is a simple procedure, relatively painless and virtually free of complications and side effects (Tab. 3). It requires deep knowledge of the face anatomy and its tissues, understanding of the skin physiology, excellent knowledge of injection techniques, ability to empathise with the patients and aesthetic sensibility.
All dentists who have had some sort of dermal filler training are aware of the reason because dentists can and should perform these treatments. Luckily, a constantly increasing number of dentists apply to theoretical and/or practical courses of dermal filler. This tendency is creating more and more professionals who have great knowledge of facial anatomy with its skeletal, muscular, vascular and nervous structure. In addition, these specialists master the injection technique better than anyone else.
The HA is just a different substance to inject. The dentist only has to learn the different pressure and speed in a few minutes and a few attempts.
If the dentist knows anatomy, the physiology and aesthetic parameters of the face better than any other specialist, is there a more qualified specialist to evaluate the relation between lips and teeth? Or the changes of tissues and perioral volume during the smile? Is there another specialist who works with the face, or at least the portion between the cheekbones and the chin, every single day during his professional career?
Is there another specialist who, daily, makes aesthetic choices, which can be immediately evaluated by the patient? If the dentist has taken a serious and complete dermal filler training, is there a specialist who can offer a better cosmetic treatment to that indivisible unity constituted by face and smile?
There are many complex treatments performed with HA in anatomic regions and tissues, which have nothing to do with the smile and face. No dentist would have dreamt to perform such treatments.
But, when the treatment of the tissue aims to complete the smile, a dentist with aesthetic sensibility, cannot limit himself to just be the doctor of the teeth. He must take responsibility to give or return harmony and health (the sum of which is beauty) to the faces of his patients.

Acknowledgements

The author declares no conflict of interest related to this study. There are no conflicts of interest and no financial interests to be disclosed.

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Questions

The most used dermal filler is:

❑a. collagen;
❑b. hyaluronic acid;
❑c. polylactic acid;
❑d. calcium hydroxylapatite.

Facial filler are usually injected in:

❑a. subcutaneous fat;
❑b. keratinized layer of the skin;
❑c. facial muscles;
❑d. dermis.

The classification of Glogau permits a clinical assessment of:

❑a. wrinkles;
❑b. facial muscles activity;
❑c. type of skin;
❑d. skin fototype.

The facial soft tissue examination is correctly performed in:

❑a. frontal view;
❑b. lateral view;
❑c. frontal and lateral view;
❑d. frontal, oblique, and lateral view.

TOOTH LOSS AND RISK FACTORS AMONG ELDERLY VIETNAMESE

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Received: April 14, 2016
Revised: May 09, 2016
Accepted: June 16, 2016
Published: June 17, 2016

Cite this article:
Nguyen MS, Voog-Oras Ü, Jagomägi T, Nguyen T, Olak J, Saag M. Tooth loss and risk factors among elderly Vietnamese. Stoma Edu J. 2016;3(3-4):178-183.

ABSTRACT

DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.7

Introduction: Oral health care systems for older people tend to be reducing tooth loss and saving functional dentition. Elderly Vietnamese had to live under challenging conditions and were not entitled to any dental care for over 30 years due to the Vietnam War. The aim of the current study was to investigate tooth loss and related risk factors among elderly Vietnamese aged 65-74.
Methodology: The sample study was 258 elderly Vietnamese aged 65–74 years old. Each absent tooth was registered as a tooth loss. Risk factors were evaluated based on the Oral Health Questionnaire for adults (WHO, 2013).
Results: The mean tooth loss for the sample was 7.6 (±7.0). 27.1% of participants had lost 1–3 teeth, 23.6% 4–6 teeth, 27.1% 7–16 teeth and 13.6% >16 teeth; 8.5% had full dentition. Within each category of predictors, a statistically higher number of lost teeth was found for: the 70-74 age group (Mean±SD, 8.8±7.9); rural residents (8.8±7.6); time in education ≤5 years (10.2±7.7); frequency of teeth cleaning ≤1 time/day (8.7±7.3); last visit to dentist >1 year ago (8.2±7.5); tobacco smoking (9.4±7.6); no alcohol drinking (8.3±7.2). The odds of having >6 lost teeth was significantly more frequent among elders with less time in education (OR=2.2, $p<0.01$) and tobacco smoking (OR=2.8, $p<0.01$).
Conclusion: There are high prevalence and number of tooth loss among elderly Vietnamese. Smoking behaviour and time in education were significantly related to maintaining teeth of the elderly community population.
Keywords: elderly, oral health, risk factors, tooth loss, Vietnamese.

1. Introduction

The World Health Organization (WHO) has called for improved oral health among the elderly who are most disposed to oral diseases, including tooth loss. It is estimated that no less than 90% of the elders are influenced by tooth loss[1].
According to the WHO, the main aims of oral health care systems for older people are reducing tooth loss and saving functional dentition with at least 20 natural teeth. Tooth loss often has an adverse impact on quality of life and general health[2,3]. Posterior tooth loss results in impaired masticatory performance and temporomandibular disorders, and anterior tooth loss influences social communication owing to reduced aesthetics[3–6].
Risk factors for tooth loss have been extensively studied. Among health behaviours, several studies have shown that tobacco smoking results in higher tooth loss[7,8]. Others have found that insufficient income can impede oral health care leading to tooth loss[5,9]. Also, the educational background may affect individuals' perception of the importance of oral health behaviours and could be the primary cause of tooth loss among the elders[2,9,10].
During the twentieth century, Vietnam faced a lot of hardship owing to the Vietnam War. People born in pre-1951 had to live under challenging conditions and were not entitled to any dental care for over 30 years. Furthermore, as far as we know there have been no studies regarding tooth loss among the Vietnamese population.
Thus, the aim of the present study was to investigate tooth loss and related risk factors among elderly Vietnamese aged 65-74.

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2. Methodology

2.1. Study sample

This cross-sectional study involved elderly people aged 65–74 years old, living in Danang, Vietnam. The participants were selected according to a multistage stratified random sampling method based on demographic characteristics.

Danang is subdivided into six urban districts and two rural districts. In the first stage of the current study, three urban districts and one rural district were randomly selected including Hai Chau, Thanh Khe, Cam Le, and Hoa Vang. The second stage, the lists of the elderly aged 65-74 were obtained from the community unions for elderly adults into which include all the citizens over 60 years of age. Forty-five participants from each of the selected urban districts and 135 participants from the rural district were randomly sampled and stratified into groups by gender and age (male:female ratio 1:1, and 65-69:70-74 years old 1:1). After factoring in 10% of compensation for the possible decline of survey participants, the total sample consisted of 300 participants; however, 42 participants withdrew during the study. Thus, the final sample was 258 participants including 128 females and 130 males. A written informed consent was obtained from each participant. Selected participants were mentally healthy persons who were able to answer questionnaires about their oral health status. The examination was performed at the local health centre or the dental clinic of the Danang University of Medical Technology and Pharmacy. Two dental students were trained to ask the questions and record the answers on an assessment form. The first author conducted all clinical oral examinations. Ten percent of the participants were re-examined to test the reliability of the collected data. The intra-rater reliability between studies was above 0.9.

2.2. Evaluation of tooth loss

Each absent tooth regardless of the circumstances would be registered as a tooth loss. In the case of at least one existing third molar, the other third molar loss was recorded. Recording all third molars would be excluded if all of them were not present during the dental examination.

The number of lost teeth was classified into categories: 1) No tooth loss; 2)1-3 lost teeth; 3) 4-6 lost teeth; 4) 7-16 lost teeth; 5) > 16 lost teeth. The number of lost teeth was also dichotomized into ≤6 lost teeth or > 6 lost teeth. The position of any lost tooth based on tooth functional groups, such as incisors, canines, premolars, and molars was also determined for both upper and lower jaws.

2.3. Evaluation of risk factors

The assessment of tooth loss risk factors was based on the Oral Health Questionnaire for adults (WHO, 2013). Personal interviews were conducted before the dental examination, and data from the questionnaires were categorised into the bivariate classes:

Sociodemographic factors: gender (female, male); age group (65–69, 70–74); place of residence (rural, urban); time in education (≤5 years, >5 years).

Oral health behaviours: Participants were asked the following questions: "How often do you clean your teeth?" (Categorised as: ≥ 2 times/day or ≤ 1 time/day); "How long is it since you last visited a dentist?" (≤1 year or >1 year); "Do you smoke tobacco, consume alcohol or have any chronic disease?" (Yes or no).

This study was registered and approved by the Human Research Ethics Committee of the Danang University of Medical Technology & Pharmacy and performed according to the World Medical Association Declaration of Helsinki.

2.4. Statistical methods

Data entry and statistical analyses were performed in version 17.0 of the Statistical Package for Social Sciences (SPSS). The Student's t-test, Chi-square test were used to analyse correlations between tooth loss status and risk factors. Binomial logistic regression was used to determine the odds of having >6 lost teeth. A confidence level of 95% and a two-tailed *p*-value of 0.05 were used to determine any significant difference.

3. Results

Among the 258 elderly Vietnamese, the prevalence of missing, at least, one incisor, canine, premolar or molar were 42.2%, 20.9%, 50.4% and 89.1% respectively. The prevalence of tooth loss (canines, premolars, and molars) in the upper jaw was statistically higher than in the lower jaw, except for incisors ($p<0.01$) (Table 1 and Fig. 1).

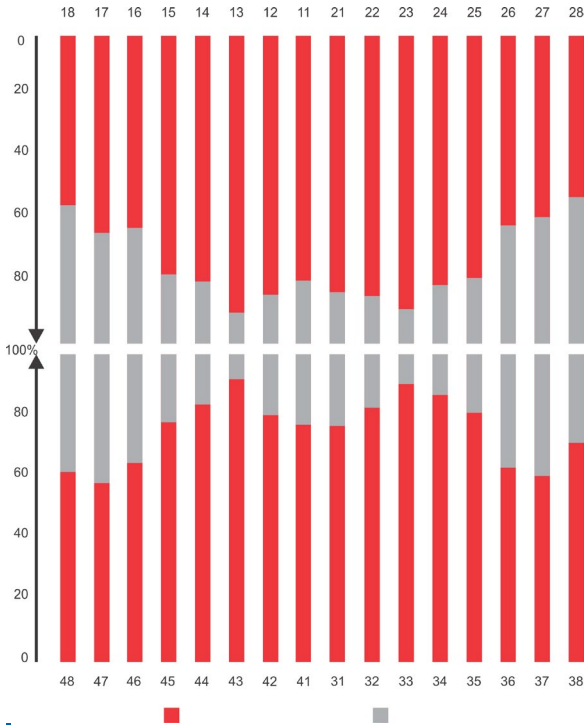

Figure 1. The distribution of tooth loss among elderly Vietnamese (red -Residual teeth; grey - Missing teeth)

Table 2 shows that the mean tooth loss for the sample was 7.6 (±7.0). Within each category of predictors, a statistically higher number of lost teeth was found for: the 70-74 age group

(Mean±SD, 8.8±7.9); rural residents (8.8±7.6); time in education ≤5 years (10.2±7.7); frequency of teeth cleaning ≤1 time/day (8.7±7.3); last visit to dentist >1 year ago (8.2±7.5); tobacco smoking (9.4±7.6), and no alcohol drinking (8.3±7.2).

Table 1. The prevalence of tooth loss for each functional group among elderly Vietnamese

Functional group	Prevalence of tooth loss (%)			*p*-value
	Upper jaw	Lower jaw	Both	
Incisor	27.9	30.6	42.2	<0.001
Canine	15.5	12.0	20.9	<0.001
Premolar	37.6	34.1	50.4	<0.001
Molar	77.5	74.8	89.1	<0.001

Chi-square test

According to the distribution of a number of lost teeth, 27.1% of the elderly participants had lost 1–3 teeth, 23.6% 4–6 teeth, 27.1% 7–16 teeth and 13.6% >16 teeth; only 8.6% had full dentition. There was a significant correlation between the distribution of a number of lost teeth and time in education, and alcohol drinking (p<0.05, Table 2).

Having >6 lost teeth was statistically significantly related to time in education, frequency of cleaning teeth, tobacco smoking and alcohol drinking (Table 2). However, the odds ratio of losing >6 teeth was calculated for time in education, tobacco smoking and alcohol drinking.

Table 2. Mean tooth loss and tooth number class percentages in relation to risk factors

Variables	n(%)	Tooth loss	*p*-value[a]	Number of lost teeth (%)					*p*-value[b]	Dichotomized number of lost teeth		*p*-value[b]
		Mean ± SD		0	1-3	4-6	7-16	>16		≤6	>6	
Age												
65-69	129(50)	6.6 ± 6.0	0.01*	10.1	26.3	28.7	26.4	8.5	0.07	65.1	34.9	0.06
70-74	129(50)	8.8 ± 7.9		7.0	27.9	18.6	27.9	18.6		53.5	46.5	
Gender												
Female	128(49.6)	8.4 ± 7.0	0.14	9.4	18.8	25.8	31.2	14.8	0.06	53.9	46.1	0.08
Male	130(50.4)	7.1 ± 7.1		7.7	35.4	21.5	23.1	12.3		64.6	35.4	
Residence												
Rural	121(46.9)	8.8 ± 7.6	0.01*	6.6	22.3	25.6	27.3	18.2	0.14	54.5	45.5	0.14
Urban	137(53.1)	6.7 ± 6.4		10.2	31.4	21.9	27.0	9.5		63.3	36.5	
Time in education												
≤5 years	105(40.7)	10.2 ± 7.7	<0.001	3.8	19.0	21.9	33.3	21.9	<0.001	44.8	55.2	<0.001
>5 years	153(59.3)	6.0 ± 5.9		11.8	32.7	24.8	22.9	7.8		69.3	30.7	
Frequency of cleaning teeth												
≤1 time/day	132(51.6)	8.7 ± 7.3	0.01*	6.8	24.2	21.2	32.6	15.2	0.24	52.3	47.7	0.02*
≥2 times/ day	124(48.4)	6.8 ± 6.7		10.5	29.0	26.6	21.8	12.1		66.1	33.9	
Last visit to a dentist												
>1 year	191(74.6)	8.2 ± 7.5	0.02*	8.9	23.0	25.1	26.7	16.2	0.09	57.1	42.9	0.28
≤1 year	65(25.4)	6.2 ± 5.3		7.7	36.9	20.0	29.2	6.2		64.6	35.4	
Tobacco smoking												
Yes	60(23.4)	9.4 ± 7.6	0.04*	8.3	21.7	15.0	38.3	16.7	0.12	45.0	55.0	0.01*
No	196(76.6)	7.3 ± 6.9		8.7	28.1	26.5	24.0	12.8		63.3	36.7	
Alcohol drinking												
Yes	56(21.9)	5.9 ± 6.4	0.02*	7.1	44.7	21.4	19.7	7.1	0.01*	73.2	26.8	0.01*
No	200(78.1)	8.3 ± 7.2		9.0	21.5	24.5	29.5	15.5		55.0	45.0	
Chronic disease												
Yes	138(53.9)	7.0 ± 7.1	0.10	9.4	32.7	21.7	23.2	13.0	0.14	63.8	36.2	0.09
No	118(46.1)	8.5 ± 6.9		7.6	19.5	26.3	32.2	14.4		53.4	46.6	
Total	258	7.6 ± 7.0		8.6	27.1	23.6	27.1	13.6		59.3	40.7	

[a]*Student's t-test*
[b]*Chi-square test*
*p<0.05

Table 3 shows the odds of having >6 lost teeth was significantly more frequent among elderly persons with less time in education (OR=2.2, p<0.01) and tobacco smoking (OR=2.8, p<0.01). However, alcohol drinking was significantly inversely associated with >6 lost teeth (OR = 0.3, p<0.01).

4. Discussion

The main finding of this study was that there was a high prevalence of tooth loss among the elderly Vietnamese aged 65-74. Tooth loss might impact the general health, cause the loss of mastication and reduce the quality of life[2,3].

Over ninety percent of the elderly Vietnamese presented tooth loss condition. This result was in line with the study conducted in the South Vietnam where 96% of the older population had missing teeth[11]. We found that posterior teeth lost more

often than anterior teeth. This finding is expected because of the morphology of the occlusal surfaces of posterior teeth, which easily accumulates plaque and food debris. Furthermore, it was often difficult for the elders to perform oral hygiene on the last position of the dental arch, and this could increase the risk of caries and periodontitis, leading to tooth loss.

We observed that the prevalence of losing canine and posterior teeth of the maxilla were statistically higher than that of the mandible. The maxilla is known as the spongy bone type, and the mandibular is of the compact bone type; consequently, inflammation of the supporting bone in the maxilla could lead to a more rapid resorption of bone and earlier tooth loss than in the mandibular[12]. However, our finding was in contrast with the study of Nguyen et al.[11], which indicated that loss of lower posterior teeth was more frequent than that of upper posterior teeth.

The elderly Vietnamese had an average of 7.6 missing teeth. At the same age group, this observed number is higher compared to the study conducted in Australia (5.3)[13], Turkey (7.0)[14], but lower than the one reported in China (11.2)[8], and Brazil (26.1)[15]. Regarding the influence of sociodemographic factors on tooth loss, participants aged 70–74 had lost significantly more teeth on average than those aged 65–69. This finding was in agreement with previous studies, which indicated that the number of lost teeth tends to increase with age[14,15].

Maintaining more than 20 teeth is a core mission of Oral health care programmes for the older population[16]. Approximately 60% of the elderly Vietnamese still had 20 teeth or more. This prevalence was far lower compared with the findings in a neighbouring country[17], but in line with a study conducted in Iran[18], and higher than the ones reported in Turkey[14].

Table 1. The odds of >6 lost teeth in relation to risk factors

Variables	Odds ratio		
	OR	95% CI	*p*-value
Frequency of cleaning teeth			
≥2 times/day	1.0(ref)		
≤1 time/day	1.4	0.8-2.7	0.15
Time in education			
>5 years	1.0(ref)		
≤5 years	2.2	1.3-3.8	0.004*
Tobacco smoking			
No	1.0 (ref)		
Yes	2.8	1.4-5.6	0.003*
Drink alcohol			
No	1.0 (ref)		
Yes	0.3	0.1-0.7	0.003*

Binary logistic regression
*Ref: reference, * p<0.01*

Rural residents had significantly higher tooth loss than urban residents. This reflected the difference in oral health services among regions in Vietnam where the density of dentists in the rural area was much lower than in the urban area (1/200,000 for rural vs. 1/13,500 inhabitants for urban)[11]. Moreover, the elderly Vietnamese living in a rural area often prefer to remove a painful tooth rather than having it restored because they think that tooth loss is a natural part of the aging process.

The frequency of dental visits reflect the attitudes of the patient or the provider, accessibility to dental care and prevailing societal attitudes regarding oral health care. We found that 74.6% of the elderly Vietnamese ignored an oral health check-up during the previous year, they only visited dentists with the unique aim to remove teeth due to an acute toothache or an impaired ability to chew (i.e. mobility teeth). Moreover, material and transportation-related obstacles, especially in the rural areas, are also factors that limit access to oral health care services[19,20]. Therefore, the number of teeth lost in this group was much higher than those who annually visited the dentist for oral care. Our finding was close to the third China National Oral Health Survey. This survey reported that more than three-fourths of the Chinese aged 65–74 had missing teeth more often than those who regularly visited a dentist[8].

The risk factors for tooth loss have been studied all over the world. However, as far as we know, no data have been reported on the risk factors of tooth loss in Vietnam. Lack of knowledge among the elderly Vietnamese regarding oral health might be influenced by the level of education[21]. Forty percent of the elderly Vietnamese in the current study who were in education ≤5 years had lost 10.2 teeth on average. Their education might have been interrupted due to the Vietnam War (1945–1975). The subjects believe that the prolonging the existence of a tooth in their mouth would have an adverse impact on the life of their descendants. Also, the elders with less time in education were significantly associated with the odds of losing >6 teeth (OR=2.2), it might be due to the lack of awareness about oral health behaviours for maintaining teeth.

In the current study, we found that smokers (23.4%) had significantly higher tooth loss (9.3±7.6) than non-smokers (7.2±6.8). It could be due to the well-

known fact that tobacco smoking can increase the risk for periodontitis. Substances in tobacco might facilitate the accumulation of bacteria and lead to the destruction of tooth-supporting tissue[22]. Our study indicated that the odds ratio for smokers losing >6 teeth was 2.8 as compared to non-smokers. These results are similar to those of studies in Japan and China[23,8]. Reports about the relationship between alcohol consumption and tooth loss have been focused on dose-related effects. Some studies have shown that drinking causes periodontitis, with the latter considered a risk factor for tooth loss[7,24]. However, alcohol consumption was not considered as indicator for losing >6 teeth in the current study. The similar findings were also reported by Yoshioka et al.[23], and Eustaquio-Raga et al.[25]

The shortcomings of our study were that the quantity and frequency of alcohol consumption were not accurately measured, and the reason for tooth loss (due to dental caries or periodontal disease) could not be exactly determined. A further study is required to investigate the impact of tooth loss on the function of the stomatognathic system in the elderly persons.

5. Conclusions

The data obtained allowed us to conclude that there were high prevalence and a high number of teeth lost among elderly Vietnamese. Smoking behaviour and time in education were significantly related to maintaining teeth of the elderly community population. The data serve setting up an oral health intervention programme for the older Vietnamese.

Acknowledgements

This study was supported by an Estonian Science Foundation grant (No. 9255), IUT20–46 grant from the Estonian Research Council and the DoRa Doctoral Studies and Internationalisation Programme. The authors declare no conflict of interest related to this study.

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Questions

According to the WHO, which age group represents the older population in the oral health survey?

❑a. Over 60 years old;
❑b. From 60 to 80 years old;
❑c. From 65 to 74 years old;
❑d. It depends on the method of study.

According to the WHO, as the target of oral health care older people have to:

❑a. Maintain at least 20 functional teeth;
❑b. Maintain at least 16 functional teeth;
❑c. Visit a dentist twice a year;
❑d. Have prosthesis to replace the missing teeth.

According the Oral health survey of WHO for the older population, the M component in the DMFT index represents a missing tooth due to:

❑a. Dental caries, excluding the third molar;
❑b. Periodontal disease, excluding the third molar;
❑c. Dental caries and periodontal disease, excluding the third molar;
❑d. Any reason, including the third molar.

Which score of DMFT represents a high level of dental caries among the older population?

❑a. DMFT≥ 8;
❑b. DMFT≥10;
❑c. DMFT≥12;
❑d. DMFT≥14.

"DOUBLE STEP REVERSE" (DSR): A NEW PROTOCOL IN POLYVINYLSILOXANES (PVS) IMPRESSION-TAKING PROCESS - TWO CASE REPORTS

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Received: July 08, 2016
Revised: August 03, 2016
Accepted: September 10, 2016
Published: September 12, 2016

Cite this article:
Manca E, Fazio M, Aiuto R, Derchi G. "Double Step Reverse" (DSR): a new protocol in polyvinylsiloxanes (PVS) impression-taking process - two case reports. Stoma Edu J. 2016;3(3-4):184-192.

ABSTRACT **DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.8**

Aim
The aim of this case report is to describe a new protocol which can be useful to the clinician and can lead to a less frustrating process while taking dental impressions for fixed prosthodontics.
Summary
With the "Double-Step Reverse" technique it is shown that it is easier to take excellent impressions, especially in the post-space and in the multiple preparation impressions, without worrying about V-shaped voids and bubbles on the finishing line.
Key learning points
The DSR protocol requires that the wash material (Aquasil Ultimate) is first delivered on preparations, then we wait for its complete setting and later we deliver the tray material, with an impression tray. The DSR technique allows greater patient cooperation and greater serenity during the 3 minutes of the setting time. It is time-saving and reduces the waste of polyvinylsiloxanes (PVS) materials.
Keywords: prosthetic dentistry, PVS impressions, accuracy, dental materials, double-step impressions.

1. Introductions

The impression-taking process has always been a delicate step in fixed and removable prosthodontics; several techniques and materials have been evaluated with varying degrees of success. The scientific papers provide us with comparisons between different impression techniques and different materials, so it is hard to find a unique agreement. On the other hand, the dental supplies offer many types of hydrocolloid materials, polyether, polysulfide and polyvinylsiloxanes (PVS).
The importance of the quality of a dental impression is well known and it is shown by many articles that compare not only the available materials[1-2-3], but also the impression techniques [4-5].
Material and technique are not the only factors that affect the accuracy of impression. In 2004 Perakis, Belser, Magne[6-7], in a review, considered, among other things, the rheology of materials, remembering the three phases of process:
1) Viscous phase which allows mixing and handling;
2) Plastic phase for the adaptation to the anatomy of the mouth;
3) Elastic phase that allows the removal of the material overcoming any undercuts.
The authors pointed out that polyvinylsiloxanes (PVS) move rapidly from a viscous to an elastic phase, then requiring a short working time after mixing. Thus, compared to polyether (PE), PVS have a shorter plastic phase.
On the other hand, the rigidity of the PE, twice as double the PVS, often makes the disconnection difficult. These data are confirmed by the work of McCabe in 1998[8].
A brand new PVS, coupled with a handpiece that is attached to the turbine hose, mixes and dispenses the wash material under pressure. Thanks to the characteristics of this new PVS and method of application it is possible to apply the wash material on preparations, then wait for its complete polymerization and later on the tray material is applied. This is called the new Double Step Reverse technique (DSR).
The purpose of this paper is to show a new protocol to take impressions in polyvinylsiloxanes (PVS)

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Figure 1. Tooth #13 with a very old crown

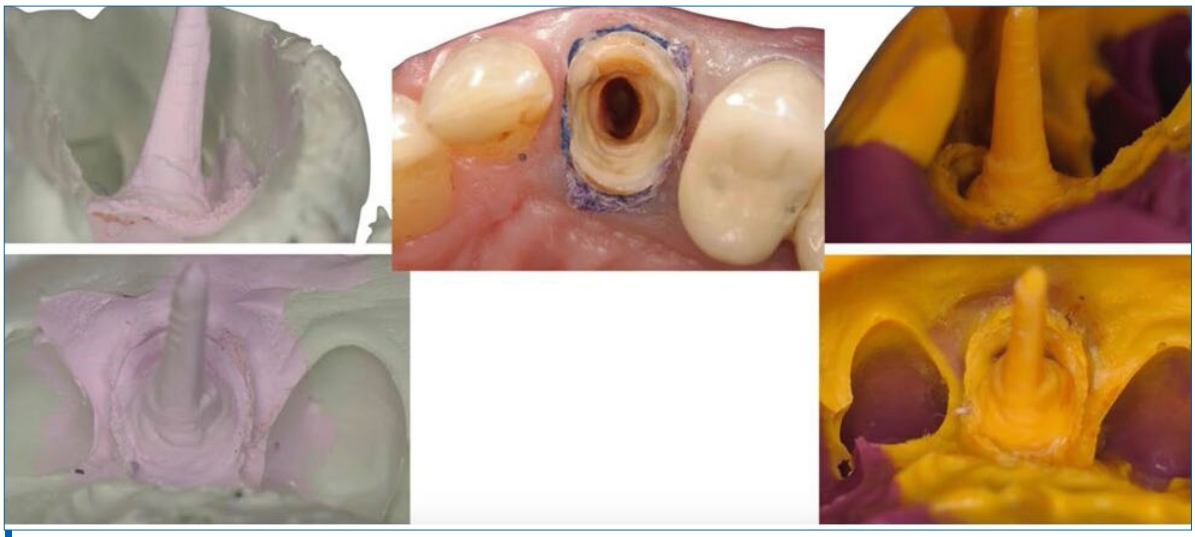


Figure 2. Post-space impression with Aquasil Ultimate on the left and Aquasil XLV on the right

by means of an Aquasil Ultimate system. The Double Step Reverse technique wants to overcome the limitation of the speed of execution, required by PVS, to keep the same application mode of Putty-Wash 1-step/ two-component technique, an is aiming to manage all the issues related to the hasty procedure of the latter.

We then aim to compare the Putty-wash 1 step technique with polivinylsiloxanes (A-silicone) and the new Double Step Reverse (DSR) with the innovative Aquasil Ultimate impression system.

In the first study, we took two impressions of each one of a 10-patient group who needed fixed prosthesis (one or more elements): one for each technique. Our laboratory then made two prosthesis for each patient. The controls were carried out on plaster models and on the patient's mouth, checked through an optic microscope, "Fit Checker" and probing of the closing edge was also done. The 30 elements examined were eligible for cementation without any evidence of dimensional differences; the closing edge has shown to be clinically acceptable in the range of 40-120 µm as indicated by McLean already in 1971[1]. The new DSR technique has shown to be clinically similar to the traditional one. The advantages were: ease of operation thanks to an easier control of the field that is free from saliva and crevicular fluids during placement of the wash, the respect of the reticulation times even in case of multiple teeth impressions and the elimination of errors due to the proper control of the thrust of the tray material ("V-shaped" voids). Moreover the patient accepted this technique well as shown by the final survey.

This work aims to describe a new workflow in the polyvinylsiloxanes (PVS) impression taking (Aquasil Ultimate, Dentsply). A handpiece connected to the air circuit of the dental unit mixes and dispenses the "wash" material pressurized. The system involves the use of a PVS provided in two textures: a "Type-3" (Aquasil Ultimate Wash) and a "Type 2" (Aquasil Ultimate Tray) according to ISO 4823.

Both the chemical and physical properties of the material allow the adoption of a new protocol in impression taking that leaves the clinician enough time to deliver the PVS in compliance with the working time specified by the manufacturer without having to rush the procedure for multiple preparations. As to do so, it is possible to have a precise control of the field and of the single elements. The new protocol is not found in the literature yet, as this new system has been available for a short time.

The procedure, called "**DSR**" (**Double Step**

Figure 3. Dies made from an Ultimate impression (U) and from Aquasil XLV + monophase (A)

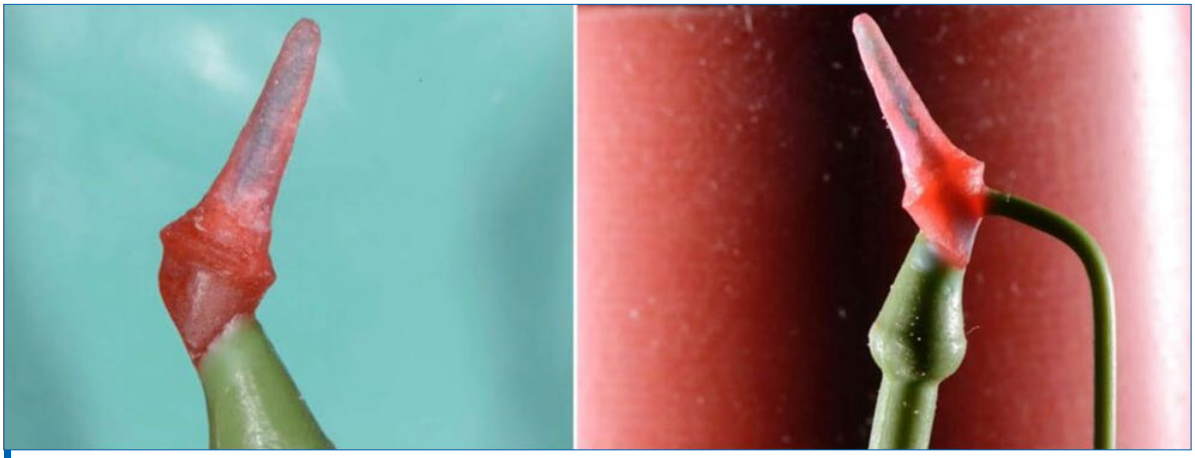


Figure 4. The duralay post ready to be transformed in a "Bio-HPP" post

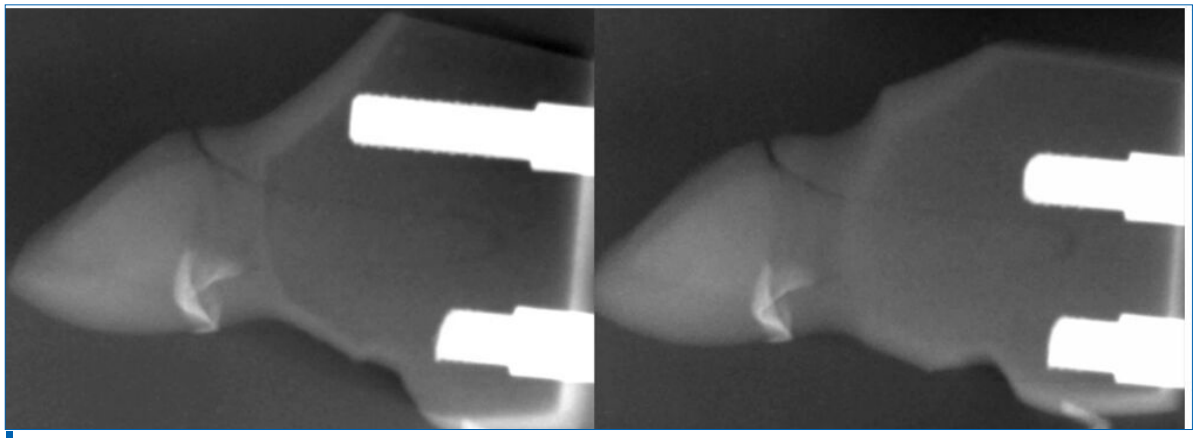


Figure 5. Endorsal x-rays that shows the space between posts and dies (Left: DRS impression, Right: traditional impression)

Reverse), requires the operator to place the intrasulcular tip straight into the sulcus for a direct material "wash" placement and leave the material wash to fully set. Exploiting the power of air-pressure, the clinician is able to precisely place the wash material over the margins in a single step without having to retract the tissues with any retraction cord or astringent paste.
Once set, the wash material is ready to be taken away from the mouth, by inserting an impression tray (with a "tray material") and positioning in patient's mouth, over the wash material.
After the recommended setting time (3 minutes), the operator removes the tray and performs a visual inspection.
The hypothesis of this work is the clinical verification of the results obtained by applying either the new DSR technique and the well-known protocol[3-6,8-9]. Putty-wash 1-step that instead recommends to place the wash material (type 3) on the preparations then the heavy-viscosity or monophase material (type 1-2).

2. Cases Reports

2.1. Case Report n°1

Tooth #13 shows a very old ceramic crown with a considerable misfit, which hides a damaged and aged core structure so that it requires a thorough

Figure 6. The sequence that leads to the definitive crown

Figure 7. Before and after the prosthetic procedures

Figure 8. Teeth #16 and #17 are in need of prosthetic treatments

replacement. (Fig.1)
We removed the metal post by means of an ultrasonic insert and then it is time to take a couple of impressions.
The First one is made following the protocol of the "DSR" technique: the "Wash material" (Aquasil Ultimate Wash), after being left for 3 minutes within the root canal, is covered and firmly bonded by the "Tray material". These two materials, after their setting time, are ready to be removed from the arch.

The Second impression is made of an eXtra-Light Viscosity (Aquasil XLV) in a monophase technique, where a lentulo is used to push the XLV material deep inside the root canal, gaining more push from the subsequent monophase material, delivered by an impression tray. (Fig. 2)
At this time, two dies are made and tagged as "U" (which stands for Ultimate) and as "A" (for Aquasil Monophase) (Fig. 3); then sent to the laboratory where they make two *duralay* resin posts according to the plaster models.

Figure 9. Juxta-gingival finish line preparation for both teeth and retraction cord to highlight the end of the preparations

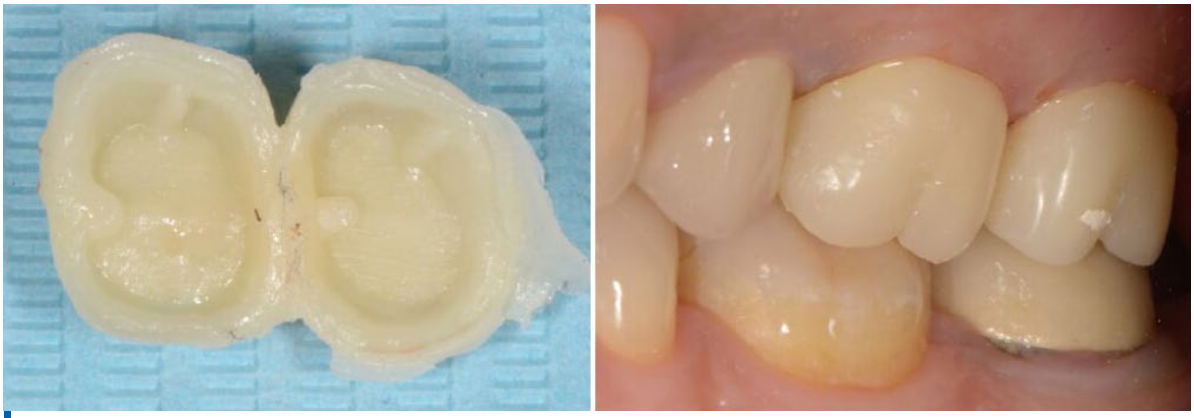


Figure 10. The temporary crowns after a direct rebasing

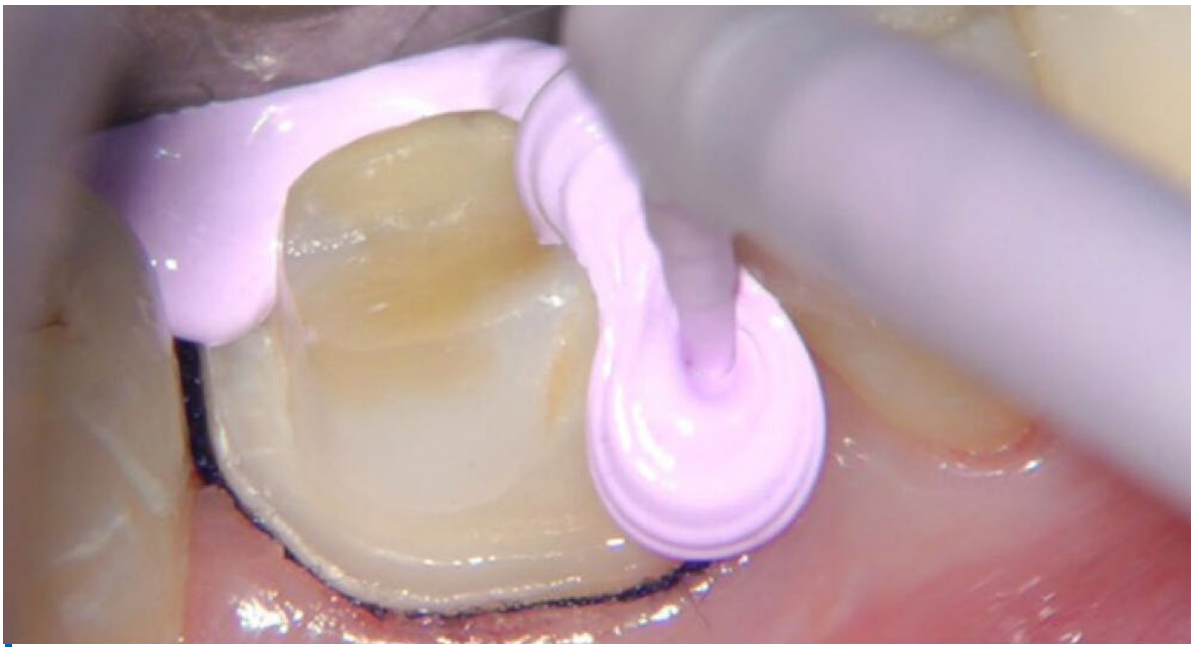


Figure 11. With a retractin cord into the sulcus, Aquasil Ultimate Wash material is delivered onto the teeth and let set for 3 minutes

Through the process of thermocompression, the duralay posts are transformed in two "Bio-Hpp" (Bredent) posts. The material is called "PEEK" (PolyEther-Ether-Ketone) and one of its characteristics is a fact that it has got a Young module very similar to the one of human dentine. (Fig. 4)

The two Bio-HPP are tried into the casts to make sure they are tight-fitting and then coated with composite resin; so as to do that we create a so called "*Post-Crown*" made of a *Bio-Hpp* core and composite resin on the outer layer.

Figure 12. In this impression the wash material is slightly different from the previous, since it is designed for multiple teeth impression and it has a longer setting time

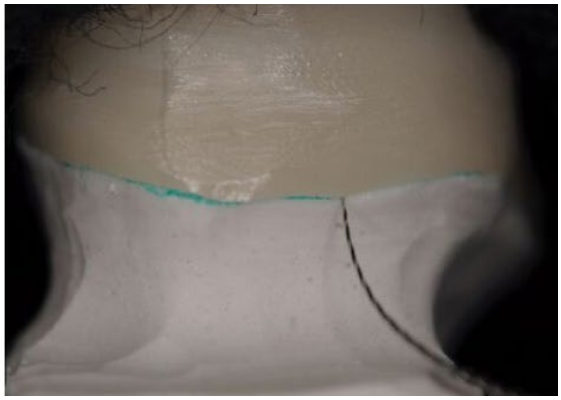
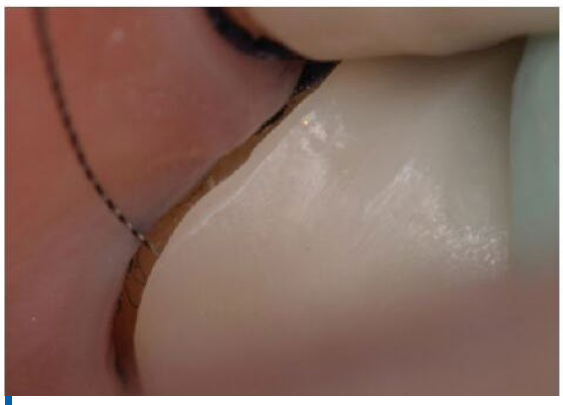


Figure 13. The finishing line is checked through an optical microscope and probed through endo files .06



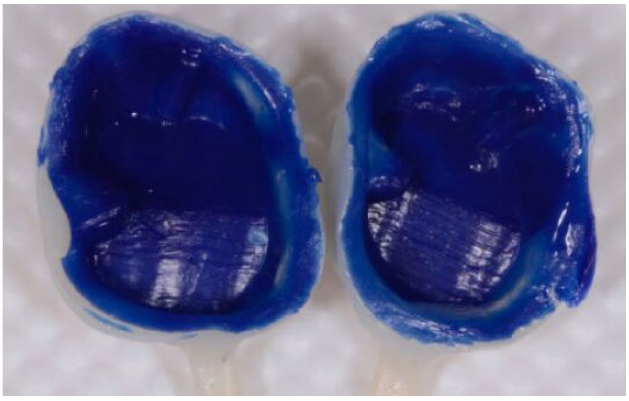


Figure 14. Further evaluation with Fit Checker Blue GC

Endoral x-rays are performed for both the models, in order to radiologically evaluate the spaces beneath the dies. (Fig. 5)
The digital x-rays show that the results are almost completely identical, therefore attesting that both the impressions and the dies are basically very reliable in terms of accuracy.
Hence the post-crown, crafted according to the DSR impression, is cemented with a radiopaque resin-based cement and hence an x-ray is taken.
Radiographically, we are able to evaluate the equal distribution of the cement all around the post.
Once we proceed with the cementation of the Crown-post, the tooth is ready to be prosthetically prepared and then another DSR impression is taken immediately. With such an accurate impression, the laboratory can craft a definitive ceramic crown with a high grade of precision. (Fig. 6)
The two impressions are very similar, as for the accuracy of the models and for the lack of deformation of the post. (Fig. 7)
Eventually, thanks to DSR technique, we can easily

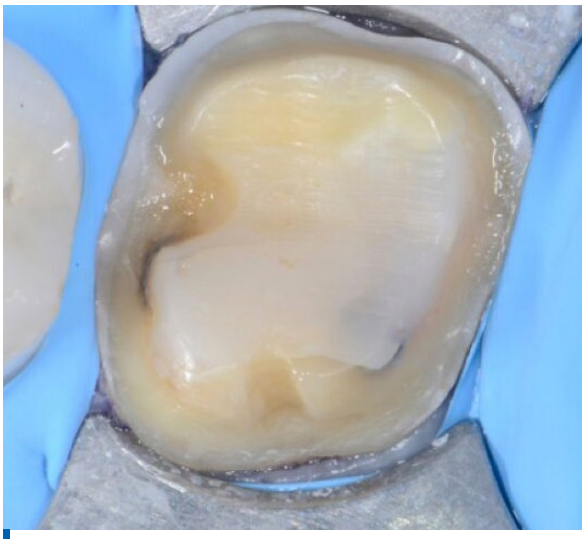


Figure 15. Dental dam application

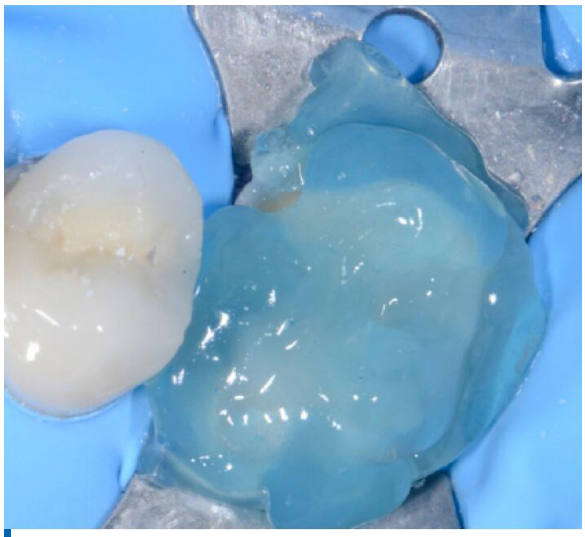


Figure 16. Etching gel on the dentin

Figure 17. Adhesive application

Figure 18. Sandblasting of the inner surface of the ceramic crown

perform an accurate impression of the root canal in case of a "post-crown" rehabilitation. This wash material has showed a "Shore hardness" of 63 and, once it is set, it does not tear off when it is time to remove the tray from the mouth.

2.2 Case Report n°2

To better highlight the advantages of this technique, we will describe another clinical case where a PVS impression with an Aquasil Ultimate system is carried out within the prosthetic rehabilitation of teeth #16 and #17 (with juxta-gingival finish line).

Case Description

A patient with a severe wear of superior posterior teeth comes to our observation, showing tooth # 17 with a massive restoration made of composite resin and #16 with a complete fracture of the disto-buccal cusp, so they are both in need of prosthetic treatments (Fig. 8).

We decided, by mutual agreement with our patient, to treat the two elements by milling a core-structure from a block of *IPS e.max ZirCAD* (Ivoclar). The CAD-CAM produced COR was veneered with *e-max* veneering ceramic. Having stated the height of the residual preparation, which guaranteed enough stability and retention of the restoration itself, a juxta-gingival abutment finish line was chosen in order to better control: the marginal trimming, the impression, the visual check of the finishing edge, the cementation and the full removal of the excess cement.

We prepared the two dental elements with a juxta-gingival finish line then we placed a retraction cord into the sulcus to highlight the end of the preparations (Fig. 9).

As for the temporary crowns, we adapted two provisional resin crowns performed in the laboratory through a direct rebasing. (Fig. 10).

We placed a retraction cord (Ultrapack #00, Ultradent) into the sulcus and, without removing the cord itself, *Aquasil Ultimate Wash* is delivered into the sulcus and on the preparations, letting it set for 3 minutes, as suggested by the manufacturer (Fig. 11).

This short time having elapsed, the tray, filled with *Aquasil Ultimate Tray*, was slowly seated on the upper arch so that the rest of the impression could be taken. In this stage, we opted for a stiff and smooth steel tray with retentive ridges where the PVS adhesive was already applied.

After 3 minutes of setting, as indicated by the manufacturer, the tray was removed from mouth

Figure 19. The crown on #16 after cementation

Figure 20. Clinical picture after the cementation of both crowns

Figure 21. The crowns from the buccal side

(Fig.12), then controlled under microscope (Leica M400 optical) at 40x of magnification and, at the end, was sent to the laboratory. After the laboratory phase, the finishing line of the cases on the respective abutments was checked through an optical microscope and probed carefully through endodontic files from 06 to 150 (according to ISO standards) in order to properly assess any hidden gaps (Fig. 13).
In the same way, we checked directly in the mouth, with Fit Checker Blue GC before resending the substructures to the laboratory for the ceramic layering. The definitive crown was again controlled and it was clear that there was no more than 120 µm and a maximum gap of 1/10 of the entire extension edge of the crown of 1.6, it was decided to proceed with cementation under dental dam for every single crown (Figs. 14 to 21).

3. Discussion and Results

By obtaining the absolute accuracy of the impressions, this new protocol allows the clinician to take impressions of multiple preparations without worrying about the setting times of PVS when he combines both wash and tray materials. The Double Reverse Step gives enough ease to the operator, allowing him to carefully the preps and apply PVS over multiple teeth in sequence; then double-checking any potential transudation, and the presence of saliva. Furthermore, the patient's increased comfort must be considered, due to the use of less fluid materials that are not likely to leak down the throat if they are in excess, and to the decreased mouth removal time of the tray (3 minutes).

4. Conclusions

In our practice, the DSR protocol has become the standard in every clinical situation since it provides us with a perfect control of the operative field, a chance of managing any sudden problems (exudation, crevicular fluid, saliva), a drastic reduction of bubbles on the finishing line (which are often related to the delivery mode of the wash material through the syringe), the absence of the V-shaped voids that often occurs when the delivery of the wash material is delayed or due to an incorrect positioning of the impression tray (not parallel to the occlusal surface nor pushed too quickly). Eventually, we have noticed a greater patient cooperation and a greater serenity during the 3 minutes of the setting time.

Acknowledgments

The authors declares no conflict of interest related to this study. There are no conflicts of interest and no financial interests to be disclosed.

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Questions

What is meant by "DSR"?

❑a. A new kind of diode-laser;
❑b. A new impression material;
❑c. A technique used to retract tissues;
❑d. An impression technique.

What does the acronym DSR mean?

❑a. Dynamic Standard Registration;
❑b. Digital Standard Records;
❑c. Double Step Reverse;
❑d. Direct Simple Records.

According to the DSR protocol, which material is first delivered on the abutment?

❑a. Extra-Light Viscosity material;
❑b. Ultimate Wash material;
❑c. Ultimate Tray material;
❑d. Both of them together.

When it is advisable to deliver the tray material?

❑a. Once the Wash material is completely set;
❑b. Along with the Light material;
❑c. Before the Light material;
❑d. It is not required by this protocol.

A COMPREHENSIVE REVIEW OF THE LOCAL RISK-FACTORS ASSOCIATED WITH THE ETIOLOGY OF PERI-IMPLANT DISEASES

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Received: March 10, 2016
Revised: April 04, 2016
Accepted: August 05, 2016
Published: September 15, 2016

Cite this article:
Alshehri M. A comprehensive review of the local risk-factors associated with the etiology of peri-implant diseases. Stoma Edu J. 2016;3(3-4):193-199.

ABSTRACT

DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.9

Background: A variety of factors (local and systemic) have been associated with the etiology of peri-implant diseases.
Objective: The aim was to provide an overview of current literature regarding the local risk-factors associated with the etiology of peri-implant diseases.
Data sources: Indexed databases were searched till June 2016 using different combinations of the following key words: "bruxism"; "oral biofilm"; "peri-implant diseases"; "peri-implantitis", "risk-factors" and "smoking".
Study selection: Clinical studies assessing the local risk-factors associated with the etiology of peri-implantitis were included. Letters to the Editor, case-reports, case-series, in-vitro studies, studies on animal models and commentaries were excluded.
Data extraction: The pattern of the present comprehensive review was customized to primarily summarize the pertinent information.
Data synthesis: Poor bone density and volume are associated with the etiology of peri-implant diseases. Excessive plaque accumulation and history of periodontitis are core etiological factors associated with peri-implant diseases. The relative risk for peri-implantitis was significantly higher in patients with a previous history of periodontitis compared to peri-implantitis patients without a history of periodontal disease. Periodontopathogens associated with periodontitis have also been isolated from peri-implant sulci of patients with peri-implantitis. Peri-implantitis is most often manifested in patients with bruxism and tobacco smoking habit. Other factors associated with the etiology of peri-implant diseases include presence of cement excess and operator's clinical experience. Bone quality and quantity, poor oral hygiene, smoking, bruxism, occlusal overloading, history of periodontitis and operator's experience are common local factors associated peri-implant diseases.
Keywords: dental implant, osseointegration, bruxism, smoking, periodontitis.

1. Introduction

Dental implants are an innovative replacement for traditional fixed and removable dental prosthesis such as bridges and dentures, respectively[1]. Numerous studies[2-4] have reported implant success and survival rates of up to 100%. Nevertheless, with the increasing number of patients receiving dental implants, the prevalence of peri-implant diseases has also increased[1,5]. Peri-implant diseases are categorized into two types namely, peri-implant mucositis and peri-implantitis. Peri-implant mucositis is characterized by soft tissue inflammation around the implant without any signs of alveolar bone loss[6]. The clinical signs of peri-implant mucositis include bleeding on probing (BOP) and/or suppuration, which are usually associated with probing depth (PD) of at least 4 millimeters (mm) with no evidence of radiographic loss of bone[7,8]. According to a consensus report from the 6th European Workshop on Periodontology, peri-implantitis is defined as the presence of inflammation of the peri-implant mucosa and concurrent loss of supporting alveolar bone[6]. Mombelli et al.[9] described peri-implantitis as a site-specific inflammatory condition, which displays clinical and radiographic features that

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are similar to those in patients with chronic periodontitis. Data regarding the prevalence of peri-implantitis are inconsistent. In the study by Koldsland et al.[10], the prevalence of peri-implantitis ranged between 11.3% and 47.1%; whereas Mombelli et al.[11] reported peri-implantitis in 20% of their study population during 5 to 10 years of follow-up. In the study by Zitzmann and Berglundh[6], the frequency of peri-implantitis varied between 28% and at least 56% of the participants and 12% and 43% of individual implants.

A variety of factors (local and systemic) have been associated with the etiology of peri-implantitis[12-16]. The most common local factor that has been reported to trigger an inflammatory response around dental implants is the oral biofilm. Moreover, tissues around implants are also more susceptible to oral biofilm-associated infections that spread into the alveolar bone and may cause bone loss[17]. Furthermore, a variety of destructive inflammatory cytokines have been identified in the peri-implant crevicular fluid of patients with peri-implantitis[18]. These cytokines have been reported to aggravate peri-implant inflammation and bone loss[18]. Although biologic differences exist between natural teeth and implants, Belibasakis[19] suggested that peri-implantitis corresponds to periodontitis. Other local factors that have been associated with the etiology of peri-implantitis include quality and quantity of recipient bone, jaw location, tobacco smoking, history of periodontitis, bruxism, habitual alcohol consumption, implant surface topography and implant overloading. Nevertheless, the contribution of systemic factors such as immunosuppression (as observed in patients with acquired immune deficiency syndrome, osteoporosis, poorly-controlled diabetes mellitus and cancer) and the use of medications (such as bisphosphonates and corticosteroids) that have also been associated with the etiology of peri-implantitis cannot be disregarded[20-24].

Considering the length of the review, the author reserved the present review to comprehensively review the local risk-factors associated with the etiology of peri-implantitis. With this background, the aim of the present comprehensive review was to provide an overview of current literature regarding the local risk-factors associated with the etiology of peri-implantitis.

2. Material and methods

2.1. Focused question

The focused question addressed was "What are the local risk-factors associated with the etiology of peri-implant diseases?"

2.2. Literature search strategy

PubMed/Medline, Scopus, EMBASE, ISI Web of knowledge and Google-Scholar databases were searched till June 2016 using the following key words: "bruxism"; "oral biofilm"; "peri-implant diseases"; "peri-implantitis", "risk-factors" and "smoking". Clinical studies assessing the local risk-factors associated with the etiology of peri-implant diseases were included (Fig. 1).

2.3. Eligibility criteria

Results from only clinical studies were included. Letters to the Editor, historic reviews, case-reports, case-series, in-vitro studies, studies on animal models and commentaries were excluded. The pattern of the present comprehensive review was customized to primarily summarize the pertinent information (Fig. 1).

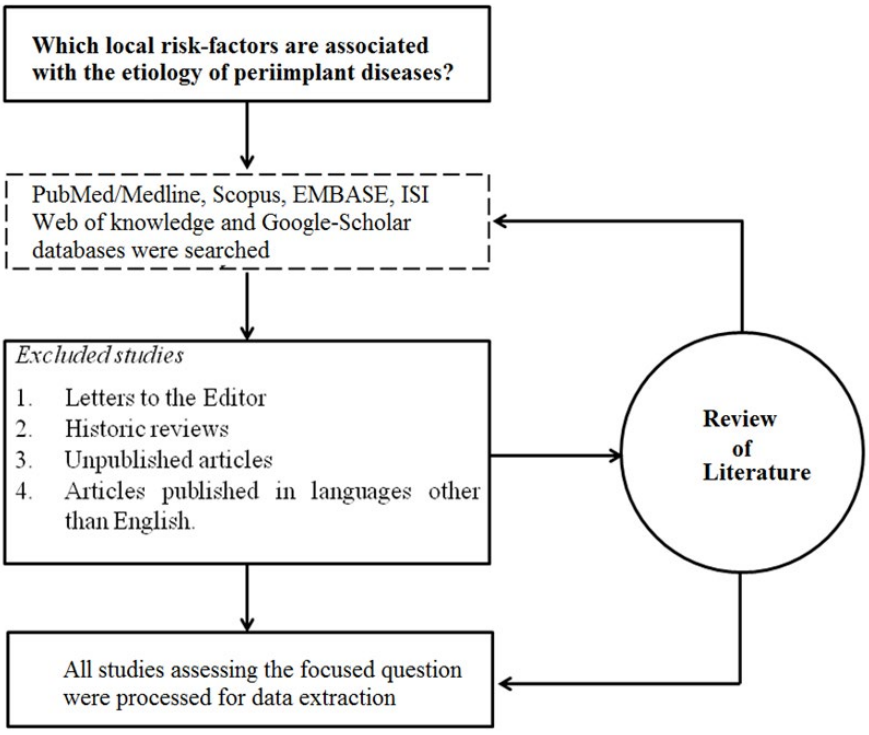

Figure 1. Literature search strategy

3. Results

Local risk-factors associated with the etiology of peri-implant diseases are summarized in Fig. 2.

3.1. Bone quality

Studies have reported that peri-implant bone loss is more often manifested in the maxilla, which is composed of less dense bone as compared to the mandible. It has also been suggested that compromised bone density is the most critical factor associated with peri-implant bone loss[25]; whereas others suggest that both poor bone density and volume are associated with the etiology of peri-implant diseases and bone loss[26-27].

3.2. Poor oral hygiene

Studies from human biopsies[28,29] have shown that peri-implantitis and periodontitis lesions have several features in common. One of such features is poor oral hygiene maintenance. The dental plaque is the core etiological factor that causes the development of oral biofilm around the teeth and dental implant surfaces[30-34]. In the study by Serino and Ström[35], most of the implants with a diagnosis of peri-implantitis were associated with no accessibility and/or capability for appropriate oral hygiene measures. This study[35] concluded that oral hygiene at the implant sites is most likely associated with the presence or absence of peri-implantitis. Moreover, studies[36-42] have also reported that microbes residing in the oral biofilm such as *Aggregatibacter actinomycetemcomitans*, *Enterococcus fecalis*, *Porphyromonas gingivalis*, and *Staphylococcus aureus* (which are also associated with the etiology of periodontitis) play a role in the initiation of peri-implantitis. It is therefore predictable to find a significant relationship between peri-implant bone loss and poor oral hygiene. In this regard, it is imperative for oral healthcare providers to educate patients regarding the significance of regular oral hygiene maintenance and routine dental check-ups towards the establishment of peri-implant and periodontal maintenance.

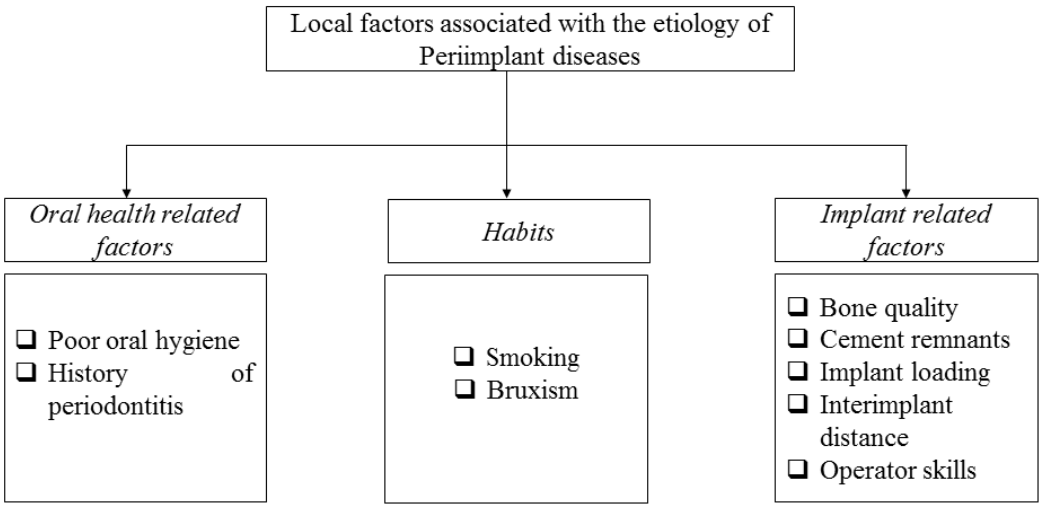

Figure 1. A diagrammatic presentation of the local risk factors associated with the etiology of peri-implant diseases

3.3. History of periodontitis

It has been claimed that peri-implantitis is a common finding in patients with a history of periodontitis[43-44]. Results from a systematic review and meta-analysis showed that the relative risk for peri-implantitis was significantly higher in patients with a previous history of periodontitis compared to peri-implantitis patients without a history of periodontal disease[43]. However, in a recent study, Meyle et al.[45] investigated the long-term clinical and radiographic parameters of osseointegrated implants in non-smoking patients with a previous history of chronic periodontitis. The results showed that patients with a previous history of periodontitis regularly attending an oral hygiene maintenance program displayed implant survival rates up to 100% after 5 and 10 years. Similarly, in a systematic review, Pesce et al.[46] concluded that there is a lack of consensus regarding the role of periodontitis in the etiology of peri-implantitis. Nevertheless, since several periodontopathogens (such as *Aggregatibacter actinomycetemcomitans*, *Prevotella intermedia* and *Porphyromonas gingivalis*) associated with the etiology of periodontitis have also been isolated from peri-implant sulci of patients with peri-implantitis[47-50]. In a recent study, Jorand et al.[30] reported that *Desulfovibrio fairfieldensis* is one of the most relevant sulphate-reducing bacteria of the human oral cavity suspected to be involved in peri-implantitis and implant corrosion. It is arduous to disregard the hypothesis that peri-implantitis is more common in patients with a history of periodontitis.

3.4. Smoking

It is well-established that periodontal inflammation and marginal bone loss are more often manifested in tobacco smokers as compared to individuals not using tobacco in any form[51-54]. Studies[12,55-57] have also reported that cigarette smokers are more susceptible to develop peri-implantitis as

compared to non-smokers. In a systematic review and metaanalysis, Sgolastra et al.[57] assessed the role of smoking as a risk factor for peri-implantitis. The implant-based meta-analysis showed a significantly higher risk of peri-implantitis in smokers [Relative risk: 2.1, 95% Confidence interval: 1.34-3.29, p = 0.001) than non-smokers. The mechanism behind peri-implant bone loss in smokers is most probably similar to periodontal bone loss. Tsigarida et al.[12] proposed that that smoking shapes the peri-implant microbiomes even in states of clinical health, by supporting a pathogen-rich community. Although the mechanisms by which smoking enhances alveolar bone loss are poorly understood; evidence suggests that smoking enhances bone loss by affecting the host response. Smoking has been reported to impair the function of neutrophils that cause decreased chemotaxis, phagocytosis, and adherence[58,59]. Moreover, it has also been reported that smokers present a decreased oxygen tension in periodontal pockets that could favor anaerobic microbial colonization[60,61]. The same mechanism could be associated with peri-implant diseases, such as peri-implant mucositis and peri-implantitis. It has also been suggested that there is a synergistic effect of tobacco smoking and carriage of interleukin-1 gene polymorphism that results in increased risk of peri-implantitis[62,63]. Moreover, tobacco smoking has also been reported to jeopardize the outcomes of periodontal surgical interventions[64]. Galindo-Moreno et al.[65] reported that the rates of marginal bone loss around implants are significantly associated with smoking. Results from a recent systematic review and meta-analysis also reported a significantly higher risk of peri-implantitis in smokers as compared to non-smokers[66].

3.5. Bruxism

There are only a limited number of case-reports that have associated the occurrence of peri-implantitis with bruxism. In a case-report, Merin RL[67] described the case of a 63-year-old female patient with a history of bruxism who reported to the clinic with pain and discomfort around an implant placed in the tooth no. 30 position. Radiographic evaluation showed that this implant had significant peri-implant bone loss. The author observed that the peri-implant bone loss was associated with heavy occlusion on the implant restoration[67]. The author performed an occlusal adjustment and a radiograph taken five months after occlusal adjustment showed significant repair of the lost alveolar bone[67]. Similar results were reported in another case-report by Lin et al.[68]

3.6. Cement remnants

A conventional approach towards restoration of dental implant using fixed prosthesis is the use of cement-retained restorations. In the absence of occlusal screw access openings, cement-retained restorations are useful in enhancing the number of occlusal contacts and simultaneously improving aesthetics[69]. However, inadequate removal of excessive cement at the time of implant cementation may lead to a complication, cement-induced peri-implantitis[69]. The probability of cement to remain in the peri-implant sulcus is high when margins of the restoration are placed 1.5mm to 3mm subgingivally[70]. In a recent systematic review, Pesce et al.[71] appraised the currently available scientific evidence to assess the role played by cement excess and misfitting components on the development of peri-implantitis. The authors reported that there is a correlation between cement excess and the presence of peri-implant disease, particularly among patients with a history of periodontitis[71]. The authors also emphasized that removal of excess cement by means of debridement helps resolve most of the symptoms of peri-implantitis[71]. Similarly, in a retrospective clinical observational study of fixed implant-supported restorations, cement associated peri-implantitis was assessed[72]. In this study, 71 patients with 126 implants were investigated. Cement residues were identified in 59.5% of the implants. BOP was observed in 80% of the implants and suppuration at 21.3% of the implants with excess cement. The results demonstrated that following removal of the excess cement and recementation, a 76.9% reduction in BOP occurred with no signs of suppuration at follow-up. However, according to Korsch and Walther[73], the frequency of undetected excess cement depends upon the type of cement used. Premier Implant Cement (PIC) tends to leave more undetected excess as compared to Temp Bond (TB) cement. In this regard, implants cemented with PIC tend to have a higher prevalence for peri-implant inflammation and cause a more severe peri-implant bone loss as compared to those cemented with TB[73].

3.7. Occlusal overloading

Occlusal overloading is a major cause of biomechanical implant complications including fracture and/or loosening of the implant. Occlusal overloading (combined with plaque accumulation) may also disturb the intricate bond between the implant surface and bone thereby leading to peri-implantitis and, if left untreated, implant failure[74-76]. Prevention of occlusal overloading is associated with performing comprehensive examinations, treatment planning, well-defined surgical and prosthetic treatments and regular maintenance. However, conflicting results have also been reported[77,78]. In a study on dogs, there was no loss of osseointegration and/or peri-implantitis following a period of 8 months of excessive occlusal load on titanium implants[78].

3.8. Interimplant distance

Studies have reported that the horizontal distance between two adjacent implants can also influence CBH[79-81]. It has been reported that when two implants are placed adjacent to one another, the distance between them influences the degree of lateral bone loss and interproximal bone peak resorption[81]. This phenomenon is

independent of the time of implant loading and surface characteristics[82]. In a histomorphometric study, Elian et al.[83] compared the effects of two interimplant distances (2 mm and 3 mm) on bone maintenance with bone level implants. The results showed that the interproximal bone loss measured from the edge of the implant platform to the bone crest was not different for interimplant distances of 2 mm or 3 mm. Moreover, according to Tarnow et al.[81], an interimplant distance of greater than 3 millimeters (mm) between two adjacent implants helps preserve the interproximal bone peak and results in an average bone resorption of 0.45 mm up to 3 years of follow up. However, under circumstances where the distance between the implants is less than or equal to 3 mm, the average resorption of the interproximal bone peak increases to 1.04 mm, which in turn compromises support for the interimplant papilla[81]. Results by Tarnow et al.[81] also demonstrated that when the distance from the base of the contact point to the crest of bone was 3mm, 4mm or 5 mm, the papilla was present almost 100% of the time; however, when the distance was 7mm, 8mm, 9mm, or 10 mm, the papilla was mostly missing. To the author's knowledge from indexed literature, the influence of interimplant distance on crestal bone loss around dental implants remains unclear.

3.9. Surgical skills and experience of operator

Surgical trauma and/or limited clinical experience have been considered as one of the most essential factors associated with the etiology of peri-implant diseases[84,85]. It has been reported that peri-implant disease are more often manifested among authors who have placed less than 50 dental implants as compared to those who have placed more than 50 implants[86,87]. Moreover, overheating of bone during implant placement procedures may result in osteonecrosis thereby inviting peri-implant diseases and even implant failure[88].

4. Recommendations

It is highly recommended that oral healthcare providers practicing implant dentistry should be aware of the risk factors associated with periimpalnt diseases. Adequate knowledge of such risk-factors may also be useful in selecting patients for future implant therapy. Simultaneously, it is imperative for healthcare providers to educate their patients (including those who have either received dental implants or those that are potential candidates for future dental implant therapy) about the detrimental effects of these risk-factors on the long-term success and survival of dental implants.

Conflict of interest and financial disclosure

The author reports no conflict of interest and there was no external source of funding for the present study.

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Questions

Peri-implant mucositis is characterized by

❑a. Necrotizing gingiva;
❑b. Bone loss;
❑c. Soft tissue inflammation;
❑d. None of the above.

Peri-implantitis corresponds to periodontitis. However, it does not cause bone loss:

❑a. Both statements are true;
❑b. Both statements are false;
❑c. The first statement is false but the second statement is true;
❑d. The first statement is true but the second statement is false.

The risk factors of peri-implantitis include:

❑a. Smoking;
❑b. Poor oral hygiene;
❑c. Bruxism;
❑d. All of the above.

Occlusal overloading of the implant may be prevented by

❑a. Using short implants;
❑b. Using cement retained implants;
❑c. Comprehensive examination and treatment planning;
❑d. Using wide diameter implants.

GINGIVAL INFLAMMATION AS A SIGN OF DIABETIC SYSTEMIC CHRONIC COMPLICATIONS

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Received: April 14, 2016
Revised: April 28, 2016
Accepted: May 27, 2016
Published: June 01, 2016

Cite this article:
Obradović RR , Mitić AD, Kesić LG, Pejčić AS, Todorović KM, Petrović MS. Gingival inflammation as a sign of diabetic systemic chronic complications. Stoma Edu J. 2016;3(3-4):200-204.

ABSTRACT **DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.10**

Introduction: Diabetes mellitus (DM) is a chronic metabolic disorder and the high level of blood glucose has profound effects on various systems of the human body. DM increases the risk of periodontal disease and the severe periodontal disease often coexists in diabetic patients with poor glycemic control. The aim of the study was to analyse periodontal health in patients with diabetes mellitus type 2 related to diabetic complications and glycohemoglobin A1c values.
Methodology: One hundred patients with periodontitis and type 2 DM participated in the study. According to the glycohemoglobin A1c value they were divided in 4 groups: group 1 (4%-6% normal), group 2 (6.1%-7% good), group 3 (7.1%-8% moderately poor), group 4 (> 8% poor metabolic control). The presence of chronic systemic microvascular diabetic complications (retinopathy, nephropathy and neuropathy) was recorded and periodontal assessments (Plaque, Gingival, Calculus and Periodontal Disease Index) performed. The results were statistically analysed using MS Office Excel, program SPSS, 15.0 version.
Results: Gingival index values depended on the level of HbA1c values and higher values of the Gingival and Periodontal Disease Index were noticed as the value of glycohemoglobin A1c was rising (p<0,001). Gingival index values were higher in diabetics with diabetic chronic microvascular complications (p<0.001).
Conclusion: It is observed that pronounced gingival inflammation in diabetics is associated with systemic diabetic complications and poor glycemic control.
Keywords: diabetes mellitus, glycohemoglobin A1c, diabetic complications, gingival inflammation, periodontitis.

1. Introduction

Diabetes mellitus (DM) is a chronic metabolic disorder caused by the ineffectiveness of the insulin produced or by deficiency in production of insulin by the pancreas. Among diabetic patients over 45 years old, more than 95% patients have type 2 DM[1].
The high level of glucose present in the blood has profound effects on various systems of the human body[1]. The determination of glycohemoglobin A1c (HbA1c) levels provides an estimate of the average blood glucose level over the preceding one to three months. The higher average blood glucose levels reflect in higher HbA1c values[2]. HbA1c level is of major clinical values in assessment diabetes prognosis and correlates well with the development of diabetic complications. The recommended HbA1c target value for people with diabetes mellitus is <7.0% and achieving this goal is very difficult[3]. DM significantly increases the prevalence, severity, and rate of progression of periodontal disease, and periodontal disease is

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recognized as one of the complications of DM[4-8]. What is less clear is the impact of periodontal disease on glycemic control of DM and the mechanisms through which this occurs. Some authors suggest that an intensive gingival inflammation relate to poor glycemic control and multiple diabetic complications[7-11]. Periodontal disease may be more frequent and severe in diabetic individuals with more systemic complications. The evidence suggests that mechanisms which account for the development of systemic diabetic complications might also be crucial in the pathogenesis of increased periodontal destruction in DM[12,13]. The diabetic state impairs the synthesis of collagen and glycosaminoglycan, enhances crevicular fluid collagenolytic activity which lead to the loss of periodontal fibres and loss of the alveolar supporting bone[14,15]. This predisposes to chronic inflammation, progressive tissue breakdown and diminished tissue repair capacity. These mechanisms cause periodontal tissue breakdown and loosening of the teeth[14-16].

The increased activity of periodontal disease in diabetic patients does not correlate with levels of plaque and calculus which do not have higher values in diabetic patients. Collectively, the evidence supports the theory that there is a relationship between the two diseases, especially in patients with poorly controlled DM[17]. This proposed dual pathway of tissue destruction suggests that control of DM is necessary for achieving long-term control of periodontal disease[7-11].

2. The aim of the study

The aim of the study was to analyze periodontal health in patients with diabetes mellitus type 2 related to diabetic complications and HbA1c values.

3. Methodology

3.1. Study design and subjects

This clinical study was carried out as a joint collaboration between Department of Endocrinology and Department of Periodontology and Oral medicine, Niš University, Faculty of Medicine. The study protocol was reviewed and approved by the Niš University Faculty of Medicine Institutional Ethical Committee (identification number 01-2800-7) and in accordance with the Helsinki Declaration of 1975, as revised in 2000.

3.2. Subjects

Patients with periodontitis and DM were selected from the pool of followed patients at the Department of Endocrinology, Niš University Medical Center. After the patient history was taken, patients who had acute systemic or oral disease, autoimmune diseases, hemorrhagic disorders, who had undergone antibiotic and corticosteroid therapy in the last three months, as well as patients who had periodontal treatment in the last three months were not included in the study.

One hundred patients with periodontal disease and type 2 DM, 48 (48%) women and 52 (52%) men, the mean age 62.57±8.57 years participated in the study. The HbA1c level was taken from the patient records. In the analysis according to the HbA1c values patients were divided in four groups: group 1 (4%-6% HbA1c; normal metabolic control), group 2 (6.1%-7% HbA1c; good metabolic control), group 3 (7.1%-8% HbA1c; moderate poor metabolic control), group 4 (> 8% HbA1c; poor metabolic control).

The presence of chronic systemic microvascular diabetic complications (retinopathy, nephropathy and neuropathy) was recorded from patients records, and according to presence of these complications patients were divided in groups: patients with chronic systemic DM complications (group A) and patients without chronic systemic DM complications (group B).

3.3. Oral examination protocol

The periodontal assessments were performed by a single examiner on four sites per tooth (mesio-buccal, disto-buccal, mesio-lingual, disto-lingual) for all (third molars excluded) fully erupted permanent teeth, using a manual periodontal probe. Using the tip of the periodontal probe inserted into the pocket with constant probing force the following were evaluated: Plaque index (PI)[18], Gingival Index (GI)[19], Calculus index (Cal)[20], and Periodontal Disease Index (PDI)[21]. Afterwards, all of the patients received oral hygiene instructions and full-mouth scaling and root planning.

3.4. Diabetes-related variables

The following information were collected from medical records: sex, duration of DM (years since diagnosis) and patient age. For the metabolic assessment, the HbA1c level was calculated from the patient records.

3.5. Analytical methods

The statistical analysis was performed using SPSS software program and parameters were shown as mean values (X) and standard deviations (SD). Student t-test, Leven method, Tukey HSD test and Dunnett T3 test were used for analysis of statistically important difference between mean values of two groups. The results are shown tabularly using MS Office Excel, program SPSS, 15.0 version.

4. Results

The study population included patients with DM type 2 aged 22-83 years, 51 women and 49 men. Mean HbA1c value was 8.70±0.45% and the mean DM duration 14.68±3.43 years.

Comparing mean values and standard deviations (X±SD) of PI, Izk, Ikon, Gi and PDI indexes according to HbA1c values, ANOVA analysis showed that Gi values depended on the level of HbA1c values (p<0,001). Higher values of investigated indexes were noticed as the value of HbA1c was rising (p<0,001) (Table 1).

Comparing mean values and standard deviations (X±SD) of PI, Izk, Ikon, Gi and PDI indexes according to presence of chronic systemic DM complications, it was noticed that only Gi values were higher in the group with chronic systemic DM complications (retinopathy, nephropathy and neuropathy) (t=5.42, p<0.001) (Table 2).

Table 1. Mean values and standard deviations (X±SD) of PI, Izk, Ikon, Gi and PDI indexes and statistically important differences between groups according to HbA1c values

Groups according to HbA_1c	N	PI	Izk	Ikon	Gi	PDI
1 (4%-6%)	/	/	/	/	/	
2 (6.1%-7%)	22	2.33±0.58	2.00±0.00	2.67±0.58	1,00±0,00	4.68±0.79
3 (7.1%-8%)	16	2.57±0.53	1.86±0.69	2.57±0.53	1,75±0,46^{def*}	5.00±0.00
4 (> 8%)	62	2.28±0.68	1.98±0.66	2.58±0.55	2,00±0,00	5.25±0.46

^{a}-1vs2, ^{b}-1vs3, ^{c}–1vs4, ^{d}-2vs3, ^{e}-2vs4, ^{f}–3vs4; * - p<0,05, ** - p<0,01, *** - p<0,001

Table 2. Mean values and standard deviations (X±SD) of PI, Izk, Ikon, Gi and PDI values and statistically important differences between groups according to chronic systemic DM complications

Groups according to DM complications	N	PI	Izk	Ikon	Gi	PDI
A (with DM complications)	70	2.23±0.69	1.63±0.69	1.66±0.76	1.92±0.27***	4.91±0.61
B (without DM complications)	30	1.87±0.74	1.47±0.52	1.73±0.96	1.64±0.50	4.53±0.83

^{a}-AvsB gr, * - p<0.05, ** - p<0.01, *** - p<0.001

5. Discussion

DM and periodontal disease are common chronic diseases in adults[22,23]. The general opinion is that there is no effect of gender on elevated blood glucose in diabetic patients, as noticed in this study, whereas both sexes were uniformly represented[24]. Diabetic patients with poor metabolic control are at a high risk for a poor periodontal prognosis[7,8]. Most studies suggest that the situation for periodontal disease is similar to that for the other systemic complications of DM[5,7,8]. The metabolic control in diabetic patients is an important variable in the onset and progression of periodontal disease and chronic systemic DM complications[5].

Lalla et al.[24] noticed that HbA1c was positively and significantly correlated with gingival bleeding. The presence of periodontal pockets and attachment loss were not significantly correlated with HbA1c higher values in diabetic patients. These findings suggest that changes in the periodontal microvasculature are related to the level of metabolic control. The results of this investigation were similar to literature data[25]. The ''poor metabolic control'' shown through the high values of HbA1c clearly increases the risk of activation of gingival inflammation and higher values of Gi index are present as the value of HbA1c was rising (p<0,001).

Salvi[26] investigated diabetics with mean HbA1c of 8.1%, and concluded that in diabetic patients with ''poor metabolic control'' the bleeding tendencies were higher than in those with lower values of HbA1c. Similar findings were noticed in the present investigation. Mean Gi values in groups with "moderately poor" and "poor metabolic control" were higher comparing to the values in group with "good metabolic control" (p<0,05).

Lalla E et al.[24] measured attachment loss and gingival bleeding separately, and similarly as previous investigators noticed that HbA1c was positively and significantly correlated with gingival bleeding, but not with attachment loss alone[24,27]. Similar findings were noticed in the present investigation where mean Gi values in groups with "moderate poor" and "poor metabolic control" were higher comparing to group with "good metabolic control" (p<0,05).

Some authors emphasize that an intensive gingival inflammation suggests the existence of poor glycemic control and multiple systemic diabetic complications[7-11]. Similar noticed in the present study where diabetics with chronic systemic diabetic complications also had higher values of Gi.

The evidence suggests that mechanisms which account for the development of systemic diabetic chronic microvascular complications might also be operating in the pathogenesis of increased gingival inflammation in DM[12,13]. Potentially a number of factors could contribute to the periodontal disease in DM (oral microflora, phagocytic and connective-tissue defects) and exploring the complex pathogenic mechanisms underlying these associations was beyond the scope of this study. Further studies with larger sample sizes are needed to investigate the pathogenic mechanisms between gingival inflammation and systemic diabetic chronic complications.

The general opinion is that diabetic patients exhibit poorer periodontal health and poorer therapeutic response than systemically health patients[28]. Good glycemic control might be essential in the prevention of periodontal complications in patients with DM[20,29,30]. During routine dental checkup, dentists detecting pronounced gingival inflammation in patients with DM can suspect the presence of undiagnosed diabetic chronic complications and refer a patient

to an endocrinologist for prompt treatment of the underlying disease and DM complications.
For proper dental care the dentist should be aware of the diabetic status of each patient. Information on the levels of HbA1c over a longer period of time and the presence/absence of any diabetic complications is needed in assessing periodontal prognosis and the need for periodontal therapy on individual basis. Close collaboration between the patient, the primary health care and oral health professionals, and application of new therapeutic modalities could be a way of improving the diabetic patient's general and oral health[7,8].

6. Conclusion

It is observed that pronounced gingival inflammation in diabetics is associated with systemic diabetic chronic microvascular complications and poor glycemic control.
As periodontal disease is a complex multifactorial disease related to DM, the prevention and control of periodontal disease must be considered an integral part of DM control. The findings in this study highlight a need to promote oral health in patients with DM as an integral component of total patient care.

Acknowledgment
This research was supported by a grant from the Serbian Ministry of Education and Science, No.175061.

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She is a member of the Serbian Medical Society and Serbian Oral Laser Society (SOLAS).
She participated in national projects, many dental courses and conferences as a lecturer, and published many papers in dental and medical journals.

Questions

Regarding diabetic periodontitis:

❑a. Mechanisms which account for the development of systemic diabetic complications might also be crucial in the pathogenesis of increased periodontal destruction;
❑b. Diabetes mellitus has no influence on periodontitis;
❑c. Periodontitis has no influence on diabetes mellitus;
❑d. Diabetes mellitus and periodontitis have no influence on each other.

Regarding this study:

❑a. 100 patients with periodontal disease and type 2 DM participated in this study;
❑b. 100 patients with periodontal disease and type 1 DM participated in this study;
❑c. 100 patients with periodontal disease and gestational DM participated in this study;
❑d. Patients with DM did not participate in this study.

Regarding to the glycohemoglobin A1c value patients were divided in:

❑a. 4 groups;
❑b. 3 groups;
❑c. 2 groups;
❑d. 5 groups.

Regarding gingival inflammation and diabetic microvascular complications:

❑a. Pronounced gingival inflammation in diabetics is associated with systemic diabetic chronic microvascular complications and poor glycemic control;
❑b. Pronounced gingival inflammation in diabetics is not associated with systemic diabetic chronic microvascular complications and poor glycemic control;
❑c. Systemic diabetic chronic microvascular complications have no influence on gingival health;
❑d. Glycemic control has no influence on gingival health.

CLASSIFICATION OF SKELETAL AND DENTAL MALOCCLUSION: REVISITED

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Received: July 02, 2016
Revised: July 29, 2016
Accepted: August 11, 2016
Published: August 12, 2016

Cite this article:
Mageet AO. Classification of Skeletal and Dental Malocclusion: Revisited. Stoma Edu J. 2016;3(3-4):205-211.

Abstract **DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.11**

Introduction: The orthodontic dental classification used datedes for more than 100 years. The skeletal and dental classification of malocclusion has an important role in diagnosis and treatment planning. The aim of this study is to facilitate the grouping of skeletal and dental malrelationships and to build an accurate diagnosis and to suggest treatment planning.
Material and method: The main orthodontic classification systems for skeletal and dental relationship were reviewed.
Results: The proposed skeletal and dental classification proved detailed accuracy and focus on relating the categories with the suggested treatment planning. The new modification of the skeletal and dental classification explained clearly the occlusal relationship and helped in setting treatment strategies.
Conclusions: The present skeletal and dental classification is faster, accurate and easily applicable clinically and dealt with the shortcoming of the previous classification systems. It also helped in the suggestion of orthodontic treatment protocols.
Keywords: orthodontic malocclusion, skeletal classification, dental classification.

1. Introduction

In 1930 Simon was the first to relate the dental arches to the face and cranium in the three planes of space: *Frankfurt horizontal plane* (F-H plane), also called (E-EP). Or-Po plane. Vertical: ***Attraction*** or ***Abstraction***; *Orbital plane* (Perpendicular to F-H plane at the margin of the bony orbit), antero-posterior: ***Protraction*** or ***Retraction***; *Median sagittal plane* (The MSP is determined by points approximate1.5cm apart on the median raphe of the palate. The raphe median plane passes through these two points at right angles to the F-H plane), transverse: ***Contraction*** or ***Distraction***[1].

2. Material and Method

Salzmann in 1950 was the first to classify the underlying skeletal structure, and he stated that ***Skeletal Class I***: Purely dental with the bones of the face and jaws being in harmony with one another and with the rest of the head. The profile is orthognathic (Straight). Then he added divisions to the skeletal I, Division 1: Local mal-relationship of incisors, canines and premolars; Division 2: Maxillary incisor protrusion; Division 3: Maxillary incisors retrusion; Division 4: Bimaxillary protrusion. ***Skeletal Class II***: Distal mandibular development in relation to the maxilla. The profile is prognathic (Convex). He subclassified skeletal II into: Class II/1: Narrow maxillary arch with crowding in the canine region; Class II/2: Lingually Inclined maxillary incisors, the laterals may be normal or proclined. ***Skeletal Class III***: Over growth of the mandible with obtuse mandibular angle. The profile is retrognathic profile (Concave)[2].

Scholar Edward Hingley Angle (1899) classified Orthodontic malocclusion in the mesio-distal relationship of teeth. His classification is based on the maxillary permanent 1st molar where he considered it as the key ridge and accordingly he classified the molar relationship into class I, II and III using Roman numbers and subdivided class II into division 1 and 2 using Arabic numbers[3].

Angle's classification has a number of drawbacks, such us: the Maxillary permanent 1st molar is not a fixed anatomic point (key ridge); cannot classify for mesially drifted, impacted, missing or extracted Maxillary permanent 1st molars; did not consider single tooth malposition; cannot classify

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the primary teeth, in addition did not classify the skeletal relationship and did not predict the etiological factors, so revisiting was always needed.
In 1915 Deway's modified Angle's Class I and III malocclusion by segregating malposition of anterior and posterior segments, **CL I**: type 1 (Crowding of Max anterior teeth); type 2 (Proclined Max incisors); type 3 (Max incisors are in cross-bite); type 4 (Posterior cross-bite); type 5 (Mesial drift of molars). **CL II** (no modifications). **CL III**: type 1: (Edge to edge bite), type 2: (Crowded Mandibular incisors and lingual to Max incisors); type 3: (Underdeveloped crowded Maxillary arch and a well developed Mandibular arch)[4].
Lischer in 1933 further modified Angle's classification by giving substitute names; **CL I** (Neutrocclusion); **CL II** (Distocclusion); **CL III** (Mesiocclusion). He also proposed terms to designate individual tooth malposition, Mesio-version (Mesial to normal position); Disto-version (Distal to normal position); Linguo-version (Crossbite); Labio-version (Increased OJ); Infra-version (Submerged tooth); Supra-version (Super-erupted); Axio-version (Tipped tooth); Torsi-version (Rotated tooth); Trans-version (Transposed tooth)[5].

3. Results

Ackerman and Proffit (1969) introduced a very comprehensive system of classification using the Venn diagram. The classification considered five characteristics and their inter-relationships were assessed, namely: alignment, profile, transverse, class and overbite[6].
Angle's classification still seems to be the most popular tool for classification of malocclusion, despite its well-known disadvantages[7]. Hans et al., (1994), noted the inadequacy of Angle's classification when they were unable to classify approximately 7% of a large sample (n=4309) of models in the Broadbent-Bolton study[8]. Another study conducted by Baumrind et al., (1996) on whether to extract in orthodontic treatment, found that 28-33% disagreement among the 5 participating orthodontist[9].
Katz (1992a) showed an inter-examiner disagreement of 49% among 270 orthodontists using Angle's classification[10]. The percentage agreement of Katz's technique proved superior to that of the classical Angle's classification[11,12]. Rinchuse found Angle's classification to be limited because it is a system of discrete classes as compared to continuous transition of maxillo-mandibular dental arches in the sagittal plane[13].
The British Standard Institute (BSI) classified dental malocclusion in 1983 according to the maxillary and mandibular incisors relationship.
Class I: When the mandibular incisor edges lie or are below the cingulum plateau of the maxillary incisors.
Class II: When the mandibular incisor edges lie posterior to the cingulum plateau of the maxillary incisors, the maxillary incisors could be proclined where it is classified as **Class II / 1**, or retroclined maxillary centrals and proclined laterals, or both central and lateral incisors are retroclined where it is grouped under **Class II / 2**.
Class III: where the mandibular incisor edges lie anterior to the cingulum plateau of the maxillary central incisors[14].
The BSI classification was more accurate in grouping the malocclusion[15]. The British method of overjet and overbite assessment[15] and the quantitative technique proposed by Katz (1992b)[16] developed over the years, proved to be more amenable to reproduction than Angle's classification[11,15].
In the Du et al. study (1998) in their study where four orthodontic faculty members at one dental school classified 25 dental casts according to the classification systems of Angle, Katz, and the British Incisor Classification[11]. The dental casts were selected from a pool of 350 pretreatment graduate orthodontic cases and were those deemed the most atypical. The results demonstrated that Katz's classification was more reliable than both the Angle and the British one. Angle's classification was the least reliable of the three methods.

4. Discussion

4.1. Skeletal classification: revisited

In the author's view orthodontic skeletal classification could be grouped into class I (straight), class II (convex) and class III (concave).
Salzmann's classification did not specify that the problem is due to maxillary protrusion, mandibular retrusion or a combination of both.
The same is true for the concave profile, his method did not specify that the problem is due to maxillary retrusion, mandibular protrusion or a combination of both.
The author agrees with all scholars that skeletal class I has a straight profile (Fig. 1), which explains homogeneous relationship between the maxilla and mandible, or in another terms they grow in unison. In cases of Skeletal I the problem is dental malrelationships. It is present in two planes, the vertical and the transverse planes where the antero-posterior plane is normal or within average.
There is always a question which arises in cases where it is straight to mild convexity or mild concavity.
The author's view is to enlarge the description of skeletal I so as to include the mild convexity and mild concavity as far as it is confirmed by the ANB angle. The range of skeletal I would be straight to mild convexity or mild concavity.
Salzmann's Skeletal II (convex profile) did not indicate either whether it is due to protruded maxilla or retruded mandible or a combination of both. In the present study, Skeletal II could be of three types; type 1 (retruded mandible), type 2 (protruded maxilla) and type 3 (combination of both). (Fig. 1)
The same applies for Class III (concave profile), again Salzmann did not specify either whether it is due to maxillary retrusion or mandibular protrusion. According to my explanation it could be due to maxillary retrusion (Skeletal III type 1), or mandibular protrusion (Skeletal II type 2), or a combination of both

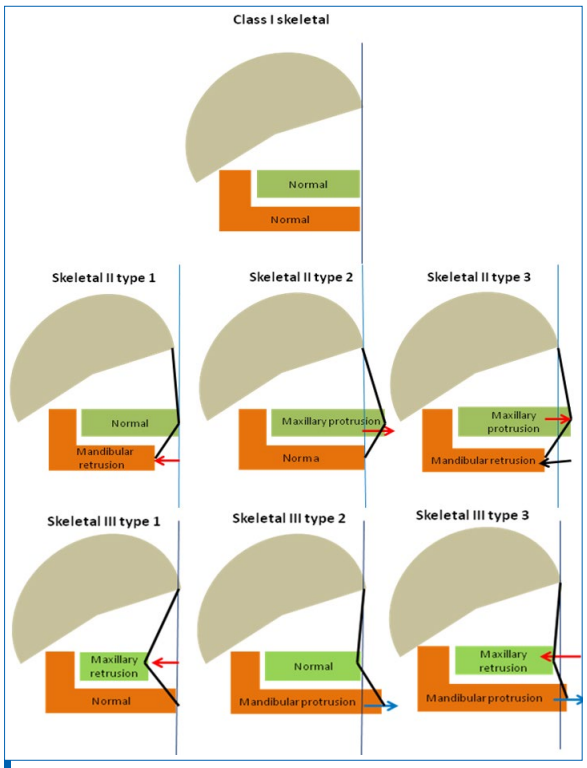

Figure 1. Skeletal classification

(skeletal III type 3), which gives detailed explanation aiding in diagnosis and treatment planning. (Fig.1)

4.2. Occlusal Classification: revisited

The BSI and Katz's classification deal with the partial description of the malocclusion.

The British system of classification related to the anterior teeth where it needs further elaboration while Katz's system focuses on the premolar occlusion and ignore the canines and molar classification.

Snyder and Jerrold (2007), have concluded that a modification of Angle's system that is more descriptive is needed, after they have sent an e-mail survey to the department chair or the program director of every orthodontic program in the United States, Canada, and Puerto Rico (n = 80).

The survey included photos of models placed into ¼ cusp, ½ cusp, and ¾ cusp distal occlusions, and the participants were asked to classify them by selecting from a list of terms or writing one of their own.

They were also asked whether they thought that the Angle molar classification was adequate for communication and diagnosis.

Fourty surveys were completed and returned. The results showed a variety of terminology being taught, and most educators do not use Angle's classification as he defined it.

About half of the respondents were dissatisfied with the Angle molar classification system[17].

In 2002 Siegel conducted 57 surveys which were mailed to department chairs in the United States, asking them to identify the definition to which their orthodontic residency program subscribes; 34 questionnaires were returned.

Twenty-two responses supported the notion that subdivision refers to the Class II side, 8 responses said that it refers to the Class I side, 3 responses supported neither view, and 1 response indicated that in the program not everyone could agree on the meaning of subdivision.

Although the prevailing belief appears to be that subdivision indicates the side with a molar malocclusion, the orthodontic community does not have a consistent standard, and it is time to resolve this controversy[18].

Due to the low reliability of the Angle method, a reconsideration is needed to develop the older classification.

The reconsideration is done in the antero-posterior and on both sides, where molar classification is more elaborated.

In this revision class IV, V and VI are generated which helped in treatment planning and suggesting treatment protocol.

Skeletal Class III malocclusion was strongly differentiated from the other sagittal classes, specifically in the mandible, as calculated through Björk and Jarabak analysis[19].

A review article emphasizes the need to identify genetic and environmental factors that cause or contribute risk to skeletal malocclusion and the possible association with other medical conditions to improve assessment, prognosis and therapeutic approaches[20].

Accurate and detailed classification is always needed to drive an accurate diagnosis and treatment plan.

The author followed the BSI incisor classification with modifications for class II and III, accepts canine classification and modifies molar classification, which are further elaborated for the ease of diagnosis and accuracy of treatment planning in orthodontics.

4.3. Incisor's Classification (Fig. 2)

Class I: When the mandibular incisor edges lie or are below the cingulum plateau of the maxillary incisor (BSI, 1983), the overjet is 2-4 mm.

Class II: When the mandibular incisors edges lie posterior to the cingulum plateau of the maxillary incisors (BSI, 1983). It could be:

- ***Class II/1***: Proclined maxillary incisors with overjet more than 4 mm.
- ***Class II/2a***: Retroclined maxillary centrals and proclined laterals, or both central and lateral incisors are retroclined with normal or reduced overjet.
- ***Class II/2b***: Retroclined maxillary centrals and proclined laterals, or both central and lateral incisors are retroclined but with increased overjet.

Class III: When the mandibular incisors edges lie anterior to the cingulum plateau of the maxillary incisors (BSI, 1983).

- ***Class III type 1***: Positive overjet but less than 2 mm.
- ***Class III type 2***: Edge to edge incisors relationship.
- ***Class III type 3a***: Negative overjet.

• ***Class III type 3b***: Negative overjet but patient can make edge to edge (pseudo Class III).
The author believes that incisor classification could also be used for esthetic considerations.

4.4. Canine's Classification (Fig. 3)

Class I: mesial incline of the upper canine overlaps the distal slope of the lower canine (The maxillary canine occludes between the mandibular canine and 1st premolar).

Class II: Distal slope of the maxillary canine occludes or contacts the mesial slope of the lower canine.

Class III: The mandibular canine is displaced anterior to the maxillary canine with no overlapping.

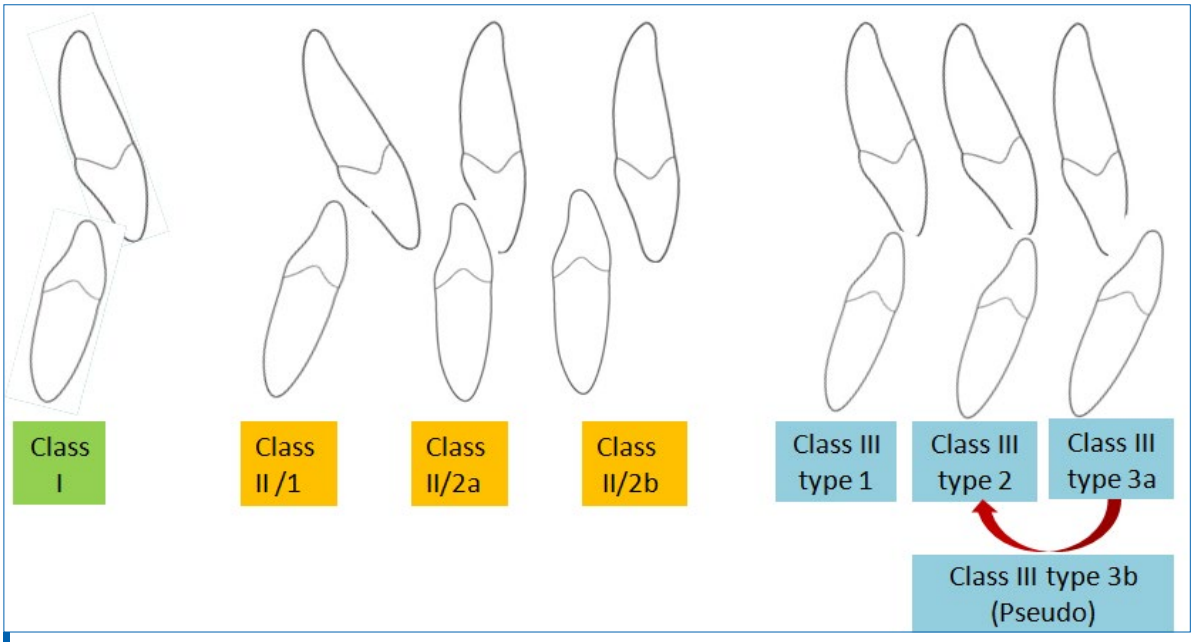

Figure 2. Incisor's classification

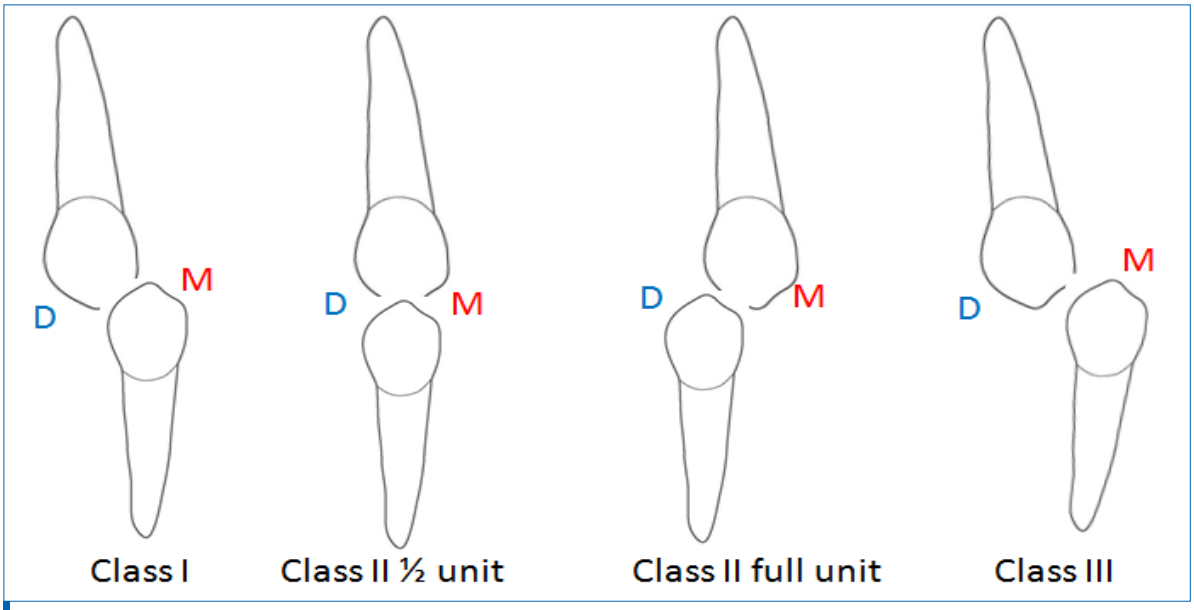

Figure 3. Canine's classification

4.5. Molar's Classification (Fig. 4)

The author modified Angle's classification to include different molar relationship on both sides and renamed the subdivision.

Class I: The mesio-buccal groove of the mandibular 1st permanent molar occludes with the mesio-buccal cusp of the Maxillary 1st permanent molar.

Class II: The mesio-buccal groove of the mandibular 1st permanent molar lie posterior to the mesio-buccal cusp of the Maxillary 1st permanent molar.

• ***Class II ½ unit***: When the maxillary 1st permanent molar cusps occlude with the mandibular 1st permanent molar cusps in an edge to edge.

• ***Class II full unit***: When the maxillary 1st permanent molar cusps occlude anterior to the mandibular 1st permanent molar.

Class III. The mesio-buccal groove of the mandibular 1st permanent molar lies anterior to the mesio-buccal cusp of the Maxillary 1st permanent molar.
Relationship between right and left buccal occlusion is further grouped to resolve the notion of subdivisions:
Class IV. Class I on one side and Class II (either ½ unit or full unit) on the other side.
Class V: Class I on one side and Class III on the other side.
Class VI: Class III on one side and Class II (either ½ unit or full unit) on the other side.
Analyzing profile photographs **to evaluate** sagittal jaw relationships is a practical tool in determining soft tissue harmony. Soft tissue measurements provide a sagittal differential diagnosis in relation to Angle's classification of malocclusion[21].
A suggested treatment protocol is easily derived from the present classification skeletal (Table 1) and dental (Table 2).

This varies from mechanics to mechanics, but the idea is to help the undergraduate to understand orthodontic diagnosis and treatment planning and for postgraduate residents and orthodontists to formulate accurate stable orthodontic treatment results.

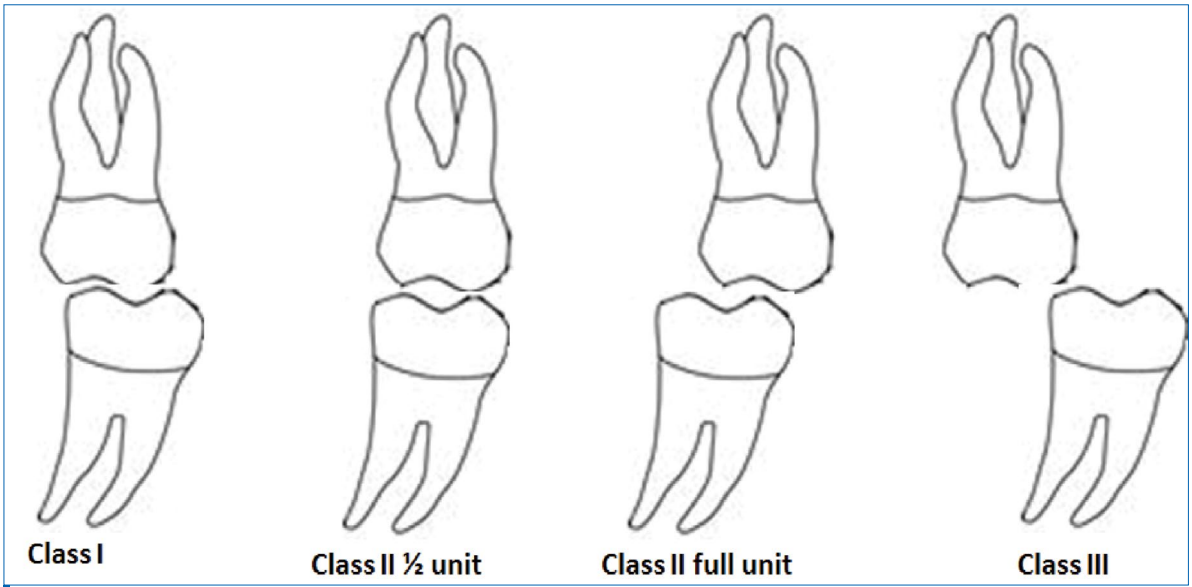

Figure 4. Molar's classification

Table 1. Suggested treatment protocol for skeletal bases

Skeletal I		There is a harmonious relationship antero-posteriorly; the problem is either in the vertical or transverse plane. Advice surgical correction if needed.
Skeletal II	Type 1	Functional appliance (growing children) or mandibular surgery (adult or syndromic patients e.g. Pierre Robin).
	Type 2	Headgear (children and adolescents) or maxillary surgery for adults.
	Type 3	Here the treatment could of combination, functional [removable e.g. twin block or fixed e.g. Forsus], Headgear, camouflage with the extraction of upper 1st premolars alone or in combination with lower 2nd premolars or Bi-maxillary orthognathic surgery.
Skeletal III	Type 1	Functional appliances e.g. Yanagisawa Class III shield (YC3)[19]. Palatal expansion ± facemask (Delaire, reverse pull headgear by Nakamura) advised before the age of 10 years.[20]
	Type 2	Mandibular excess is treated with surgery e.g. Bilateral sagittal split osteotomy (BSSO).
	Type 3	Here the treatment could of combination: functional (Yanagisawa,YC3), palatal expansion ± facemask, camouflage with the extraction of lower 1st premolar and upper 2nd premolars, or extraction of a single lower central incisor, Bi-maxillary orthognathic surgery (Le Fort I ± BSSO) or genioplasty in some cases.

Table 2. Suggested treatment protocol for dental malocclusion

Class I malocclusion		**Non extraction:** stripping, expansion, derotation, uprighting or distalisation Extraction: U/L 4s, U/L 5s, U/L 6s, U/L 7s or a symmetric extraction e.g. right U/L 4s + left U/L 5s, U/L 6s + U/L 4s or 5s, single tooth extraction.
Class II malocclusion	Type 1	**Non extraction:** Distalisation with headgear Extraction: 4s, (U 4s + L 5s), (U/L 6s), (U/L 7s) or a symmetric extraction e.g. (right U/L 4s + left U/L 5s), (U/L 6s + U/L 4s or 5s). or a single U4.
	Type 2a	Always advise non extraction treatment using a headgear + Nudger or an intra-oral distalizer. If crowding is to be relieved by extraction, then it is advisable to extract the 2nd premolar than the 1st premolar because of difficulty of space closure. Transfer the case to CL II/1 and treat accordingly.
	Type 2b	Headgear + Nudger Orthognathic surgery treatment (proclined upper anteriors and retroclined lower anteriors-decompensation: plan for surgery)
Class III malocclusion	Type 1	Camouflage with stripping lower arch and proclining upper teeth. Expansion of upper arch ± fixed appliance therapy.
	Type 2	Expansion of upper arch ± fixed appliance therapy with CL III elastics. Extraction of lower 1st premolars and upper 2nd premolars + U/L fixed orthodontic therapy with CL III elastics. Expansion of upper arch + extraction of a single lower central incisor + U/L fixed orthodontic therapy with CL III elastics.
	Type 3a	Expansion of upper arch ± fixed appliance therapy with CL III elastics. Extraction of lower 1st premolars and upper 2nd premolars + U/L fixed Orthodontic therapy with CL III elastics. Expansion of upper arch + extraction of a single lower central incisor + U/L fixed orthodontic therapy with CL III elastics.
	Type 3b	Expansion of upper arch ± fixed Orthodontic therapy. Extraction of lower 1st premolars and upper 2nd premolars + U/L fixed Orthodontic therapy. Expansion of upper arch + extraction of a single lower central incisor + U/L fixed Orthodontic therapy with CL III elastics.

5. Conclusion

Incisor, canine and molar classification should always be used accurately to diagnose and to plan the final occlusion.

A final class I incisor and canine relationship at the end of treatment is always the aim **so** to **provide** long term stability while molar relationship could be class I, II (full unit) or III relationship.

The author recommends further study on methods of classification and establishing orthodontic treatments' protocols.

Acknowledgments

The author declares no conflict of interest related to this study. There are no conflicts of interest and no financial interests to be disclosed.

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CV

Licensed by CPQ (UAE), the Saudi Commission for Higher Specialties and the Sudanese Medical Council as a consultant orthodontist. I treat orthodontic problems from mild to complex cases with a variety of treatment options, removable, functional, fixed, clear orthodontics, orthodontic part of orthognathic surgery and cleft lip / palate cases. I also manage snorers and mild to moderate obstructive sleep apnoea hypopnoea patients using intra-oral appliances. I have been working as an orthodontist for the past 20 years. Examiner of the RCSEd for the 2nd part MFDS and the M. Orth. Reviewer of the Oral Hygiene and Dental Management Journal. Published many articles in reputable journals.

Questions

An 11 year-old female patient with a chief complaint "my upper teeth are crowded". She presented a Class II/2 incisor relation, class II ½ unit canines and molars, on Skeletal II base deep bite and centre line shift. Lateral cephalometry shows SNA of 84°, SNB 78° ANB of 6° and decreased maxillary mandibular plane angle. The treatment would be:

❑a. Extraction of 14 and 24 with upper and lower fixed Orthodontics treatment;
❑b. Distalisation of upper 16 and 26 by HG and a Nudger appliance with upper and lower fixed
❑c. Extraction of 14, 24, 35 and 45 with upper and lower fixed Orthodontics;
❑d. Transfer the case to CL II/1 and treat with functional appliance and treat accordingly.

What is the treatment of choice in case of skeletal Class III cases is with reduced anterior cranial base and retruded maxilla in a 9 year-old boy.

❑a. Rapid palatal expansion alone;
❑b. Functional appliance and fixed Orthodontics;
❑c. Rapid palatal expansion and Face mask;
❑d. Orthognathic surgery by Le Fort I osteotomy.

How do you define Class II/2b incisor relation from the article:

❑a. Upper incisors retroclined laterals are procline;
❑b. All upper anteriors are retroclined with increased overjet;
❑c. All upper anteriors are retroclined with a deep bite;
❑d. Upper incisors retroclined laterals are procline.

Define skeletal Class III type 3 from the paper:

❑a. Retruded maxilla;
❑b. Retruded maxilla with protruded mandible;
❑c. Straight profile;
❑d. Protruded maxilla.

CONTEMPORARY ESTHETIC PERIODONTICS

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Received: August 16, 2016
Revised: August 23, 2016
Accepted: September 07, 2016
Published: September 08, 2016

Cite this article:
Bronstein D, Suzuki K, Garashi M, Suzuki JB. Contemporary Esthetic Periodontics. Stoma Edu J. 2016;3(3-4):212-222.

ABSTRACT **DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.12**

Aim: In contemporary dentistry, disease prevention and regeneration have dictated the paradigm shift from the practitioner's reactive approach to disease occurrence in his increasingly educated and demanding patient population to an innovative and proactive patient treatment. This clinical paper with case reports will address these aspects of muco-gingival surgery around teeth and implants.
Summary: Successful periodontal disease control and elimination by skilled dental professionals may leave patients with an esthetic or sensitivity concern. The historical "longer teeth, or no longer teeth" and its sequela require targeted intervention from today's dental team to prevent lesion progression and improve patient satisfaction.
After surgical technique and patient compliance with oral hygiene and wound care instructions, the patient's physiology, immunology and molecular biology, is responsible for the clinical outcome of the procedure.
Key Learning Points: In cases with lack of keratinized attached gingiva, the results of the present case reports on teeth and implants, indicate that a free gingival graft which deepened the vestibule and created a wide band of attached and keratinized gingiva can aid in reducing discomfort during oral hygiene practices by the patient, improve gingival health and overall patient satisfaction.
Keywords: periodontics, gingival recessions, periodontal surgery, oral health-related quality of life.

1. Introduction

In contemporary dentistry, disease prevention and regeneration have dictated the paradigm shift from the practitioner's reactive approach to disease occurrence in his increasingly educated and demanding patient population to an innovative and proactive patient treatment. Successful periodontal disease control and elimination by skilled dental professionals may leave patients with an esthetic or sensitivity concern. The historical "longer teeth, or no longer teeth" and its sequelae require targeted intervention from today's dental team to prevent lesion progression and improve patient satisfaction.
After surgical technique and patient compliance with oral hygiene and wound care instructions, the patient's physiology, immunology and molecular biology are responsible for the clinical outcome of the procedure. This article will address aspects such as muco-gingival surgery around teeth and implants.

2. The biological background of wound healing in esthetic periodontal surgery

The fundamental difference in wound healing of tissues surrounding the tooth compared to other areas of the body is in the interface of the soft tissue to the hard tissue. The different healing patterns after flap surgery have been identified by previous histological and animal studies[1-4]. The surgical elevation of a full thickness flap from the underlying dental and osseous structures leads to a variety of healing mechanisms. Long junctional epithelium constitutes healing by tissue repair and is a hemi-desmosomal adhesion between the connective tissue of the periodontal flap and

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Figure 1. 29 year-old white, male patient presents with fractured, hopelessly involved tooth #21 (Mucogingival defects of recession and inadequate keratinized gingiva are also present)

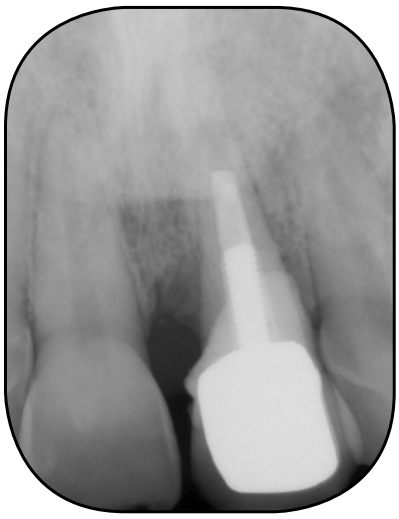


Figure 2. Periapical film showing failing tooth #21

Figure 3. Tooth was extracted and ridge augmented with freeze-dried bone allograft and membrane; 4 months healing. Note keratinized gingiva was still lacking in buccal aspect of #21 site

Figure 4. Autogenous free gingival graft completed at #21 ridge prior to implant placement to augment keratinized gingiva

the denuded tooth surface. In the apical region of the flap, histological slides have shown repair by connective tissue attachment of the flap to the tooth surface[5]. The approximation of the flap to the tooth is the prerequisite for proper wound healing. In tandem with the patient's compliance, the holding quality of the sutures determined by the skill level of the surgeon will prevent wound healing failure. The down growth of epithelium at the interface along the root surface is a barrier to connective tissue attachment. If a space is allowed between the flap and the tooth during the healing phase the epithelium will occupy that space first. Epithelium proliferates more rapidly than connective or osseous tissue. When the flap is allowed to remain tightly adapted by an undisrupted fibrin clot and adequate sutures during the ten days of initial healing, contact inhibition will stop the epithelium on the outside of the flap from progressing and lining the inside of the flap that is facing the root surface[5].

Healing by regeneration requires new formation of cementum, bone, periodontal ligament and gingiva with a short epithelial attachment to the tooth. This healing does not occur spontaneously or by resective procedures. Usually biomaterials and modifiers are added to the surgical site to induce or promote regeneration of lost tissues by new technologies. Guided tissue regeneration techniques and soft tissue coverage procedures are used today around teeth and implants.

Soft tissue healing surrounding implants differs from periodontal healing around a tooth. The peri-implant mucosa is isolated from the implant surface by the long junctional epithelium coronally. The supracrestal connective tissue fibers are dense and oriented parallel to the long axis of the implant above the crest of the bone, since insertion of

Figure 5. Keratinized graft was allowed to heal 3 months (now 7 months since extraction and bone graft)

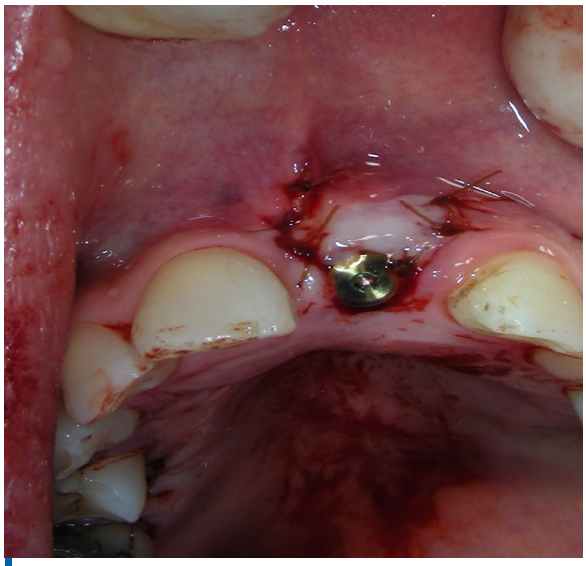


Figure 6. #21 Implant placed with healing abutment in one-stage procedure and allowed to heal 4 months

Figure 7. Final torque test and tissue evaluation performed at 4 months

Figure 8. Final restoration clinical photo; note adequate hard and soft tissue contours present on implant site as well as opposing dentition site, which also had a clinical recession presenting. #24 was treated with a free gingival graft as well

Sharpey fibers into the implant is not possible. Soft tissue procedures are limited in implant dentistry and guided bone regeneration is favored[6].

2.1.Soft tissue coverage of dental recessions and implant soft tissue regeneration

Armitage[7] defined gingival recession by the apical position of the free gingival margin to the cemento-enamel-junction (CEJ) of the tooth or teeth. The indications for periodontal root coverage procedures include: tooth sensitivity, progression of recession, poor oral hygiene maintenance and patient dissatisfaction with appearance[8]. The objective of the corrective surgical procedure is to achieve a color match with the adjacent tissues and symmetrical margins while thickening the tissue to avoid relapse in the absence of inflammation with clinical presentation of probing depth.

Gingiva is a specialized and keratinized mucosa. It consists of the free marginal gingiva around the tooth and the attached gingiva, extending from the free gingival margin to the muco-gingival junction. Not all keratinized gingiva is attached, as the free margin and any gingival and periodontal pocketing is unattached by definition. Coincidently, non-keratinized gingiva may be attached, as keratinization is lost at the onset of inflammation, while pocketing has not yet occurred and the gingiva is attached to the tooth. From this biology stems the notion that the lack of keratinized gingiva is compatible with periodontal health, while still attached, in the absence of inflammation[26].

In the presence of inflammation when patients have difficulty to keep the sites clean or when sensitivity and progressive attachment loss prevail at the recession site, surgical intervention is indicated.

Pedicle and coronally positioned flap, with the base of the flap attached and the coronal part of the flap covering the denuded root surface, with and without autogenous connective tissue graft have demonstrated healing by repair with long junctional epithelium[9]. Meticulous root debridement and surgical technique have been

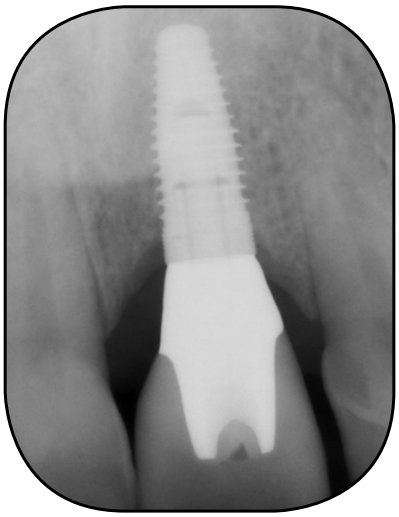


Figure 9. Radiograph showing integrated implant with completed restoration

Figure 10. Clinical preoperative photograph of the maxillary right posterior region showing decreased vestibular depth, frenum pull, and lack of keratinized gingiva associated with an FPD with teeth #16 & #14 as abutments and tooth #15 as a pontic

found to be the determining factor for predictability and success of the procedure[10]. Enamel Matrix Derivative, as Emdogain ® has been found to enhance root coverage and healing by repair through connective tissue attachment[11,17]. Root conditioning with Citric Acid has heterogeneous results in soft tissue grafting and improvement of healing by connective tissue attachment versus long junctional epithelium[12-16].

2.1.1. Membranes

When using membranes to augment soft tissue, the amount of connective tissue attachment achieved is similar to an autogenous connective tissue graft that is applied to and covered by a coronolly advanced flap at the recipient site[19,20]. Guided tissue regeneration (GTR) results in better histological outcomes, regardless whether resorbable or non-resorbable membranes used[11,21].

Guided tissue regeneration requires space and the limitation in root coverage is the surgical space available for clot stabilization and selective cell repopulation[1].

2.1.2. Bio-Modifiers

When using Emdogain®, an enamel matrix protein derivative, during guided tissue regeneration procedures or with a connective tissue graft, no additional benefits were observed. However, Emdogain® with a coronally positioned flap alone led to regeneration, which could be histologically verified. The heterogeneous results reported by different studies are due to variation in study design and strength[17].

2.1.3. Platelet Rich Plasma and Platelet Derived Growth Factor (PDGF)

The use of recombinant growth factors has demonstrated regeneration histologically and by micro-computed tomography (CT) with Tricalcium Phosphate in randomized controlled clinical trials[22,23].

2.1.4. Soft Tissue Allo- and Xeno-Graft

By using a soft tissue substitute in lieu of an autogenous graft, the patient does not have the increased morbidity of a second surgical donor site[25]. Allogenic acellular dermal matrix and xenogenic collagen matrix (MUCOGRAFT®) have been used in periodontal plastic surgery and regeneration has been shown[24]. The three dimensional scaffold of the graft allows for space maintenance angiogenesis and fibroblast proliferation. Histology at 6 months showed healing comparable to "scar tissue", dense connective tissue with predominantly elastic fibers[27].

Free gingival (FGG) and connective tissue (CTG) autografts have been successful in augmenting keratinized tissue around teeth. FGG are taken from an adjacent edentulous ridge or palate and may differ in appearance, presenting esthetic challenges. Since CTG are being mostly covered by the flap of the recipient sites, their esthetic appearance blends with adjacent tissue better during healing, however, post operative shrinkage compromises treatment outcomes.

2.1.5. Implants

Not much human histology is currently available on the management of gingival deficiencies on dental implants[1]. Past research has focused on implant surface modification and bone grafting to improve osseous integration and treat peri-implantitis.

3. Cases Reports

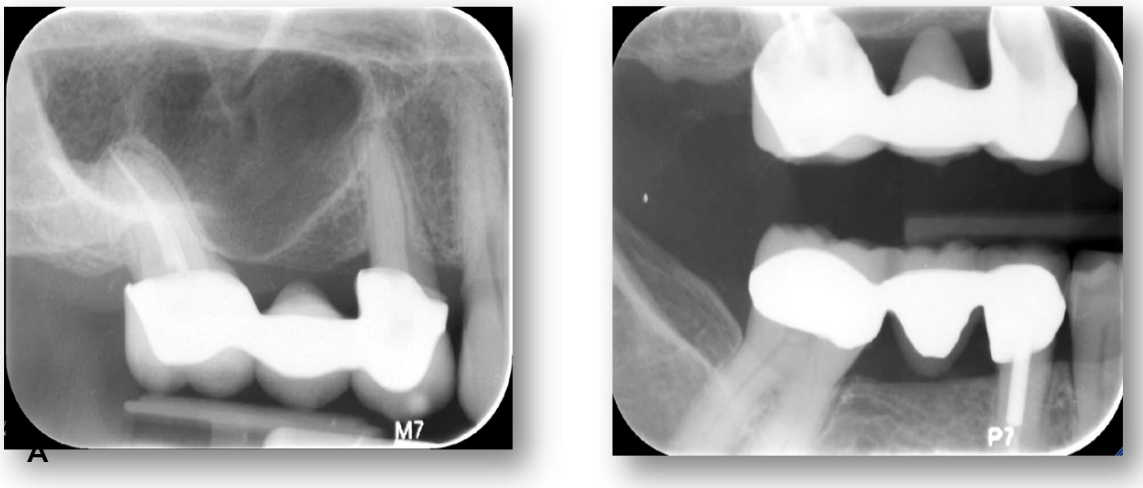
3.1. Case 1

Background

29-year-old white male patient with noncontributory medical history, no known drug allergies, and no social factors presents with chief complaint of a fractured front tooth. Diagnosis upon examination reveals a fractured tooth #21 with presence of a mucogingival defect (recession) and absence of adequate keratinized gingiva (Figs. 1-2). The prognosis is hopeless. The etiologic factors include trauma and thin morphotype. Treatment plan and completed treatment included: Extraction of tooth #21 (Fig. 3) with concurrent ridge augmentation using a freeze dried bone allograft and non-

Table 1. The clinical parameters associated with teeth # 16 & # 14

Clinical Parameters	Baseline		5 months	
	# 16	# 14	# 16	# 14
Buccal PD (mm)	3,2,3	2,3,3	2,1,2	2,2,3
KT width (mm)	1	0	4	1-4
Vitality	-	+	-	+
Mobility	-	-	-	-



Figures 11a and 11b. An Intraoral periapical and bitewing radiograph of the maxillary right posterior region

absorbable membrane (removed at 1 month). The site was allowed to heal while the patient was provisionalized with an essix retainer for 4 months. A keratinized autogenous free gingival graft was performed to augment the buccal gingiva of the #21 site lacking sufficient keratinized tissue (Fig. 4). After 3 months of healing (Fig. 5) a dental implant was placed (4.3x11.5 Nobel Replace Select Tapered Groovy RP) with healing abutment via use of a surgical prosthetic guide (Fig. 6). The implant was allowed to heal for 4 months before restoration (Fig. 7). A new radiograph and torque test were performed at 4 months and the implant was restored with a cement-retained crown (Figs. 8-9).

3.2. Case 2

Background

A 77-year-old female non-smoker with controlled hypertension presented to the Post Graduate Periodontology Clinic, Nova Southeastern University, Fort Lauderdale, Florida, in February 2016 with a chief complaint of "sensitive gums and discomfort when brushing" associated with an FPD in the maxillary right posterior region (#16-X-14). Intraoral examination revealed good oral hygiene, thin gingival biotype with generalized lack of keratinized gingiva, and generalized mild to moderate gingival recession. In the maxillary right posterior, there was decreased vestibular depth and lack of keratinized gingiva associated with an FPD with teeth #16 & #14 as abutments and tooth #15 as a pontic (Fig.10).

The FPD (fixed partial denture) was fabricated by her previous dentist 2 years ago and she recently had RCT (root canal treatment) on tooth #16 before presenting to the Periodontics Department. The clinical parameters associated with teeth #16 & #14 are described in Table 1.

An intraoral periapical and bitewing radiograph of the region are shown in Fig. 11. The patient was informed of the bulky overhanging margins of the FPD, however, refused to proceed with any prosthetic treatment at this time. It was decided to use a Free Gingival Graft harvested from the palate to create a band of attached keratinized gingiva and increase the vestibular depth. Witten informed consent for periodontal surgery was obtained from the patient.

Case Management

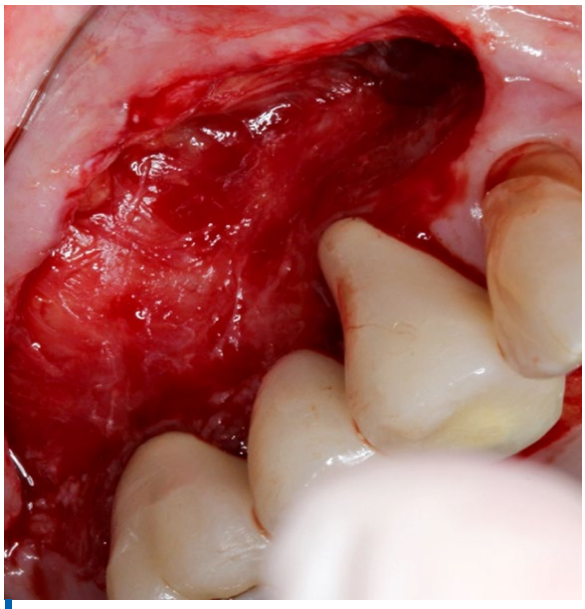


Figure 12. Clinical intraoperative photograph showing the recipient bed around the teeth and in the pontic region

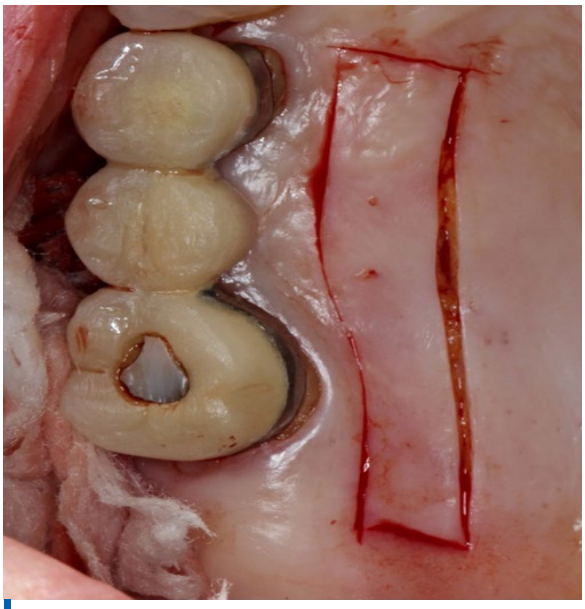


Figure 13. Clinical intraoperative photograph showing the donor site (right side of palate). An outline was made with a new 15c blade

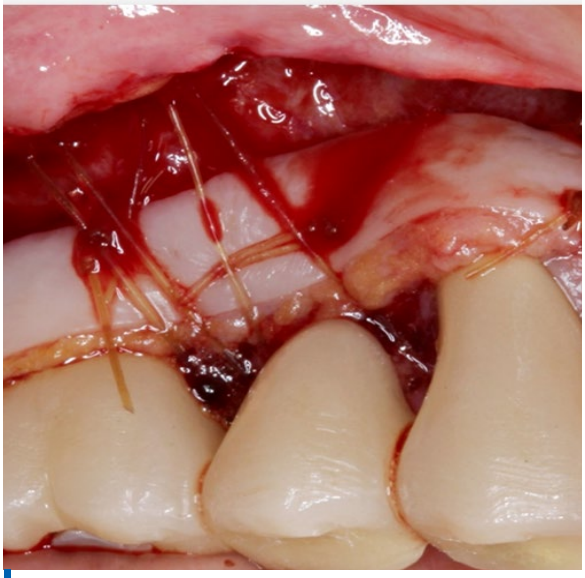


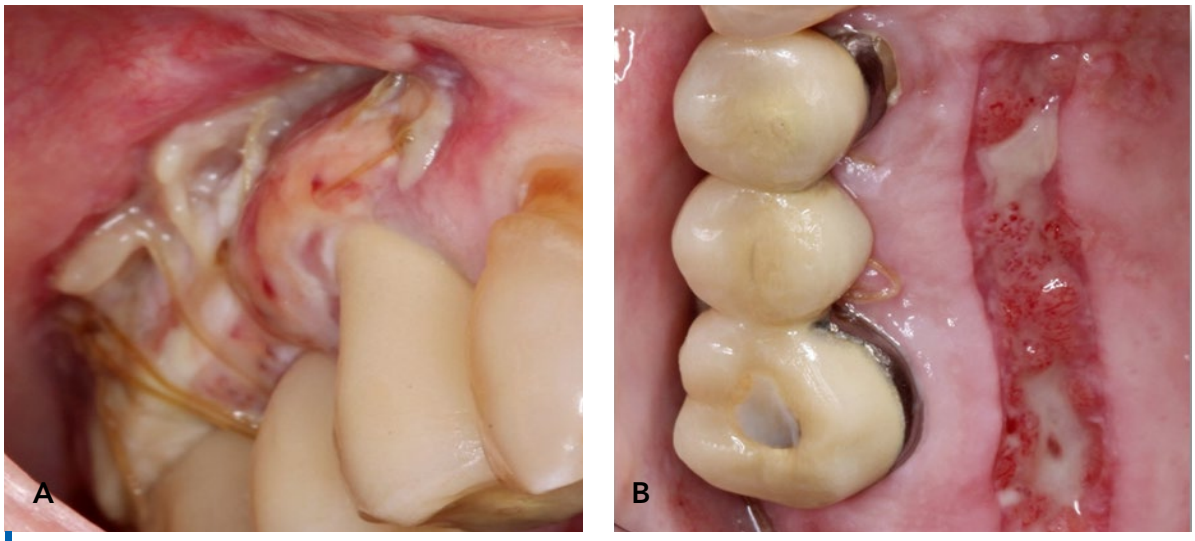
Figure 14. Clinical intraoperative photograph showing the graft stabilized and immobilized via periosteal and single interrupted sutures

The attached keratinized gingiva is dense, resilient and tightly attached to the underlying tooth and bone, while the alveolar mucosa is thin, mobile, and apparently less capable of withstanding the functional stresses of mastication and oral hygiene practiced by the patient. The autogenous free gingival graft is a predictable surgical procedure to increase the width of keratinized attached gingiva, eliminate frenum and muscle pull, and to extend the vestibular depth depth[18].

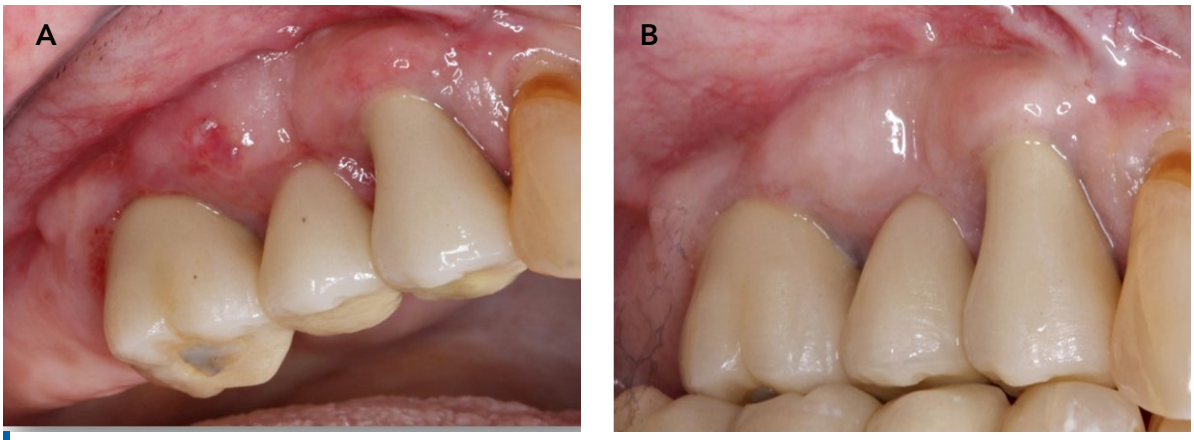
After the administration of anesthesia to the recipient site via local infiltrations on the buccal and palatal aspect of the maxillary right posterior region, periodontal curettes were used for subgingival debridement of the root surfaces of teeth #16 & #14 without damaging the crown margins, then the FPD was wiped with gauze soaked in 0.12% chlorhexidine for 30 seconds. Subsequently, the recipient site's epithelium, CT, and muscle fibers were sharply dissected down to the periosteum using 15c and 12 blades and micro-scissors to create a large recipient bed around the teeth and in the pontic region (Fig. 12). Immediately after, a Free Gingival Graft was harvested from the right side of the palate using a new 15c blade (Fig. 13). The graft was immediately transferred to the recipient site, which was stabilized and immobilized via periosteal and single interrupted sutures with 4.0 chromic gut sutures (Fig. 14). Finally, tactile pressure was placed over the graft to remove any blood clots between the graft and recipient bed and to achieve close adaptation of the graft. No periodontal dressing was used to cover the graft and the patient was instructed to follow a liquid diet for the first 24 hours, followed by a soft diet for the remaining week and eat on the left side only. Patient was instructed to refrain from oral hygiene practices in the surgical site while rinsing with 0.12% chlorhexidine gluconate (three times daily) for 2 weeks, take 500 mg Amoxicillin (every 8 hours) for 7 days and 800 mg Ibuprofen (every 8 hours) as needed for discomfort. The postoperative follow-ups were conducted at 1 (Fig. 15 A & B), 3 (Fig. 16 A), and 6 weeks (Fig. 16 B).

Clinical Outcomes

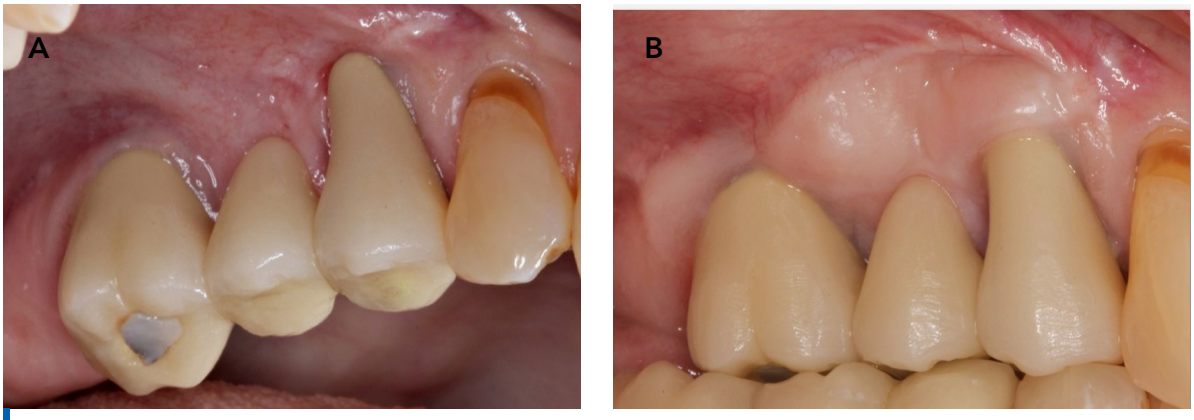
Healing was uneventful at both the donor and recipient sites. At the 1-week follow-up only visual examination was performed which revealed slight erythema and edema consistent with normal post-surgical healing and no swelling or infection was present (Fig. 15). At the 3- and 6-week follow-ups the surgical area was irrigated gently with 0.12% chlorhexidine and plaque surrounding the FPD was removed with Q-tips soaked in chlorhexidine (Fig. 16 A and Fig. 16 B).



Figures 15a and 15b. Clinical photographs of recipient and donor sites 1 week after surgery



Figures 16a and 16b. Clinical photographs of recipient site 3 weeks (A) & 6 weeks (B) after surgery



Figures 17a and 17b. Clinical photograph of recipient site preoperative and 5 months post-surgery

At the 5 month follow up, the patient reported no gingival discomfort when brushing the maxillary right posterior region. The clinical examination revealed a deepened vestibule and gain in attached and keratinized gingiva around the FPD abutments #16 & #14 and facial aspect of the pontic. The probing depths ranged from 1-3mm surrounding the FPD with no BOP (Fig. 17 B, Table 1).

Conclusion

In cases with lack of keratinized attached gingiva, the results of the present case report indicate that a free gingival graft which deepened the vestibule and created a wide band of attached keratinized gingiva can aid in reducing discomfort during oral hygiene practices by the patient.

3.3. Case 3

Clinical Presentation

A 35-year-old male non-smoker with non-contributory medical history presented to the Post Graduate Periodontology Clinic, Nova Southeastern University, Fort Lauderdale, Florida. In April 2016 with a chief complaint of "my dentist

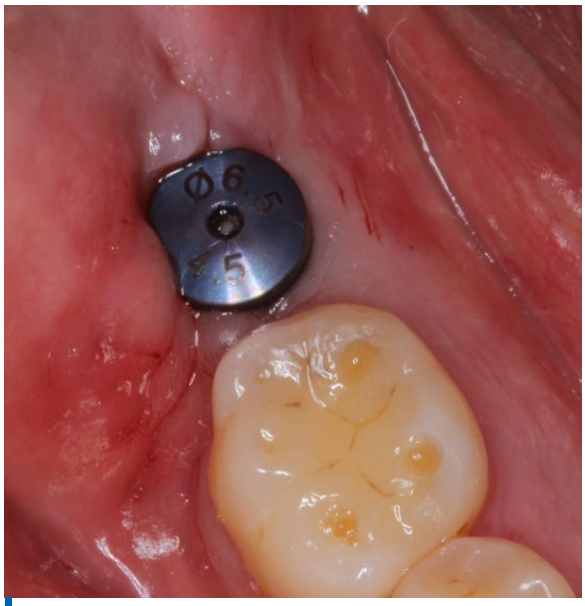


Figure 18. Clinical preoperative photograph of the mandibular right posterior region showing decreased vestibular depth and lack of keratinized gingiva associated with implant #47

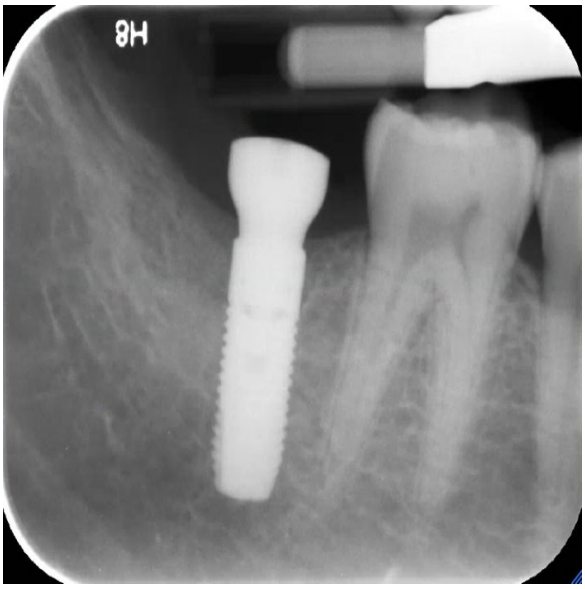


Figure 19. An intraoral periapical radiograph of the mandibular right posterior region showing implant #47 with a healing abutment in place

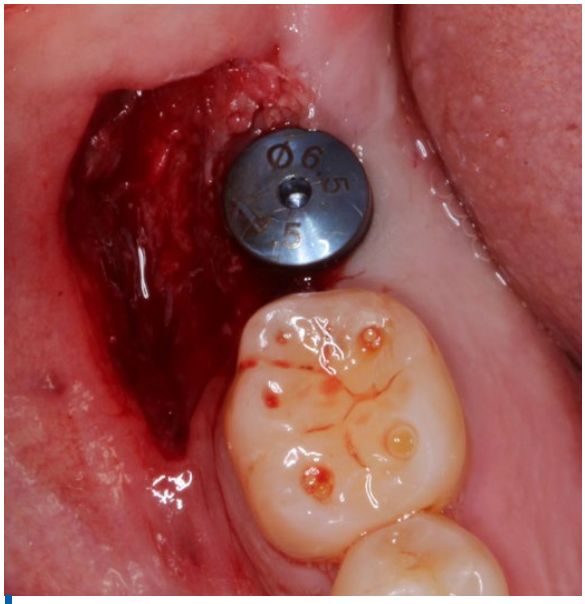


Figure 20. Clinical intraoperative photograph showing the recipient bed on the buccal aspect of implant #47

Figure 21. Clinical intraoperative photograph showing the donor site (right side of palate). An outline was made with a new 15c blade

said I may need some gum treatment around my implant." Intraoral examination revealed good oral hygiene, an intact dentition with only one missing tooth #47, which was replaced by a dental implant. Specifically, in the mandibular right posterior, there was lack of keratinized attached gingiva on the buccal aspect of the implant #47 (Fig. 18). An intraoral periapical radiograph of the region is shown in Fig. 19. The patient also reported discomfort when brushing the healing abutment and expressed concern if this discomfort would be present after his dentist provides the final implant crown.

The clinical findings were explained to the patient and what was recommended was to use a Free Gingival Graft harvested from the palate to create a band of attached keratinized gingiva and increase the vestibular depth around the implant. A written informed consent for periodontal surgery was obtained from the patient.

Case Management

After the administration of anesthesia to the recipient site via local infiltrations on the buccal and lingual aspect of the mandibular right posterior region, the recipient site's epithelium, CT, and muscle fibers were sharply dissected down to the periosteum using 15c and 12 blades

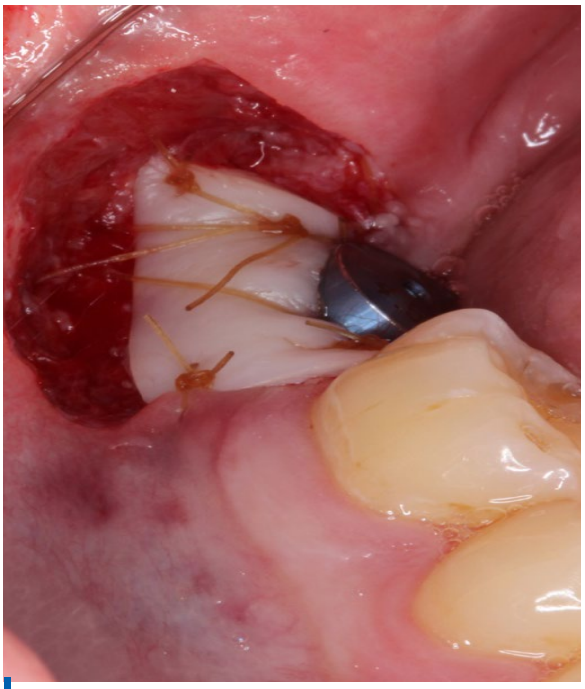
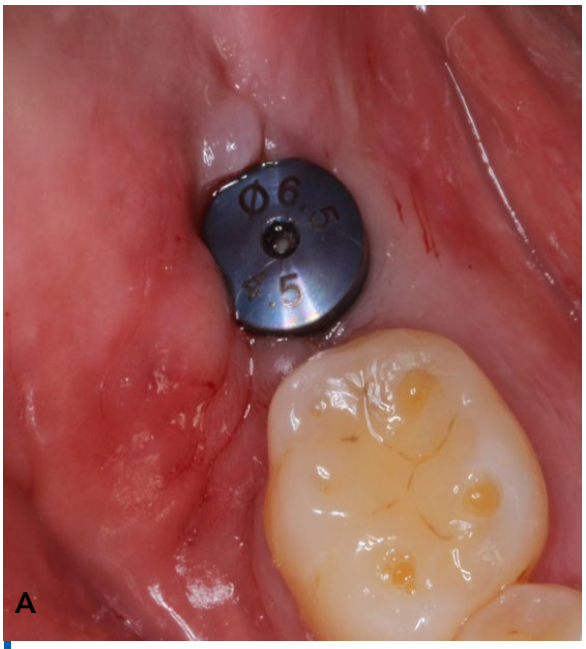
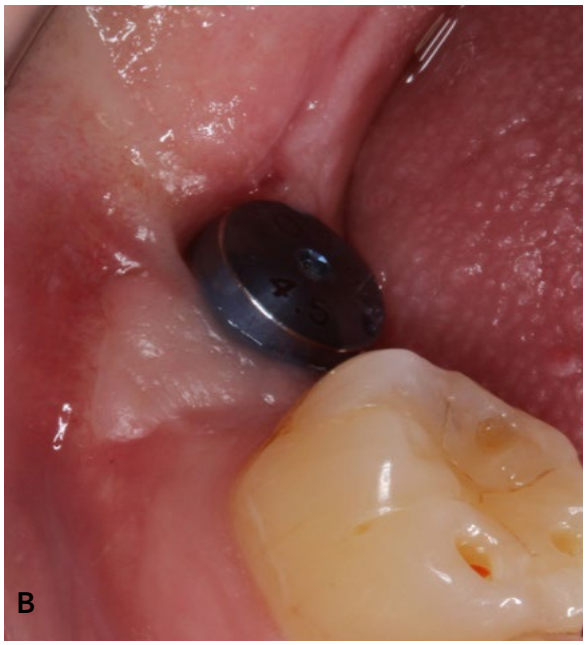


Figure 22. Clinical intraoperative photograph showing the graft stabilized and immobilized via periosteal and single interrupted sutures

Figure 23. Clinical photograph of the recipient site 1 week after surgery





Figures 24a and 24b. Clinical photographs of the recipient site preoperative and 8-weeks after surgery

and micro-scissors to create a large recipient bed around the buccal aspect of healing abutment (Fig. 20). Immediately after, a Free Gingival Graft was harvested from the right side of the palate using a new 15c blade (Fig. 21). The graft was immediately transferred to the recipient site, which was stabilized and immobilized via periosteal and single interrupted sutures with 4.0 chromic gut sutures (Fig. 22). Finally, tactile pressure was placed over the graft to remove any blood clots between the graft and recipient bed and to achieve close adaptation of the graft. No periodontal dressing was used to cover the graft and the patient was instructed to follow a liquid diet for the first 24 hours, followed by a soft diet for the remaining week and eat on the left side only. The patient was instructed to refrain from oral hygiene practices in the surgical site while rinsing with 0.12% chlorhexidine gluconate (three times daily) for 2 weeks, take 500 mg Amoxicillin (every 8 hours) for 7 days and 800 mg Ibuprofen (every 8 hours) as needed for discomfort. The postoperative follow-ups were conducted at 1 and 8 weeks.

Clinical Outcomes

Healing was uneventful at both the donor and recipient sites. At the 1-week follow-up only visual

examination was performed which revealed slight erythema and edema consistent with normal post-surgical healing and no swelling or infection was present (Fig. 23). At the 8-week follow-up the surgical area was irrigated gently with 0.12% chlorhexidine and plaque covering the healing abutment and adjacent tooth was removed with Q-tips soaked in chlorhexidine. At the 8-week follow up, the patient reported no gingival discomfort when brushing the healing abutment with a soft toothbrush. Clinical examination revealed a deepened vestibule and gain in attached and keratinized gingiva on the buccal aspect of the implant. Fig. 24 A and B show the preoperative and 8-week postoperative clinical presentation.

4. Conclusions

While the need for keratinized tissue to prevent the occurrence of recessions or to achieve complete recession coverage in the literature is controversial, the literature supports higher predictive values for home care and plaque control combined with patient compliance in regard to maintenance intervals, rather than keratinized tissue widths. Soft tissue thickness of at least 0.8 mm is required to achieve complete root coverage when using a coronolly positioned flap, while tissue thinner than 0.8 mm more often lead to incomplete recession coverage[28]. Recessions treated with guided tissue regenerationare more successfully covered in thick biotype patients[29]. Modifying tissue thickness may improve complete root coverage regardless of keratinized tissue width or depth of recession[1]. Maintaining blood supply to the graft is crucial for success of procedure. Vascularization can be recruited from the periosteal bed for the thick free gingival graft or in case of connective tissue graft and allograft also from the covering flap. The double blood supply for the connective tissue graft contributes to its success, when compared to thick free gingival graft. Flap retraction apically during healing due to tension from lack of mobilization or suturing, will reduce success of procedures[28]. Flap design and suturing technique must be planed accordingly. Coronally advanced flaps are not indicated in cases of shallow vestibules as flap retraction is increased and recessions reoccur more often. Tunneling procedures avoid recurrent recessions and preserve the papillae. Ultimately, adequate case selection will determine surgical and clinical success as it is the experience and the skill of the practitioner to determine indication and technique details[29,30]. The most important prognostic factor for success of surgical and non-surgical cosmetic and periodontal recession treatment is patient compliance with home care, maintenance and atraumatic tooth brush techniques.

Acknowledgments

The author declares no conflict of interest related to this study. There are no conflicts of interest and no financial interests to be disclosed.

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Questions

Which of the following tissues proliferates the fastest?

❑a. Epithelium;
❑b. Connective Tissue;
❑c. Bone;
❑d. They all proliferate at an equal speed.

Healing by true Periodontal Regeneration, involves formation of the following:

❑a. Cementum;
❑b. PDL;
❑c. Bone;
❑d. All of the above.

All of the following are advantages of Free Gingiva Grafts, except:

❑a. Increase the width of keratinized gingiva;
❑b. Increase the thickness of the gingiva;
❑c. Deepen the vestibule;
❑d. Superior esthetics and color match.

As described in the previous clinical cases, the patient was instructed to refrain from oral hygiene practices in the grafted area for how long?

❑a. 24 hours;
❑b. 1 week;
❑c. 2 weeks;
❑d. 3 weeks.

PROSTHETIC RECONSTRUCTIONS AND REFERRING IMPLANT SURVIVAL IN A POSTGRADUATE PROGRAM: A RETROSPECTIVE STUDY

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Received: July 12, 2016
Revised: August 02, 2016
Accepted: August 17, 2016
Published: August 19, 2016

Cite this article:
Gebistorf MC, Bader CL, Takeichi T, Katsoulis J. Prosthetic reconstructions and referring implant survival in a postgraduate program: A retrospective study. Stoma Edu J. 2016;3(3-4):223-234.

ABSTRACT

DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.13

Aims: To analyze frequency distribution of prosthetic reconstructions and therapeutic modalities with implant-supported reconstructions (ISRs) applied in a university graduate program.
Methodology: Data of implant placement and related ISR were obtained from treatment plans, surgical protocols and patients' charts, covering the 2005 to 2010 time period. Loading time, implant survival and type of ISR, i.e. fixed (single crown (SC), short-span fixed dental prosthesis (FDP), full-arch FDP (IB)) and removable ISR (denture with ball attachments (RDP), bar-supported overdenture (Bar-IOD)) were determined and analyzed with descriptive statistical methods.
Results: Data of 819 patients with a mean age of 62.3 ± 11.6 years were available. Graduate students placed 2337 implants and 1133 related ISRs were fabricated. The observation time ranged from 1 to 8 years (mean 4.7 ± 1.8). The number of implants supporting fixed and removable ISRs was 1053 (45.1%) and 1284 (54.9%), respectively. The percentage distribution of implants per ISRs exhibited 337/337 SCs (14.4%), 422/190 FDPs (18.1%), 294/54 IBs (12.6%), 374/198 RDPs (16.0%) and 910/354 Bar-IODs (38.9%). Thirty-one implants were lost (12 before and 19 after loading) resulting in an 8-year cumulative survival rate of 98.6% without difference between implants of different groups (fixed vs. removable ISRs, splinted vs. non-splinted ISRs, no GBR/SFE vs. GBR/SFE, upper vs. lower jaw).
Conclusions: A broad variety of fixed and removable implant supported prostheses for partially and completely edentulous patients was identified. Although these data represent learning curves for graduate students working under supervision, implant survival was successful in a short-term range.
Keywords: implant-dentistry, graduate training, implant survival, prosthetic reconstructions, CAD/CAM.

1. Introduction

Implant dentistry has become an integral part of clinical practice. Already in the early nineties when basic research in osseointegration and clinical application of implants grew rapidly, clinicians and university educators discussed the teaching of implantology for undergraduate students and for postgraduate trainings[1]. At this time the lack of trained and qualified teachers appeared to be a limitation when implantology should be introduced in university curricula[2]. However, gradually implant restorations were included into general and specialist dental practice[3]. Nevertheless, the topic of undergraduate training was taken up again only after the year 2000 and is currently being discussed worldwide.

Surveys and reviews that gathered data from dental schools in Northern America and less frequently in Europe revealed that implant dentistry has been incorporated to a high percentage into the undergraduate training[4-11]. Teaching implant dentistry often focused on the surgical aspects

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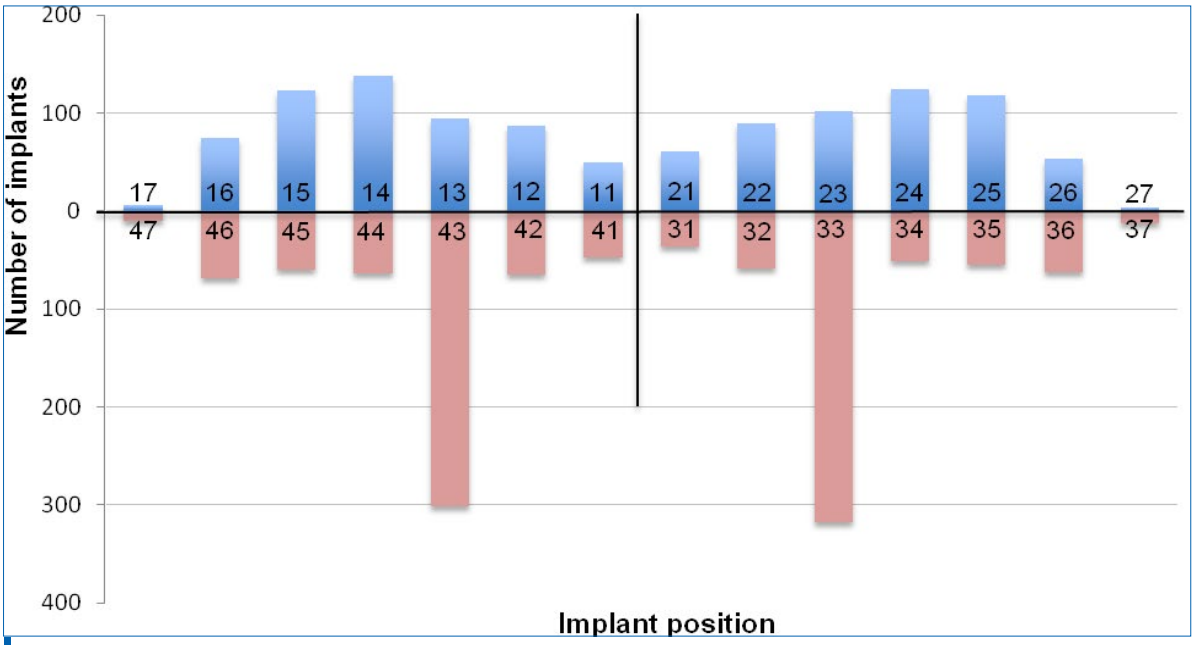

Figure 1. Distribution of implants placed in the maxilla and the mandible

and was performed by specialists in oral surgery, maxillofacial surgery and by periodontists[12] while prosthdodontists took an active role if patients were to be prosthetically restored with implants[13]. Such publications demonstrate the clear trend toward teaching implantology at universities and dental schools, otherwise they illustrate that there remain great variations how education in implant dentistry is provided for undergraduate students. In some schools teaching consists either exclusively in lecture-based theory or they include Typodont model and laboratory training while clinical interaction with patients and delivering implant supported restorations is not yet the standard. Implant placement by students is rarely reported and electively performed[6], however the students attend the surgical procedures as clinical observers[4]. Today, local and international courses for general practitioners and specialists, master programs offered by dental schools and dental associations or by private organizers are announced worldwide and various specialty degrees and diplomas can be obtained. Furthermore, courses are often sponsored by the industry[14]. Global standards for quality criteria or competency levels of such education and training programs are not available. The International Team for Implantology (ITI) published a grading system that classifies the surgical and prosthodontic procedures into straightforward, advanced, complex (SAC)[15]. Consensus conferences were also held and attempts made to establish teaching goals and to look at further needs and development in implant training. They summarize to what extent knowledge should be provided, and the level of skills that should be reached by undergraduate and postgraduate students[10,16-18]. Guidelines were proposed by various dental associations such as the American Academy of Implant Dentistry[1]. In this context, the aim of this retrospective study was to analyze frequency distribution of implant-supported prosthetic reconstructions and referred implant survival of implants placed from graduate students in a university training program.

2. Methodology

2.1. Admission to the program

A structured postgraduate program in prosthodontics and implant dentistry was established at the former Department of Prosthodontics, University of Bern, Bern, Switzerland. This comprehensive curriculum comprises prosthetic therapy and implant-surgery in one University clinic during a minimum of 3 years. The admission criteria for the program are that the graduate students have completed firstly a two yaer-clinical training in general dentistry, which includes training in oral surgery and secondly a doctoral thesis as general dentist (Dr. med. dent.). The focus was on problem based teaching and evidence-based, patient-centered comprehensive treatment. Furthermore, a scientific article had to be published by the graduate student or the university must have accepted another thesis. During the entire curriculum period the graduate students also took also an active role in theoretical teaching, planning sessions and clinical training of the undergraduate students in Prosthodontics, which comprised straightforward implant reconstructions such as mandibular overdentures, single crowns and short span fixed dental prosthesis. Such teaching assignment broadened their experience and helped to develop skills in social behavior and attitudes toward students, patients and teachers.

2.2. Study material

Prosthetic patients were consecutively admitted for treatment in the course of this postgraduate curriculum. They signed an informed consent willing to be treated by graduate students. This

Table 1. Number of implants according to the gender and the dental status

		Implants in maxilla	Implants in mandible	Total implants
Gender	Male	556	575	1131 (48.4%)
	Female	569	637	1206 (51.6%)
Dental status	Partially dentate	527	421	948 (40.6%)
	Edentulous	598	791	1389 (59.4%)
Total		1125 (48.1%)	1212 (51.9%)	2337 (100%)

Table 2. Number of implants according to the type of ISR performed

Type of ISR		Maxilla Implants / ISRs	Mandible Implants / ISRs	Total Implants / ISRs	Lost implants preload; loaded
Fixed	SC*	180* / 180	157* / 157	337 (14.4%)* / 337	1; 6
	FDP	207 / 92	215 / 98	422 (18.1%) / 190	1; 3
	IB	228 / 39	66 / 15	294 (12.8%) / 54	1; 2
Removable	RDP*	236* / 121	138* / 77	374 (16.0%)* / 198	1; 3
	Bar-IOD	274 / 66	636 / 288	910 (38.9%) / 354	8; 5
Total		1125 / 498	1212 / 635	2337 (100%) / 1133	12; 19

* non-splinted implants from SCs and RDP (total 711, 30.4%)
ISR: Implant supported reconstruction
SC: Single crown
FDP: short-span fixed dental prosthesis
IB: Full-arch FDP (Implant bridge)
RDP: Removable dental prosthesis
IOD: Implant-Overdenture

survey was part of a quality control assessment of the dental consultation. The data were based on an abstraction of the oral examinations and were collected strictly anonymously. The study respected the regulations of the Helsinki Declaration from 1975 and was performed in accordance with the STROBE statements. The study protocol was reviewed and approved by the University of Bern School of Dental Medicine Institutional Ethical Committee. The progress of the patients' treatment was regularly supervised and documented in case presentations either live chairside or with adequate digital presentations.

The case presentations followed the PICO structure[19,20], meaning that decision making and implant therapy should be based on the best evidence available and meet the patients' needs. The students performed the implant surgery and prosthetic rehabilitation under the guidance and supervision of the director and staff specialists of the Department.

Detailed records and photographs were obtained from all patients during the entire treatment period. When the treatment was completed all patients were included in a well-organized maintenance program.

The goal of the 3-year training curriculum was to reach a competency level of grade A (advanced) for surgical and prosthodontic procedures according to the ITI treatment guide. Complex treatments and invasive approaches that were not frequently encountered were performed by the supervisors and assisted by the students.

2.3. Patient management

The patients involved in the graduate curriculum were partially dentate or edentulous in one or both jaws. They often presented failures of old reconstructions and teeth not worth being maintained. They had a different background (recall, prevention, etc.) and the reasons for tooth loss were long in the past. The patient management followed a strict protocol as described below:

- The patient's chief complaint and demands were assessed.
- The records of the patient's history comprised social aspects, general health, special habits (smoking, bruxism, alcohol and drug abuse) and dental history. Records on medications were kept and the family physician was contacted, if necessary.
- Clinical examination and dental/oral diagnosis: It included the periodontal status, caries, tooth wear and in single case a dietary protocol by the patient, occlusal analysis and assessment of the vertical dimension, functional analysis of temporomandibular joints (TMJ), single radiographs, status of endodontically treated teeth, pathologies of oral mucosa or pathological findings on the panoramic radiography, atrophic jaw (areas), evaluation of old reconstructions, aesthetic analysis (facial morphology, smile line, gummy smile, gingival border and papillae, tooth axis, lip closure and biotype of gingiva).

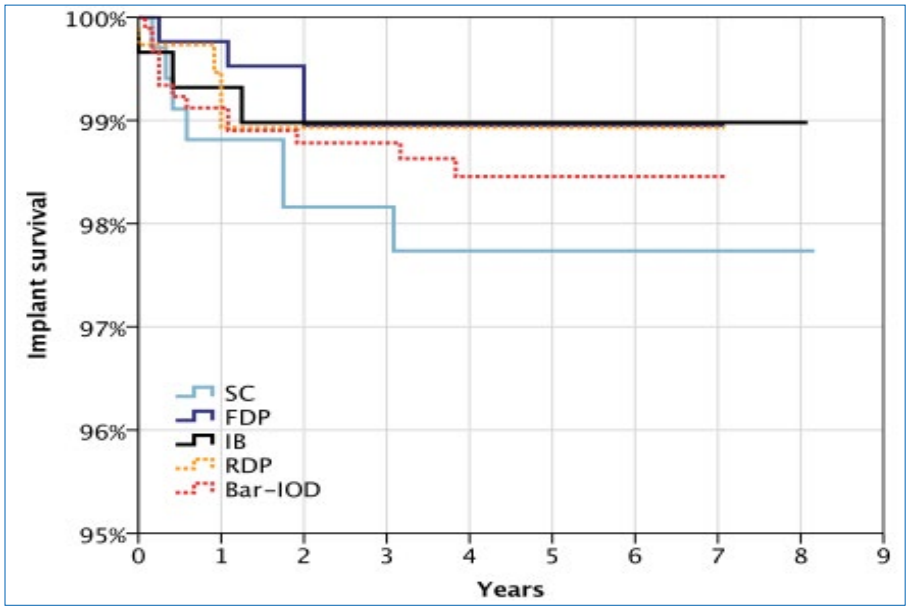

Figure 2. The implant survival was not significantly different for the implants supporting the different prosthetic reconstructions

- Planning: It was based on the clinical examination and comprised analysis of casts mounted with a face-bow, a prosthetic tooth setup simulating the prospective treatment outcome, evaluation of the best treatment plan based on objective criteria and possible modification of the plan which reflect the patients' benefit and demands, cost estimate, case presentation and establishing of the final procedures, and a virtual three-dimensional implant planning with specific software program.
- Pretreatment phase: It consisted in a smoking cessation protocol, periodontal treatment, fillings, endodontic treatment, tooth extraction and tooth setup, mockup, provisional prostheses including splints, reevaluation of the pretreatment, fabrication of radiographic splints and virtual implant placement with special computer software, fabrication of surgical splints. Based on proper treatment planning and case presentation the permission by the director of the department was obtained to perform implant surgery.
- Implant surgery: In the beginning the graduate students assisted implant surgery taking the role of the nurse and eventually performed all types of surgery themselves under guidance. According to the SAC criteria this included standard implant placement and eventually more complex surgery, such as staged or simultaneous local guided bone regeneration (GBR), sinus floor elevation (SFE) with transcrestal access or with lateral fenestration, submerged healing, in selected cases immediate implants or immediate loading, small connective tissue grafts, reevaluation of surgery and case presentation. The Nobel Replace implant system (Nobel Biocare, Gothenburg, Sweden) was used.
- Prosthetic phase: This phase consisted in the reevaluation of the provisional prostheses and modifications needed for the final prostheses, impression taking with individual trays, bite registration, final setup with orientation index and try-in session, case presentation, delivery of finale prosthesis and case presentation. The implant-supported reconstructions (ISRs) consisted of fixed (single crown (SC), short-span fixed dental prosthesis (FDP), full-arch FDP (IB)) and removable ISR (denture with ball attachments (RDP), bar-supported overdenture (Bar-IOD)). The fixed ISRs were either cement retained on an abutment or screw retained directly to the implant.
- Maintenance: The maintenance care program comprised at least one scheduled visit per year and monitoring of the oral hygiene by the dental hygienist. It was carried out by the graduate students during their training period. Handling of complications was equally part of the educational program since patients of the maintenance care program who exhibited any kind of problem were attributed to the trainees during their curriculum period.

2.4. Prosthesis design and materials

At the beginning of the time period covered by the present study standard technologies i.e. porcelain fused to metal were applied for fabricating of SCs and FDPs. Removable prostheses were connected to soldered rigid gold bars, using prefabricated elements as provided by the manufacturer, less

Table 3. Number of implants supporting CAD/CAM fabricated ISRs made from zirconium dioxide (ZrO_2) and titanium

Type of ISR	Implants in 2005	Implants in 2006	Implants in 2007	Implants in 2008	Implants in 2009	Implants in 2010	Total implants
Total fixed ISR	145	233	205	158	113	199	1053
CAD/CAM ISR ZrO_2	54 (37%)	34 (15%)	60 (29%)	34 (22%)	65 (58%)	68 (34%)	315 (30%)
Total removable ISR	208	247	225	207	213	184	1284
CAD/CAM bar titanium	15 (7%)	26 (11%)	87 (39%)	95 (46%)	123 (58%)	117 (64%)	462 (36%)

CAD/CAM: computer-aided-design/computer-assisted-manufacturing
ZrO_2: zirconium dioxide
ISR: implant supported reconstruction

Table 4. Life table analysis reporting on the totally 31 implant failures

Observation period (year)	Implants at risk (N)	Implant drop-outs (N)	Implant failures (N)	Interval survival (%)	Cumulative survival (%)
Preload	2337	0	12	99.49	99.49
0-1	2325	0	9	99.61	99.10
1-2	2316	294	7	99.70	98.80
2-3	2015	343	1	99.95	98.75
3-4	1671	354	2	99.88	98.63
4-5	1315	410	0	100.00	98.63
5-6	905	464	0	100.00	98.63
6-7	441	379	0	100.00	98.63
7-8	62	59	0	100.00	98.63
8-9	3	3	0	100.00	98.63

frequently to ball anchors and locators. Gradually the computer-aided-design/computer-assisted-manufacturing (CAD/CAM) fabrication for prosthesis frameworks and bars was introduced and recently became the prevalent technology[21]. Most frequently the Procera system (Nobel Biocare, Gothenburg, Sweden) was used for titanium and zirconium dioxide (ZrO2) reconstructions, followed by Zeno and Lava technology. Subsequently, all bars were milled from homogenous block of titanium grade IV. Milled titanium was also an option for large frameworks of full-arch IBs. In parallel, ZrO2 became the preferred material for all types of fixed prostheses. A close cooperation with laboratory technicians, who were trained and willing to apply modern CAD/CAM techniques, was established. All reconstructions were intended to be screw retained, directly from the implant shoulder without the interposition of an abutment. Thus, optimum implant planning and surgery was required, with proper alignment of the implant axis.

2.5. Data Collection

The present study material covers the data collection of these patients and related treatment, performed during the time period from January 2005 to December 2010. All necessary information was available from the patients' documentation that had to be kept by the graduate students. Additionally all data on implants, surgery procedures and prostheses were registered in a separate excel file. The data collection of the present study was based on the treatment plans, surgical protocols and daily records in the patients' charts during the treatment phase and the maintenance care period. The patients' age and gender, date of implant placement, implant location and loading time, implant survival, and type of ISR were determined.

2.6. Statistical analysis

The primary outcome was implant survival. The secondary outcome was the type of ISR performed and in particular the specific design and type of material used for the prosthetic reconstruction. Descriptive statistics included mean values, standard deviation (SD) and proportional analysis. A life table analysis was performed and the cumulative implant survival rate was calculated. The significance level was 5%. The SPSS software (SPSS 18.0, Chicago, IL, USA) was used for analysis and graphical illustrations.

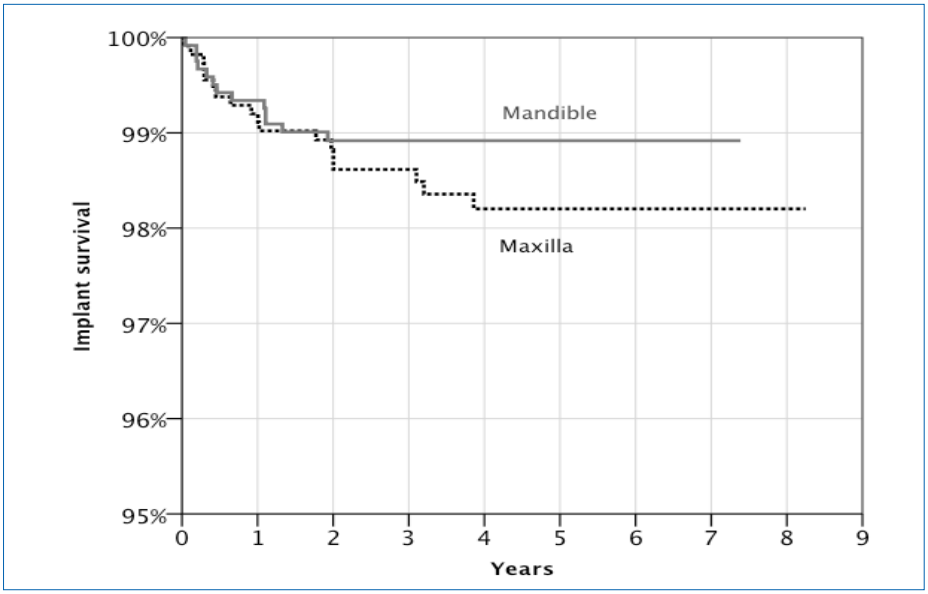

Figure 3. The implant survival was not significantly different between the upper and lower jaw

3. Results

3.1. Number of patients

Data of 819 patients, 420 women and 399 men were available. The mean age at the time of implant placement was 62.3 ± 11.6 years. 507 patients (62%) were > 60 years old. The observation time ranged from 1 to 8 years (mean 4.7 ± 1.8 years). Altogether 2337 implants were placed and 1133 related ISRs fabricated during the 6 years of implant placement. The average number of implants per patient was 2.9.

3.2. Number of implants

The distribution of the implants within the jaws was equal in the maxilla and mandible with exception of the canine FDI-positions 43 and 33 which was 6 times higher (Fig. 1).

Partially dentate patients received totally 948 implants (40.6%) compared to 1389 (59.4%) in the edentulous ones (Table 1).

The graduate students themselves placed 80% of the implants under guidance and supervision in the context of their education program. 10% of these implants were inserted in patients that were selected for the training in the undergraduate student course.

The remaining 20% of the implants were placed by the program director and instructors while the graduate-students took the role of the assistant nurse.

3.3. Number of reconstructions

The number of implants supporting fixed and removable ISR was 1053 (45.1%) and 1284 (54.9%), respectively.

The percentage distribution of implants per ISR exhibited 337/337 SCs (14.4%), 422/190 FDPs (18.1%), 294/54 IBs (12.6%), 374/198 RDPs (16.0%) and 910/354 Bar-IODs (38.9%) (Table 2). While the absolute and relative number of CAD/CAM fabricated removable ISR increased from 7% to 64%, the proportion of ZrO2-based fixed ISR varied between 15% and 55% without a clear trend during the observation time (Table 3).

3.4. Implant survival

Thirty-one implants were lost resulting in a cumulative survival rate (CSR) of 98.6% after 8 years. Twelve implants failed before loading while 19 implants were lost 1 to 4 years after loading (Table 4). Totally 12 implants in 8 patients were lost before functional loading. These patients were between 51 and 79 years old, all non-smokers and without significant general health problems. Eight (of 12) implants were located in the mandible (7 interforaminally, one at FDI position 36). One woman suffered from chronic osteoporosis that was treated with an oral bisphosphonate (Fosamax 10mg/day, MSD Merck Sharp & Dohme AG, Luzern, Switzerland) and showed no problems after replacement of the failed implant. Another female lost the first three interforaminally positioned implant and the second two implants, as well. She had no risk factors and was finally treated with a complete lower denture without implants.

Out of a total of 19 implants lost after functional loading 15 implants were located in the maxilla. Detailed information about the restorations and the patients are shown in Table 5. No statistically significant difference was observed for the survival rates between the prosthetic reconstructions (Table 2, Fig. 2). Further analysis revealed no difference comparing fixed vs. removable ISRs, implants with

Table 4. 19 late implants failures occurred in 16 patients after a loading time of 3 to 46 months. Implant removal (explantation) was performed in local anesthesia and a local disinfection was performed for 2 weeks

Patient	Gender	Age (Years)	General health status (Medication)	Implant type, diameter / length (mm)	Implant position (FDA)	GBA	SFE	Immediate implant placement	Immediate load	ISR	Months in situ
1	Male	64	Pneumonia 3 weeks after implant surgery	NRG, 10 / 4.3	12	Yes	No	No	No	Bar-IOD	3
			Complication: Periimplantitis (8 mm crestal bone loss distal and mesial, pus palatal), mild pain; Etiology: Periimplantitis, general risk factors? / Therapy: explantation, relining of IOD.								
2	Female	49	Smoker (25 pack years)	NRG, 13 / 3.5	34	Yes	No	No	Yes	SC	4
			Complication: slightly mobile cement-retained SC, no bone loss, no mucosal inflammation, no pus, no pain / Etiology: Overload while implant was loaded immediately? / Therapy: explantation and new implant after 5 months incl. GBR, new SC.								
3	Male	84	Nephritis, obstructive sleep apnea syndrome, tuberculosis (1944 – 1947), daily alcohol consumption, angina pectoris (2008)	NRG, 10 / 4.3	16	Yes	Yes	No	No	SC	5
			Complication: Periimplantitis (7 mm crestal bone loss distal and mesial, distal pus), no pain; Etiology: Periimplantitis, general risk factors? / Therapy: explantation.								
4	Female	58	Healthy	NRG, 13 / 4.3	36	Yes	No	Yes	No	SC	7
				NRG, 13 / 3.5	14	No	No	Yes	No	SC	21
			36: Complication: mobile SC / implant fracture 2mm apically of shoulder, no crestal bone loss, slight mucosal inflammation, no pus, no pain / Etiology: screw loosening, patient missed recal, i.e. was abroad > 1 year / Therapy: explantation and new implant immediately, new SC after osseointegration. 14: Complication: Periimplantitis (10 mm crestal bone loss distal, pus), occasional pain; Etiology: Periimplantitis / Therapy: explantation and new restoration 15-x.								
5	Female	50	Smoker (25 pack years), weekly cannabis consumption, status after tx of colon and uterus carcinoma, rheumatism, hepatitis C	NRG, 10 / 4.3	25	Yes	Yes	No	No	Bar-IOD	7
			Complication: Periimplantitis (8 mm crestal bone loss mesial and distal, pus), occasional pain; Etiology: Periimplantitis, general risk factors? / Therapy: explantation and bar shortened, relining of IOD								
6	Female	60	Smoker (40 pack years), chronic depression, osteoporosis	NRG, 13 / 4.3	15	Yes	Yes	No	No	SC	10
			Complication: Periimplantitis (7 mm crestal bone loss distal and mesial, pus), occasional pain; Etiology: Periimplantitis, general risk factors? / Therapy: explantation.								
7	Male	60	Smoker (25 pack years - stopped smoking before implant surgery)	NRG, 13 / 3.5	24	Yes	No	No	No	Ball abutment / IOD	11

			Complication: slightly mobile implant, circumferential 0.5mm bone loss, slight mucosal inflammation, no pus, no pain / Etiology: Overload? general risk factor? / Therapy: explantation and relining of RDP.								
8	Male	65	Hypertension	NRG, 13 / 3.5	23	Yes (autogenous bone)	No	No	No	Locator abutment / IOD	12
				NRG, 13 / 3.5	13	Yes (autogenous bone)	No	No	No	Locator abutment / IOD	12
			13: Complication: mobile locator / implant fracture 7mm apical to shoulder, no crestal bone loss, slight mucosal inflammation, no pus, no pain / Etiology: overload, bruxism? / Therapy: explantation, relining of IOD. 23: Complication: slightly mobile locator, circumferential 0.5mm bone loss, slight mucosal inflammation, no pus, no pain / Etiology: Overload, bruxism? / Therapy: explantation, relining of IOD.								
9	Male	65	Status after heart surgery	NRG, 13 / 4.3	46	Yes	No	No	No	FDP	13
			Complication: Periimplantitis (9 mm crestal bone loss distal and mesial, pus), no pain; Etiology: Periimplantitis / Therapy: explantation and shortening of cement-retained FDP 44-x .								
10	Male	42	Smoker 5 cigarettes/ day Chronic periodontitis	NRG, 13 / 4.3	35	No	No	No	No	SC	15
			Complication: Periimplantitis (6 mm crestal bone loss distal and mesial, pus), no pain; Etiology: Periimplantitis, local risk factors? / Therapy: explantation and new implant after 5 months incl. GBR, new SC.								
11	Male	53	Meliodisis, Diabetes type II, heart operation	NRG, 10 / 4.3	25	Yes	No	No	No	Bar-IOD	23
			Complication: IOD tooth fracture region 23, radiographic 5mm crestal bone loss mesial and distal, no inflammation, no pus, no pain / Etiology: Overload? / Therapy: explantation and new implant 3 months after removal, bar and IOD adaptation.								
12	Male	77	Chronic depression, Hypertension, Smoker (daily pipe smoker - stopped before implant surgery)	NRG, 10 / 4.3	16	Yes	Yes	No	No	FDP	24
				NRG, 13 / 3.5	14	Yes	No	No	No	FDP	24
			Complication: slightly mobile FDP 16x14, circumferential 0.5mm bone loss, no mucosal inflammation, no pus, no pain / Etiology: Overload? (depression and bruxism after colon-carcinoma surgery in 2010 / Therapy: explantation.								
13	Male	66	Healthy	NRG, 13 / 3.5	14	No	No	No	No	SC	32
			Complication: Periimplantitis (7 mm crestal bone loss distal and mesial, pus), occasional pain; Etiology: Periimplantitis / Therapy: explantation.								
14	Male	56	Chronic periodontitis, Smoker (30 pack years)	NRG, 10 / 4.3	14	No	Yes	No	No	SC	37
			Complication: Periimplantitis (6 mm crestal bone loss distal and mesial, pus), occasional pain; Etiology: Periimplantitis, local risk factor? / Therapy: explantation.								

15	Male	54	Smoker (40 pack years), daily alcohol consumption (one beer), angina pectoris, hypertension, reflux disease	NRG, 10 / 4.3	24	No	No	No	Yes	Bar-IOD	38
			Complication: at 1.5 year recall mild periimplantitis, at 3 years additional circumferential 0.5mm bone loss, mild mucosal inflammation, no pus, no pain / Etiology: Overload and periimplantitis / Therapy: explantation.								
16	Male	55	Smoker (36 pack years)	NRG, 13 / 3.5	24	Yes	No	No	No	Bar-IOD	46
			Complication: Periimplantitis (8 mm crestal bone loss distal and mesial, pus), occasional pain; Etiology: Periimplantitis, local risk factor? / Therapy: : explantation and bar shortened, relining of IOD.								

GBA: Guided Bone Augmentation, i.e. simultaneous buccal augmentation with Bio-Oss / particulated autogenous bone and Bio-Gide membrane (Geistlich, Wolhusen, Switzerland)
SFE: Sinus Floor Elevation
NRG: NobelReplace Tapered Groovy Implant (Nobel Biocare, Gothenburg, Sweden)
ISR: Implant supported reconstruction
SC: Single crown
FDP: short-span fixed dental prosthesis
IB: Full-arch FDP (Implant bridge)
RDP: Removable dental prosthesis
IOD: Implant-Overdenture

vs. without GBR or SFE, splinted vs. non-splinted ISRs and ISRs in the upper vs. lower jaw (Fig. 3).

4. Discussion

The aim of this retrospective study was to analyze frequency distribution of implant-supported prosthetic reconstructions and referred implant survival of implants placed from graduate students in a university training program. A broad variety of fixed and removable ISRs for partially and completely edentulous patients was identified. Although these data represent learning curves for graduate students working under supervision, implant survival was successful in a short-term range. The overall implant CSR of 98.6% after 8 years is comparable to other studies where implants where placed by novice operators that were supervised by experts during implant placement. In a recent study[22] the survival rate of 49 implants and referring SC that were placed and fabricated by undergraduate students was 94% after 10 years of loading. The authors concluded that it is acceptable to include implant therapy in the clinical undergraduate dental curriculum, provided the focus remains on straightforward cases with substantial supervision by trained dentists and oral and maxillofacial surgeons. This teaching situation is comparable to the setting in the present study.

However, the 5-year cumulative survival rate of the implants was considerably higher with 98.6%. A learning curve has to be considered but cannot be specified for the single students. Maxillary implants were slightly less successful, as it is often reported from clinical studies. Some specific treatment outcomes are also represented by various clinical studies performed during the same time period, based on the same study material[23-29]. Since the present data were collected within a prosthodontic department the number of edentulous jaws that were included in the data collection is relatively high. This is in contrast to a study performed in a department for oral surgery where the most frequent reconstruction performed was an implant supported SC[30]. This difference is also represented by the average number of implants per patient of 1.5 vs. 2.9 in the present study.

Another study investigated the 12-months clinical outcome of immediate implants placed by novice operators showing that the success rate was high and predictable provided there were routine school procedures and supervision from experienced surgeons[31]. The clinical studies available in the literature reporting on success rate of implants placed by graduate students include only a small number of implants. At the Prosthodontic Department of the University of Washington a number of 273 implants was observed during at least 5 years and showed a comparable survival rate of 96.3%[32].

At the University of Kentucky College of Dentistry a total of 415 patients with 963 implants were interviewed. The implant survival rate was 97%, and 88% of the implants were considered successful as determined by patient-centred criteria[33]. These results suggest that work standardization (in the form of specific treatment protocols) and the use of a formal, incremental learning system can result in positive patient outcomes. Clinical outcomes should be monitored in academic dental settings as part of the clinical process improvement, and these outcomes can provide a means of assessing the effectiveness of the training program.

So far little information was provided in the literature on the treatment outcomes of implant-placed prosthodontic graduate training curricula. As mentioned in the introduction many articles show clear trends that implant dentistry becomes integrated worldwide in the undergraduate training of dental students. Implant dentistry knowledge, however, is mostly a basic theoretical overview on implants. It appears that if the undergraduate students get in touch with implant dentistry they are more likely to incorporate implant treatment in their practice[34]. A small survey restricted to a local area revealed that particularly male general practitioners felt the need to obtain training in implant dentistry[35]. Today young dentists will meet patients who will ask for implant treatment[7] and who have already all kind of information on implants. In this respect, it seems important that in-depth knowledge is provided and the graduate students must achieve a good level of skills in well structured implant programs.

A recent survey conducted in the States revealed that today many postgraduate prosthodontic curricula allow students to perform implant surgery in their advanced education program[36]. The answers indicate that up to 50% of students judged their implant-surgery skills on a level of good competence while others felt the need of more training to reach a better level of competence. One study showed that even a short but intense and closely supervised training of 4 sessions 3 days each may significantly improve surgical skills and as a result also implant survival[37]. Postgraduate implant programs in University settings often underscore the multidisciplinary aspect of implant dentistry, as there are oral or maxillofacial surgery, prosthodontics and periodontology. With regard to implants, the specialty training programs subsequently focused on their own, specific knowledge and skills, and several specialists perform the implant treatment. Therefore, the comprehensive character of implant dentistry does not become sufficiently visible.

In general, the intent of oral surgery is the removal of a pathological process and treatment of dental or oral diseases. Although implant placement is a surgical procedure, as well, its result is not the pathology but the prosthetic rehabilitation after tooth loss. The implant itself is a tool used to enable, improve and perform prosthetic treatment. Thus, implant dentistry must be prosthetically centered and driven, with regard to analysis, planning and the final outcome. Already in the nineties some authors emphasized the importance of prosthodontics training with regard to implant therapy[1,2]. The chewing function, phonetics and esthetics are the crucial aspects oft implant treatment. The term „backward planning" was created and this should become the standard in any implant treatment, particularly for full mouth rehabilitation. Accordingly, a comprehensive prosthetic training including implant placement and implant restoration appears to be the most effective approach to a broad understanding of the potential and limitations in implant rehabilitation.

The data of the present study show that the students were involved in the whole broad, therapeutic spectrum of implant dentistry, including the surgical and prosthodontic part as well as maintenance care. Thus, they reached full competence level of grade A (advanced) for surgery and prosthetics, while level C (complex) can be practiced under close supervision, particularly with regard to the surgical techniques. At the end of the training curriculum it is expected that the students are able to properly judge their own knowledge and skills and to adhere to strict patient selection criteria. Furthermore, the use of CAD/CAM technology for implant supported fixed and removable reconstructions helped to standardize the fabrication workflow and minimize inaccuracies due to manual errors. As reported in another investigation, the specific analysis revealed a predictable outcome of the implant reconstructions with improvements for the digital workflow[38].

In the current competitive and fast developing market of implantology, which is often business driven, it becomes essential that high quality education and treatment is guaranteed. Therefore, theoretical knowledge and training of clinical skills must be an integral part of well-structured educational programs in comprehensive implant dentistry to reach the required competence and to maintain a high standard of care[39]. The majority of articles on implant curricula deal with undergraduate education while information on specialty training for young dentists and general practitioners is somehow confusing and less clear. If implant teaching in University curricula is described, a variety of terms are applied, such as: undergraduate, predoctoral, graduate, postgraduate or residency and specialty training, advanced education or master program. It appears that there is no consensus and common use of these terms - except with regard to undergraduate education, which would clearly address the degree of training and specify the level competence.

Furthermore, two universities recently reported on a predoctoral implant program where selected students placed a series of implants themselves. While the students highly benefited from this experience by improving their understanding of the connection between surgical implant placement and definitive prosthodontics reconstruction, their interest for a postgraduate implant program to improve theoretical and clinical skills became more intense[40].

The placement of implants by undergraduate students as part of an implant program would require significant efforts in theoretical education, pre-clinical laboratory training and clinical treatment. However, it has been demonstrated that this approach may result in acceptable clinical outcomes, patient satisfaction and positive student perception[41].

5. Conclusions

Within the limits of this retrospective study we conclude that a broad variety of fixed and removable implant supported prostheses for partially and completely edentulous patients was identified. Although these data represent learning curves for young graduate students working under supervision, implant survival was successful in a short-term range. Well-structured educational programs in comprehensive implant dentistry providing theoretical knowledge and clinical skills may enhance a high standard of maintenance care and a high treatment outcome quality in the current competitive market of implantology.

Acknowledgements

The contributions of the postgraduate students and the supervisors are greatly acknowledged. The authors report no conflict of interest.

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CV

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Questions

The mean age of the patient seeking implants was

❑a. 30 years;
❑b. 40 years;
❑c. 60 years;
❑d. 80 years.

The cumulative survival rate (CSR) after 8 years of observation time was

❑a. 95.4 %;
❑b. 97.1 %;
❑c. 98.6 %;
❑d. 100 %.

Did the different prosthetic reconstructions have an influence on the implant failure rates ?

❑a. Yes, because an implant bridge had a significantly lower survival rate than single crowns (SC);
❑b. Yes, because removable suprastructues had a significantly lower failure rate than fixed suprastructures;
❑c. Yes, because SC had a significant higher failure rate than the other suprastructures;
❑d. No, there was no significant difference.

The implants inserted were positioned mainly

❑a. In the anterior maxilla;
❑b. In the anterior mandible;
❑c. In the posterior maxilla;
❑d. In the posterior mandible.

STANDARDIZED ELECTROMYOGRAPHIC INDEXES ALLOW A RELIABLE MEASUREMENT OF MASTICATORY MUSCLES FUNCTION

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Received: March 15, 2016
Revised: June 04, 2016
Accepted: July 11, 2016
Published: July 14, 2016

Cite this article:
Rosati R, Semelewa E, Satygo E, Ivanova EP, Rosati F, Silin A, Ferrario VF. Standardized electromyographic indexes allow a reliable measurement of masticatory muscles function. Stoma Edu J. 2016;3(3-4):235-242.

ABSTRACT

DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.14

Introduction: Surface electromyography (sEMG) allows the quantitative and qualitative analysis of muscles recruitment and it is a method currently used in research and in the clinical practice. Considering that sEMG assesses the portion of muscular electrical activity that reaches cutaneous surface, a well-standardized protocol should be used, allowing to remove (or reduce) technical and biological artefacts.
Methodology: To evaluate the repeatability of the normalized indexes describing masticatory muscles sEMG, the standardized cutaneous myoelectric activity of Temporalis Anterior and Masseter muscles was recorded twice during a one week interval (Acquisition sessions T1 and T2) in 20 young healthy adults. The data obtained during T1 and T2 were compared. A clinical case was shown as an example of clinical sEMG application.
Results: No significant differences in the standardized indexes elaborated by sEMG signals of T1 and T2 acquisition sessions were found, strengthening the effectiveness of the standardization procedure.
Conclusion: sEMG indexes allow the evaluation of occlusal-induced proprioceptive mediated muscular recruitment in a reliable way. This measurement protocol can be clinically applied to estimate the muscular adaption to new occlusal conditions or to re-establish physiological muscular coordination.
Keywords: sEMG, dental proprioception, occlusion, oral rehabilitation, overlay.

1. Introduction

Every day the stomatognathic apparatus constantly performs many physiologic activities, such as speech, mastication, suction, deglutition. The muscles responsible for the mandibular, tongue, hyoid, soft palate, lips movements generate mechanical forces that are dissipated by the hard tissues (bones, temporomandibular joint, teeth). In all these functions several muscle groups are involved and coordinated by the central nervous system under the influence of peripheral inputs. Surface electromyography (sEMG) is a low-cost, non-invasive method usable in research and in dental clinical practice for the quantitative and qualitative analysis of head and neck muscles[1-23]. As sEMG does not directly assess the muscular fibers, a well-standardized protocol should be used, allowing to remove (or reduce) technical and biological artefacts. Indeed, the thickness of the hypodermis, crosstalk from different muscles, the instrumental noise and the position of the electrodes relative to the muscle fibers and the motor point can influence the sEMG signal. Taking into account these technical features, a correct sEMG assessment should be performed only with a reproducible protocol, and with standardized/normalized potentials to remove most of biological and technical noise[2,3,8,9,10,13]. The aim of the present study was to evaluate the repeatability of masticatory muscles normalized indexes obtained during maximal voluntary clenching sEMG acquisitions.

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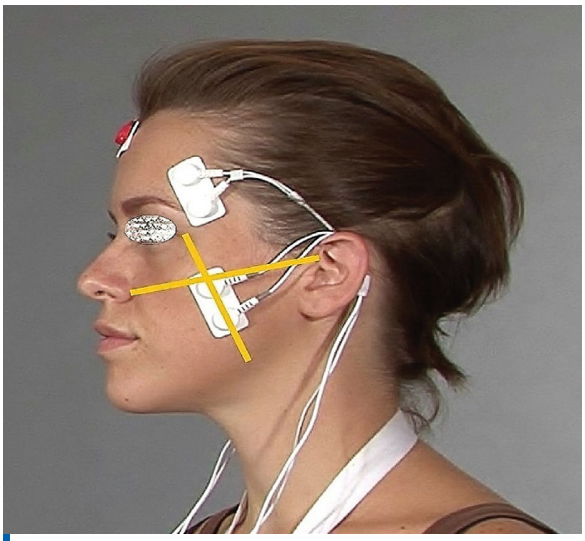

Figure 1. Masseter and Temporalis Anterior electrode placement

Figure 2. Initial clinical condition

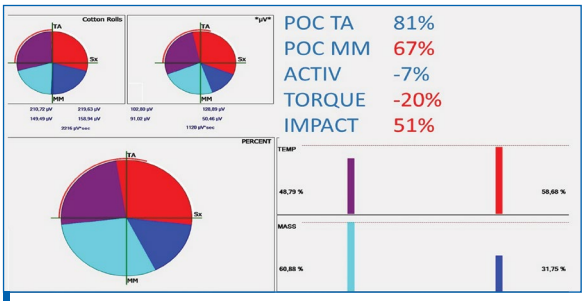

Figure 3. Initial sEMG differential test. Reported indexes are: Temporalis Anterior and Masseter percentage overlapping coefficient (POC TA and POC MM); activity index (ACTIV); torque coefficient (TORQUE) and standardized activity index (IMPACT)

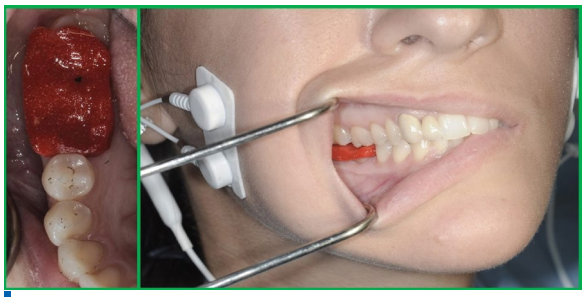

Figure 4. Resin jig used to arrange vertical dimension following muscle performance

2. Methodology

2.1. Study design

Standardized cutaneous myoelectric activity of Temporalis Anterior and Masseter muscles was acquired twice with a one-week interval (Acquisition sessions T1 and T2) in 20 young healthy adults. The data obtained during T1 and T2 were compared.

2.2. Subjects

Twenty young healthy adult volunteers (5 males, 15 females, age range 24-28 years, mean 26, SD 2), volunteers were recruited for the study after a detailed explanation of the experimental protocol and possible risks involved.

They all gave their consent to the investigation according to the principles outlined in the Declaration of Helsinki. The study protocol was approved by the local ethic committee. All data collections were performed in the clinic of Dental Faculty of North-Western State Medical University named after I.I. Mechnikov (Saint Petersburg, Russian Federation).

The subjects were visited by a dentist (SE); all the subjects were in general good health, free from stomatognathic apparatus and neck pathologies and were selected for the study according to the following inclusion criteria: a minimum of 28 permanent teeth, no parodontal problems, no craniofacial and cervical trauma and surgery, no temporo-mandibular and craniocervical disorders, no current orthodontic treatment and no painful sensation when clenching their teeth. The subjects were excluded from the study if they had neurological problems that could interfere with the experimental procedure, or if they were taking drugs that could affect the musculoskeletal system, such as anti-inflammatory or pain relief drugs. During the sEMG recording, the environment was quiet and with low light. The subjects sat in a comfortable office type chair, in an erect posture with their feet flat on the floor, and arms resting on their legs.

2.3. Electrode type and positioning

The Masseter (MM) and Temporalis Anterior (TA) muscles of both sides (left and right) were examined. Disposable pre-gelled silver/silver chloride bipolar surface electrodes (rectangular shape, 21x41 mm, 20 mm inter-electrode distance) (F3010, Fiab, Firenze, Italy) were positioned. The

Table 1. Comparison of standardized sEMG indexes obtained in two different data collection sessions (all values are percentages). No statistically significant differences were found

Masticatory sEMG standardized indexes repeatability					
	POC TA	POC MM	Activity	Torque	Impact
Session 1					
Mean	82.3	84.5	1.5	-1.0	114.2
SD	1.3	1.2	4.6	4.0	16.3
Session 2					
Mean	82.0	84.4	1.1	0.6	113.5
SD	0.8	1.1	4.7	3.2	12.5
Difference					
Mean	0.2	0.1	0.4	-1.5	0.7
SD	0.8	0.7	4.1	4.8	13.7
TTest	0.166	0.408	0.691	0.166	0.821

electrodes were placed on the muscular bellies parallel to muscular fibres as follows (Fig. 1):

- MM: the operator, standing in front of the seated subject, palpated the muscular belly while the subject clenched his/her teeth. The electrodes were fixed parallel to the exocanthion-gonion line and with the upper pole of the electrode under the tragus-labial commissura line.
- TA: the muscular belly was palpated during tooth clenching and the electrodes were fixed vertically along the anterior margin of the muscle (corresponding to the fronto-parietal suture)[24].

A disposable reference electrode was applied to the forehead. To reduce skin impedance, the skin was carefully cleaned prior to the electrode placement, and recordings were performed 5 min later, allowing the conductive paste to adequately moisten the skin.

2.4. sEMG recordings and measurements

Instrumentation

The surface EMG activity was recorded using a computerized instrument (Easymyo, 3 Technology S.r.l., Udine, Italy). The analogic sEMG signal was amplified (gain 100, bandwidth 0–1000 Hz, peak-to-peak input range from 0 to 3600 μV) using a differential amplifier with a high common mode rejection ratio (CMRR=115 dB in the range 0–60 Hz, input impedance 100 GΩ), digitized (24-bit resolution, 4000 Hz A/D sampling frequency), and digitally filtered (Butterworth type, high-pass filter set at 30 Hz, low-pass filter set at 400 Hz, band-stop for common 50–60 Hz noise). The signals were averaged over 25 ms, with muscle activity assessed as the root mean square (RMS) of the amplitude (μV). sEMG signals were recorded for further analysis. Before the acquisition session the subjects were properly trained to elicit true teeth maximal voluntary contraction using an on-time sEMG signal visualization.

3. Results

3.1. Standardization procedure

To normalize the sEMG signals two 10-mm thick cotton rolls were positioned on the mandibular second premolars/first molars of each subject and a 5-s maximum voluntary contraction (MVC) was recorded. The mean sEMG potential of each muscle obtained in that first acquisition was set at 100%, and all further sEMG potentials were expressed as a percentage of this value (μV/μVx100).

3.2. Analyzed task

The sEMG activity was recorded during a 5-s MVC test in intercuspal position (IP): the subject was invited to clench as hard as possible and to maintain the same level of contraction for all the test. For each patient, the central 3 s of the MVC test were analysed, and the sEMG potential was standardized as detailed before.

3.3. sEMG data analysis

Separately for each acquisition session (T1 and T2), the sEMG waves were compared by computing a series of standardized indexes using the instrument software tools:

1. the percentage overlapping coefficient (POC, unit %), an index of symmetric muscular contraction. The index ranges between 0% and 100%: when two paired muscles contract with perfect symmetry, a POC of 100% is obtained. Masseter and Temporalis Anterior POCs were obtained for each patient[24,25].
2. the torque coefficient (TORQUE, unit %) was assessed to evaluate if an unbalanced contractile activity of the contralateral Masseter and Temporalis Anterior muscles, such as that of the right Temporalis Anterior and the left Masseter, might give rise to a potential lateral displacing component. TORQUE ranges between 100% (complete prevalence of the right Temporalis Anterior and left Masseter) and -100% (complete prevalence of the left Temporalis Anterior and the right Masseter)[24,25].
3. the activity index (ATTIV, unit %), was obtained as the percentage ratio of the difference between the mean Masseter and Temporalis

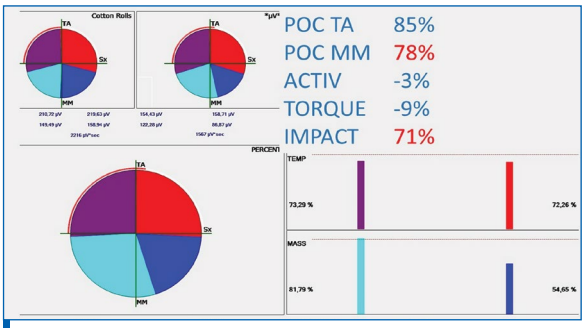

Figure 5. First test clenching wearing the jig

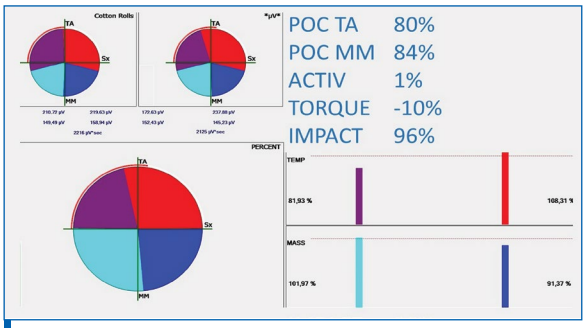

Figure 6. Final test wearing the (modified) jig

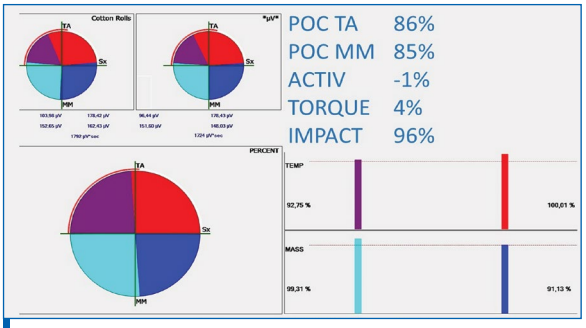

Figure 7. Final sEMG test clenching with cemented overlay

Figure 8. Final reconstructions

Anterior muscles standardized potentials and the sum of the same standardized potentials, to individuate the most prevalent pair of masticatory muscles. The index is positive (up to 100%) if the Masseter muscles standardized potentials are larger than those of the Temporalis Anterior muscles, negative (up to 100%) if the Temporalis Anterior muscle potentials are larger[26].

4. the standardized activity index (IMPACT, unit %*s) was calculated to quantify the total muscular activity performed during MVC relative to the standardization clenching on cotton rolls; IMPACT was estimated computing the mean (Masseter and Temporalis Anterior) total muscle activities as the integrated areas of the sEMG potentials over time[26].

3.4. Statistical evaluation

To quantify the acquisition session effect on the sEMG standardized indexes, the values obtained from T1 and T2 were compared. Normality data distribution was assessed using Shapiro-Wilk test. Paired Student's T test ($p < 0.05$) was used to evaluate the systematic error between the two muscular measurements.

Table 1 shows the mean values and standard deviation of the standardized indexes obtained in the two data acquisition sessions, together with the mean difference in individual values. Paired Student's T tests found no statistically significant differences.

4. Discussion

The surface electromyogram comprises the sum of the electrical contributions produced by the active motor units as detected by cutaneous electrodes. Several parameters could be analysed in the captured electrical signal. The discharge rates, signal amplitude, spectral analysis could be investigated to estimate the neural control strategies involved in the muscles management.[27] These instrumental assessments should be performed applying the correct protocols; in fact, the myoelectric activity signal may vary due to many factors such as change in the electrode location, change in the tissue properties, tissue temperature, muscle resting length, velocity of contraction and fiber type[27-30].

In the last 30 years the effect of electrodes position on conduction velocity estimation (CV), amplitude and spectral variables of the surface EMG has been addressed in a number of methodological and clinical publications taking into account muscles (or groups of muscles) ranging from the masticatory muscles to the muscles of the shoulder, of the arm and leg too[31]. Changing the electrode location through innervation zones to tendons affect the detected activity: signal spectrum shifts towards higher frequencies, the amplitude decreases and the conduction velocity is biased towards higher values[27]. Moreover we have to underline that surface electrodes, in many cases,

capture electrical signals generated from several muscles -crosstalk effect- preventing a single muscle measurement. In facial cutaneous areas, the mimic muscles and sometimes anatomical variability, could complicate the univocal sEMG signal-muscle matching (as previously reported platysma to masseter partial coverage)[32].
Indeed it is well known that some muscles functional compartmentalization due to their anatomical and innervation complexity thwarts a simple function assessment; in particular Temporalis muscles is a composite morphologic-functional entity not yet fully understood[33,34].
In any case, taking into account the technical complications, it appears reasonable to apply sEMG analysis to understand the functional areas central management instead of focusing on single muscle function measurement.
Notwithstanding the amount of experimental and theoretical studies, no global consensus was achieved in the sEMG raw signal interpretation. For this reason, studies that could increase the understanding of sEMG advantages and limits in order to allow a more aware clinical application are required.
The most revealing standardization effort occurred in 1997–1999 within the European Project on "Surface EMG for Non Invasive Assessment of Muscles" where a fine analysis was presented for a number of sEMG acquisition technical factors[35,36]. Yet, when comparing several EMG studies published in the year 2004, Armijo-Olivo et al. stated that 60% of the analysed studies did not report a normalization procedure, making comparisons of the EMG signal difficult due to anthropomorphic differences between recording sites and individuals[37]. They underlined that comparison of muscle function evaluating the absolute values of the recorded potentials (that is, microvolt values) provides inaccurate results. As a consequence of this inaccuracy, comparing the EMG activities between subjects and under different conditions requires a normalization process.
The efficacy of intra-subjects standardization procedure was investigated also for the jaw stretch reflex. In fact, Koutris et al. demonstrated that when the amplitude of the masseter muscle during the jaw stretch reflex is normalized relative to the prestimulus EMG amplitude, it becomes independent from the location of the electrodes over the muscle[38]. In the present study, the repeatability of standardized (normalized) indexes calculated in independent sEMG acquisitions was evaluated. Indeed, as suggested by Ferrario et al., sEMG could be usefully employed for the control of the muscular modifications induced by variations in the occlusal conditions, either natural (for instance, different occlusal classes, crossbite occlusion), or artificial (for instance, dental prostheses, fillings, or even orthodontic treatment)[26,39]. The use of sEMG can help in the correct construction of oral devices[40]. To simplify the understanding of occlusal induced muscular modifications, easy-to-interpret indexes could be helpful in the clinical device/ prosthesis-adapting procedures. In order to perform a correct evaluation of these indexes in the everyday clinical practice, their reliability should be accurately understood.
No significant differences in the standardized indexes elaborated from sEMG signals of T1 and T2 acquisition sessions were found, strengthening the effectiveness of the standardization procedure. The small sample analysed in the present study does not allow the evaluation of the values in an epidemiologic perspective. The average POC of Temporalis Anterior and Masseter, obtained during this study, resulted slightly lower than the ones reported by De Felicio et al. and by Ferrario et al., probably due to differences in the selection of the sample [9,16,24].
As regards the standardization of masticatory muscles sEMG signal, a unique agreement within the scientific community does not exist[28]. Different sEMG studies have made use of the protocol and related indexes proposed by Ferrario et al. to evaluate the masticatory muscles[16,24,41-44]. The only difference between two acquisitions (on cotton rolls and in IP) is dental contact, thus limiting the technical and biological noise inherent in this instrumental analysis. This way, through the estimate of standardized indexes, it is possible to evaluate the muscular reaction to dental proprioception. Other stimuli, that can influence the muscular activity in both tests (for instance, intramuscular pain), cannot always be identified by evaluating the standardized indexes (supposing that they can influence the standardization task and the teeth clenching in the same way). For this reason, an effective dental occlusion instrumental evaluation applying sEMG protocol needs healthy supporting tissues (bones, teeth, periodontium). Applying these clinical recommendations, the proposed standardization approach allows dental proprioception effect on functional areas management isolation, reducing the crosstalk and technical signal confounding factors relevance.
Anyway, instrumental information about muscular functional adaptation at dental contact can be useful for the classification of dental patients, and the functionalization of therapeutic procedures as removable and fixed prostheses. As an example, patient L.D., a woman aged 26, needed rehabilitation of incongruous composite fillings (Fig. 2). An initial sEMG test could aid the Dentist to estimate if the reduced posterior vertical dimension, due to filling wear, can cause altered muscular performance. As shown in Fig. 3, the initial sEMG test revealed that the pre-operative occlusal condition did not allow a maximal muscular activity.
Masseter POC was lower than 80% as the result of a no-synchronous and asymmetric Masseter recruitment. This performance alteration hesitated in a torque effect during maximal voluntary clenching (Torque index -20%). The Impact index

confirmed that the occlusal condition needed muscular adaptation (while clenching in maximal intercuspation, the muscles performed only 51% of electrical activity developed while clenching with cotton rolls).
After a detailed explanation of the clinical and instrumental conditions, the patient agreed to rehabilitate her first and second right mandibular molars with overlays, changing her right posterior occlusal support.
During the final impression taking appointment, a stiff flat resin jig was set on reduced tooth substance to slightly increase the posterior vertical dimension. A sEMG acquisition was made, and the patient was invited to perform two maximal voluntary clench: the first one with cotton rolls between the dental arches and the second one wearing the jig (Fig. 4). Fig. 5 shows that the torque effect was reduced; muscular total work and Masseter coordination increased but did not reach physiologic values (Impact index from 51 to 71% and POC Masseter 78%). The jig was then slightly reduced and re-tested obtaining a muscular recruitment very similar to those recorded in healthy young subjects with sound dentition (Fig. 6)[24,41-42]. The new EMG tested mandibular position (wearing the modified jig) was used as occlusal posterior vertical index to produce the final indirect overlays.
During the subsequent appointment, the overlays were bonded in a dry setting and the function verified again acquiring muscle performance with the same standardized protocol.
The new posterior occlusal morphology well integrated in the patient stomatognathic structures, and she had a good masticatory muscles coordination: her performance with the new dental surfaces well overlapped the "occlusion-free" reference test (clench on cotton rolls) (Fig. 7). The functional test was satisfactory so reconstructions were accurately polished (Fig. 8).

5. Conclusions

Standardized sEMG indexes allow the evaluation of occlusal-induced proprioceptive mediated muscular recruitment in a reliable way.
Merging biomechanical concepts with sEMG standardized indexes, occlusal devices and prosthesis adapting procedures could be clinically performed in order to reduce the muscular adaption to the new occlusal conditions or to re-establish physiological muscular coordination[45].

Acknowledgments

The authors declares no conflict of interest related to this study. There are no conflicts of interest and no financial interests to be disclosed.

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Questions

Which factors could influence the surface electromyographic signal?

❑a. the thickness of the hypodermis;
❑b. the instrumental noise;
❑c. the position of the electrodes relative to the muscle fibres;
❑d. all the previous factors.

The Percentage Overlapping Coefficient:

❑a. it measures the muscle force;
❑b. it quantifies the symmetry of muscles contraction;
❑c. it could be greater than 100%;
❑d. it is always lower than 50%.

The Surface electromyography:

❑a. it uses needle electrodes inserted into muscle belly;
❑b. it is performed applying electrodes on cutaneous surface;
❑c. it is painful;
❑d. it is invasive.

The Raw electromyographic signal, standardized on clenching with cotton rolls, allows:

❑a. the muscle pain measurement;
❑b. the dental proprioception related muscle reaction measurement;
❑c. the muscle force evaluation;
❑d. the TMJ position analysis.

SILVER MODIFIED ATRAUMATIC RESTORATIVE TECHNIQUE (SMART): AN ALTERNATIVE CARIES PREVENTION TOOL

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Received: August 17, 2016
Revised: September 02, 2016
Accepted: September 15, 2016
Published: September 17, 2016

Cite this article:
Alvear Fa B, Jew JA, Wong A, Young D. Silver modified atraumatic restorative technique (SMART): an alternative caries prevention tool. Stoma Edu J. 2016;3(3-4):243-249.

ABSTRACT

DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).art.15

Aim: Introduction of Silver Modified Atraumatic Restorative Technique (SMART) as an alternative caries prevention tool advances the existing dental armamentarium.

Summary: Caries management strategies have advanced far beyond simply "drilling and filling" teeth, which does nothing to halt the underlying causative disease process. Effectively treating the caries disease starts with a careful hard-tissue exam and caries risk assessment (CRA) followed by treatment intervention strategies based on the patient's individual risk status. The latest addition to the caries prevention armamentarium, silver diamine fluoride (SDF), entered the US market in 2015 shortly after it was cleared by the United States Food and Drug Administration (FDA) in 2014 to treat tooth sensitivity. It is being used off-label to treat and prevent caries, using CDT billing code D1354. The case presentation showcases a technique called Silver Modified Atraumatic Restorative Technique (SMART) in which SDF is applied and immediately restored or sealed with conventional GIC. Placement of SDF and GIC on the same appointment is especially useful when, for whatever reason, the patient will not be able to return for subsequent dental treatment and it is deemed advantageous to use a minimally invasive procedure rather than nothing at all.

By placing SMART restorations you kill bacteria and cut off the nutrient source for any remaining bacteria by placing a chemically sealed restoration that will arrest and remineralize the caries lesion, preserving tooth structure and enhancing pulp vitality. The following case study showcases a different approach to using GIC material in combination with SDF.

Keywords: cariology, minimally invasive caries treatment, dental armamentarium, restorative technique.

1. Introduction

Caries management strategies have advanced far beyond simply "drilling and filling" teeth, which does nothing to halt the underlying causative disease process. Effectively treating the caries disease starts with a careful hard-tissue exam and caries risk assessment (CRA) followed by treatment intervention strategies based on the patient's individual risk status[1]. The ADA Caries Classification System (ADA CCS) was published to classify all stages of caries lesions and to help discern when surgical restoration (verses chemical remineralization) is likely needed[2]. The latest addition to the caries prevention armamentarium, silver diamine fluoride (SDF), entered the US market in 2015 shortly after it was cleared by the FDA in 2014 to treat tooth sensitivity. SDF is being used off-label to treat and prevent caries[3], using CDT billing code D1354.

The safety and efficacy of using SDF for caries treatment were reviewed by Horst and others in 2016[3]. Randomized clinical trials evaluated the efficacy of SDF and clearly demonstrate that repeated applications of SDF are required for more predictable caries arrest[4,5]; however, on occasions, there may be a situation where the patient is not likely to return for subsequent treatment or have the ability to receive treatment elsewhere. In this

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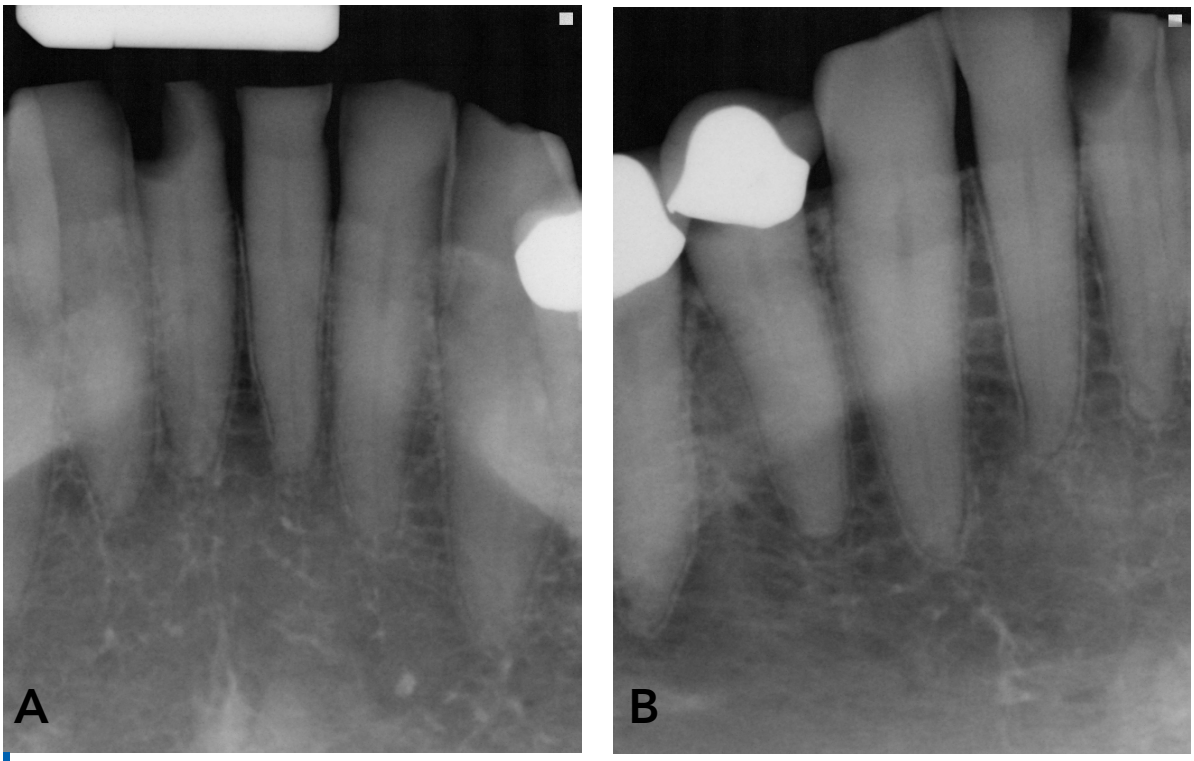


Figures 1A and 1B. Radiograph of distal D3 approximal lesion on tooth #41

case, the healthcare provider has limited options:

1. no SDF placement at all (do nothing),
2. place SDF once knowing success may be limited, or
3. place SDF and a glass ionomer cement (GIC) sealant/restoration during the same appointment to limit access of fermentable carbohydrates and improve chances of SDF caries arrest.

The damage from acids affecting the tooth surfaces through the process of demineralization, as well as the process of remineralization to help replenish the lost substrates from the effects of the acid damage have both been extensively studied[6]. Perhaps what is more exciting are studies demonstrating that conventional GIC produces a sealed chemical bond and remineralized layer at the material-tooth interface[7].

2. Rationale

The case presentation showcases steps when applying a technique called Silver Modified Atraumatic Restorative Technique (SMART)* in which SDF is placed and immediately restored or sealed with conventional GIC. Placement of SDF and GIC on the same appointment is especially useful when, for whatever reason, the patient will not be able to return for subsequent dental treatment and it is deemed advantageous to use a minimally invasive procedure rather than nothing at all. Some examples include, children, humanitarian dentistry in underserved populations, or when there are long wait times for hospital dentistry. The technique presented will combine advantages of three proven principles:

1. the antibacterial and remineralizing effects of SDF causing caries arrest[4,5],
2. partial/incomplete caries removal on deep caries lesions approaching a vital and asymptomatic pulp[8, 9], and
3. proper placement of a chemically sealed and bonded GIC restoration[10].

By placing SMART restorations you kill bacteria and cut off the nutrient source for any remaining bacteria by placing a chemically sealed restoration that will arrest and remineralize the caries lesion, preserving tooth structure and enhancing pulp vitality.

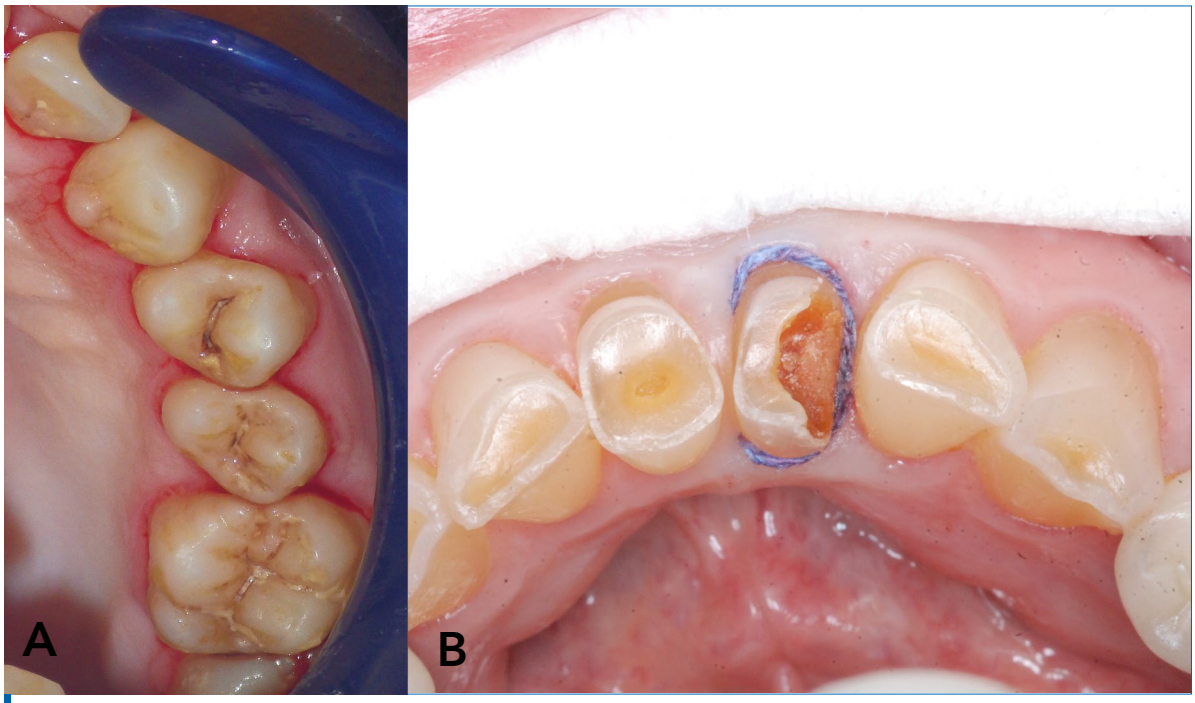
3. Case Study

SDF Placement with Immediate Restoration Using GIC

A 71-year-old female with a medical history significant for hypothyroidism, osteoporosis, gastroesophageal reflux disease, and schizophrenia presented to the practice. She was taking medication for hypothyroidism, osteoporosis. Her chief concern was to address her front teeth and to avoid extraction if possible.

During her clinical exam and CRA, saliva appeared thick and ropey, multiple lesions presented throughout her mouth, and hygiene was relatively fair (moderate plaque, moderate calculus, and multiple areas of bleeding upon probing). The patient was diagnosed with moderate xerostomia, generalized mild chronic periodontal disease and extreme caries risk.

The treatment plan proposed to the patient was limited scaling and root planning to address the periodontal health, and placed on 4 month recall. Upon vitality testing, tooth #41 was diagnosed as vital and a treatment formulated to address the



Figures 2A and 2B. 2B (Pre-Op) Initial ICDAS 2 lesions2 present on teeth #24 and #25. Tooth #41 with an advanced lesion prior to treatment. Retraction cord is optional; cotton roll isolation is recommended

Figure 3. The lesion was desiccated prior to placing SDF

asymptomatic advanced lesion[2] (Figs. 1A and 1B). Due to extreme caries risk from xerostomia and numerous areas throughout her mouth with active carious lesions (approximal and facial-lingual), the patient was placed on high fluoride toothpaste, encouraged to drink water with medication, and to use an anti-cavity mouth rinse. In addition, treatment of GIC sealants immediately after SDF placement was appropriate in order to address the patient's ICDAS 2 lesions on teeth #24 and #25 (Fig. 2A). Prior to beginning treatment, the patient was provided with an informed consent discussing the risks, benefits, and alternatives to agreed upon treatment. This included disclosing that the infected area of the tooth would turn a dark brown to black during the placement of SDF and may show through the restoration especially at the marginal areas. Furthermore, oral hygiene instruction was delivered to the patient to emphasize the importance of better hygiene methods.

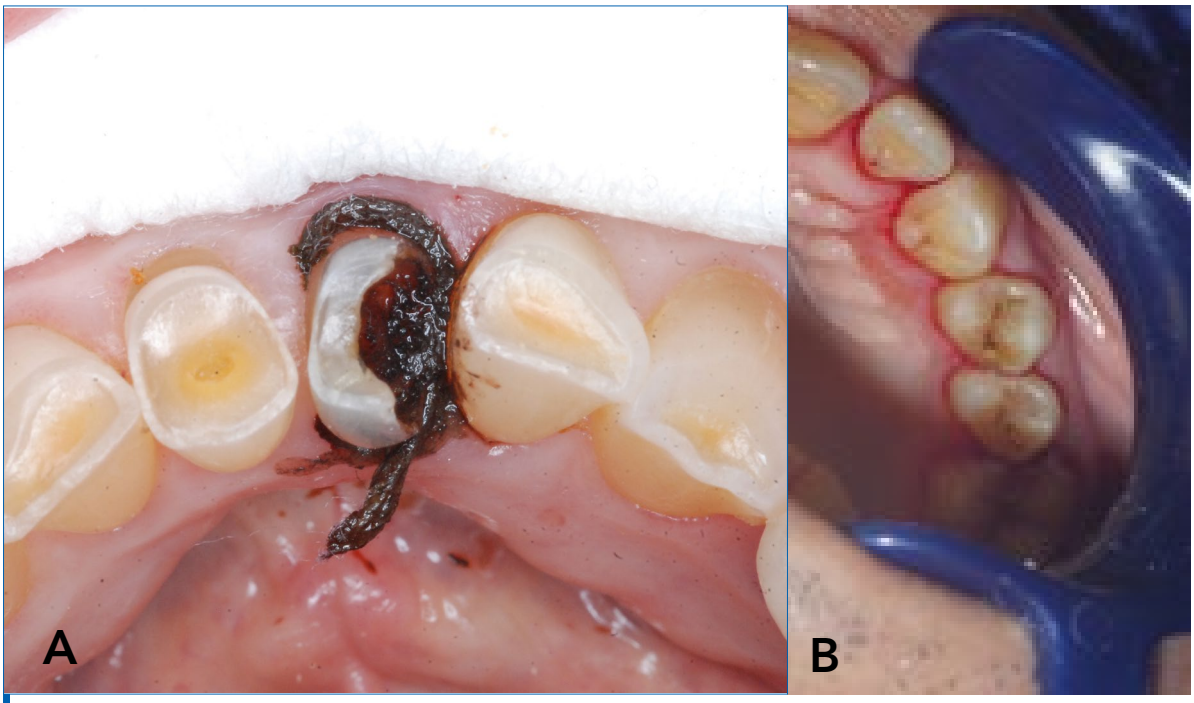
Treatment of the anterior tooth #41, addressed the patient's chief concern of avoiding extraction and applying restoration. After tooth #41 was anesthetized, retraction cord and a cotton roll were placed for isolation (Fig. 2B), followed by desiccation of the lesion (Fig. 3). After transfer of SDF using a microbrush, SDF was left in place for 1 minute (Fig. 4A). It is normal for the area of active disease to remain dark brown to black after application of SDF (Fig. 4B).

The cavosurface margins were prepared using water, a hand piece and a round bur without removing axial decay to avoid pulp exposure (Fig. 5A). In order to achieve an ideal chemical bond with GIC, the tooth structure should be free of debris and decay. Using grey pumice or an air polisher to clean the entire tooth surface will ensure that biofilm or pellicle has been removed (Fig. 5B). A matrix system can be applied to create supportive walls for the GIC restoration.

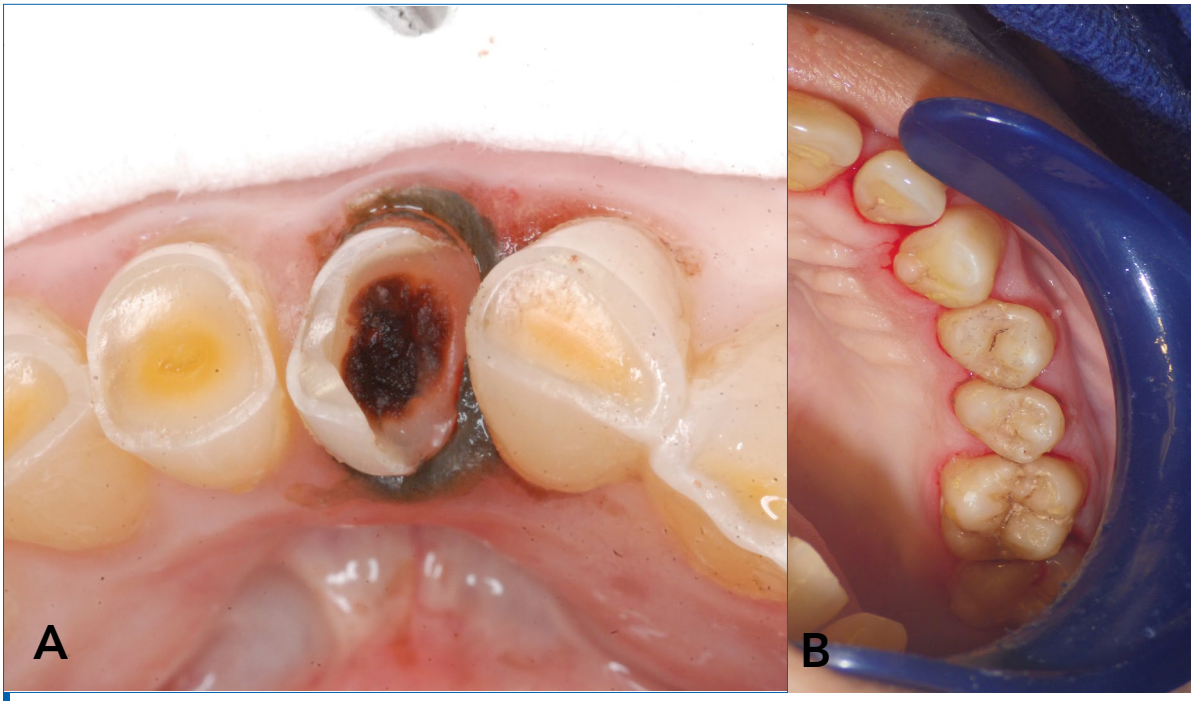
Apply polyacrylic acid to the cavosurface margins or clean the surfaces of teeth for 10 seconds (Fig. 6). Rinse off polyacrylic acid for 10 seconds, and then blot dry. This particular step cleans the smear layer off and provides proper chemical bond with tooth structure.

During rinsing, the assistant can mix the GIC capsule. Prior to placing GIC over the clean moist tooth surface, it is advisable to avoid desiccating the tooth surface.

With the proper amount of moisture, the tooth surface should appear with no pooled water before



Figures 4A and 4B. Using a microbrush, SDF is transferred from a dappen dish to lesions and left for 1 minute



Figures 5A and 5B. Clean perimeter margins in #41 and ICDAS 2 lesions after 10 sec rinse making sure not to desiccate

GIC placement. Keeping the tooth properly moist (careful not to desiccate) GIC can be dispensed over 10 seconds and applied over pits and fissures and preparation. It is essential to not touch or move the GIC after 30 seconds from start of mix.
When working on multiple teeth some use the "finger push" technique. If using a finger press technique, consider changing gloves to avoid potential SDF transfer extraorally (skin, clothes, surfaces) Dispose contaminated items to prevent accidental contact by others.

With a gloved finger slightly lubricated with unfilled resin or manufacturer coat, push the GIC in the pits and fissures and at the same time removing the excess (Fig. 7).
Helpful hint: To avoid adjusting the occlusion you can mark the occlusal contacts (including excursions) prior to GIC placement with articulating paper then avoid applying GIC to those areas.
If you see some GIC in the marked areas you have 10 sec to carve it off and remove any unwanted excess. Excessive GIC can be removed from

Figure 6. Polyacrylic acid over the entire occlusal tooth surface applied with a microbrush

Figure 7. GIC sealants placed on teeth #24 and #25

Figures 8A and 8B. Postoperative photo of tooth #41 after GIC placement. Red articulating paper marks are visible. Note the darkened margin on the facial

unwanted areas using an instrument lubricated with a thin film of unfilled resin. After placement of GIC it is best to allow it set for 2 minutes from the start of the mix before finishing and polishing.

The use of unfilled resin or manufacturer's coat is best to ensure water loss or water gain. Light cure is not needed for this step as the GIC is setting. Light curing will intensify the blackening of the tooth and restoration. As an alternative to using unfilled resin to coat surface, one could simply wet the area with saliva or water when the GIC starts to look "frosty" during the setting process.

Once matrices were removed from preparation, bulk reduction was accomplished with high-speed finishing burs and profuse water spray for anterior tooth, #41.

Contouring was accomplished with light pressure, and polishing cups under water spray to help establish anatomical features (Figs. 8A and 8B). Surface drying is avoided as surface cracking and unesthetic opaqueness can result.

Abrasive use of high speed and burs during contouring can also end in "ditching" the surface of the restoration

4. Clinical Implications

Practitioners and patients benefit from the additional opportunity for a caries prevention

tool and techniques. Although this case study is indicative for this specific patient, the preliminary diagnostic information is essential to collect from all patients prior to the start of treatment.
Furthermore, as SDF and GIC restorations are furthered studied, it is essential for practitioners to present appropriate informed consents and alternatives to treatment to ensure understanding for their patients.

Acknowledgements
The authors would like to acknowledge Drs. Steven Duffin, John Frachella, Jason Hirsch, Jeremy Horst, Martin Macintyre, Cate Quas, and Douglas Young for the term "Silver Modified Atraumatic Restorative Treatment (SMART)" as pioneers for this technique. SMART has several possible variations one of which is presented here. The authors would also like to thank Drs. Vu Le and Allen Wong for contribution of the figures provided in this case study.

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Questions

Safety and efficacy of silver diamine fluoride (SDF) have been studied and demonstrate:

❑a. Repeated application are required for more predictable caries arrest;
❑b. One application is enough for the patient's lifetime;
❑c. Ineffective and limited in practice;
❑d. Superior method of prevention for adult patients.

Application of glass ionomer cement (GIC) at the same appointment after SDF placement:

❑a. Benefits tooth structure increasing chances of remineralization;
❑b. Kills bacteria and cuts off their nutrient source;
❑c. Benefits populations of various age groups.;
❑d. All of the above.

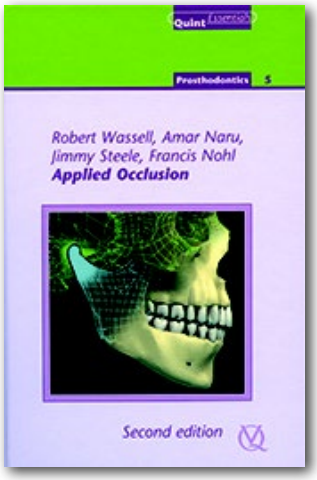
Best way to address the side effects of SDF can be presented to the patients through:

❑a. Performance of the procedure, then showing patients side effects in the operatory chair;
❑b. Verbal explanation and providing a thorough informed consent;
❑c. Word of mouth referrals;
❑d. Directing patients to online resources.

Once lesion is desiccated, SDF should be transferred and left on lesion for:

❑a. 10 seconds;
❑b. 30 seconds;
❑c. 1 minute;
❑d. 3 minutes.

Applied Occlusion (Book/DVD Set)



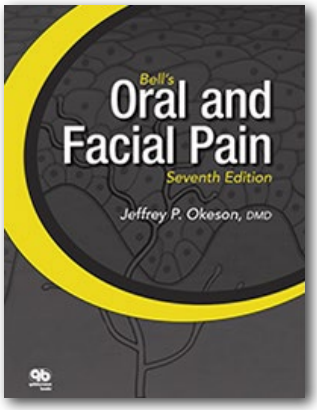
Author(s)/Editor(s): Robert Wassell / Amar Naru / Jimmy Steele / Francis Nohl
Publisher: Quintessence Publishing Co Ltd
Language: English
ISBN: 978-1-85097-098-9
Edition: 2/e
Publish Year: 2015
Pages: 178, illustrated
Price: $ 95.00

DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).bookreview.1

This second edition of the book entitled "Applied Occlusion" is an essential contribution highlighting how important it is for dentists and students to understand the function of the teeth. Dental occlusion is felt throughout the entire postural system and therefore any dental treatment should be done in the occlusal balance. This book is divided into eight chapters. The first two chapters present normal occlusion in static and dynamic. The following two chapters focus on the effects of deflective contacts, interferences and parafunction and demystify the reorganization of the occlusion. Chapters 5, 6 and 7 tackle considerations relating to the periodontium, implant restorations and temporomandibular disorders. The final chapter contains details about occlusal examination, intercuspal registration, articulator selection, diagnostic waxing, copying anterior guidance, occlusal splints and occlusal adjustment. The clinical videos accompanying the book narrate the process of investigating and managing occlusal problems. This book is useful for dental students, clinical dental students and dental practitioners to understand the function of the teeth, and find much better solutions for occlusal disorders.

The Books Review is drafted in the reviewer's sole wording and illustrates his opinions.

Bell's Oral and Facial Pain (Formerly Bell's Orofacial Pain)



Author(s)/Editor(s): Jeffrey P. Okeson
Publisher: Quintessence Publishing Co Inc
Language: English
ISBN: 978-0-86715-654-6
Edition: 7/e
Publish Year: 2014
Pages: 560, illustrated
Price: $ 98.00

DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).bookreview.2

According to Dr. Welden E. Bell "pain is far more than a simple sensation; pain is an experience".Because pain is a major health care problem, research knowledge is expending exponentially. This revised edition incorporates the latest findings from neurophysiology studies and the central processing of pain, so the result is a new guide of diagnostics, classification, and treatment.
This textbook is divided into three major parts. Part One, namely "The Nature of Pain" has six chapters and presents the neural anatomy and physiology of the trigeminal system. Part Two, entitled "Clinical Considerations of Oral and Facial Pain" includes four chapters and presents the classifications of oral and facial pain and the diagnosis principles and therapeutic modalities. The nine chapters of Part Three, whose title is "Clinical Pain Syndromes" talk about cutaneous and mucogingival pain, dental pains, muscle pains, TMJ pains, musculoskeletal and visceral pain, vascular, neurovascular and neuropathic pains. Because the dental practitioners' interest in oral and facial pain disorders has increased, this textbook is very useful and provides the readers with information that will assist in resolving patients suffering from orofacial pain. This textbook is very well illustrated (260 illustrations) and for better understanding it is supplemented with case reports and full-color photographs and illustrations.
Bell's "Oral and Facial Pain" is addressed to the dental practitioners and the gnathologists interested in oral and facial pain disorders, the aim being to alleviate the suffering of TMD's patients.

The Books Review is drafted in the reviewer's sole wording and illustrates his opinions.

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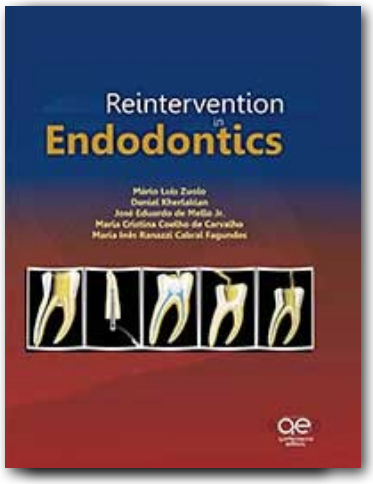
Reintervention in Endodontics

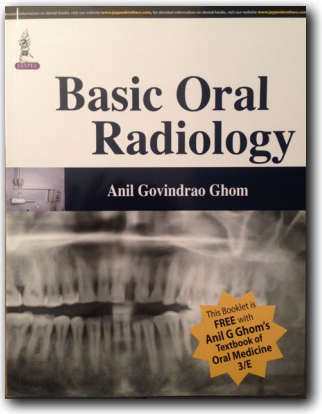


Author(s)/Editor(s): Mario Luiz Zuolo / Daniel Kherlakian / José Eduardo de Mello Jr / Maria Cristina Coelho de Carvalho / Maria Inês Ranazzi Cabral Fagundes
Publisher: Quintessence Editora - Sao Paulo, Brazil
Language: English
ISBN: 978-85-7889-042-1
Edition: 1/e
Publish Year: 2014
Pages: 332, illustrated
Price: $ 180.00
DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).bookreview.3

A team of Brazilian specialists wrote this book to help practitioners improve the quality of the endodontic retreatment. Because nowadays compromised retreatments are no longer an option this book together with the latest materials, tools, and technologic resources increases the predictability and quality of endodontic reinterventions. This book is divided into thirteen chapters. The introduction speaks about the definition and purpose of endodontic re-treatments. The indications and contraindications for non-surgical endodontic retreatment are presented in the next chapter. The tools needed in this type of treatment are discussed in chapter three. The following four chapters cover endodontic access, removal of intra radicular posts, techniques for removing gutta-percha and solid materials. Techniques for repreparation of the root canal system are presented in a separate chapter. Steps, materials and techniques for refilling the canal system are very well described. Prevention and treatments protocols for mishaps and special cases are tackled in two other chapters. Restoration after endodontic retreatment and predictability rates of endodontics versus implantodontics are discussed in the final chapters. The authors manage to write a concise text and to providea complete description of the treatment protocols for a wide variety of reintervention cases. The book also covers all the relevant topics in a simple manner and is accompanied by more than 1,350 illustrations. This book is necessary to dental practitioners and endodontists to help them find the best solution for treatment in reintervention cases.

The Books Review is drafted in the reviewer's sole wording and illustrates his opinions.

Basic Oral Radiology



Author(s)/Editor(s): Anil Govindrao Ghom
Publisher: Jaypee Brothers Medical Publishers (P) Ltd
Language: English
ISBN: 978-93-5152-321-5
Edition: 1/e
Publish Year: 2014
Pages: 208, illustrated
Price: $ 45.60
DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).bookreview.4

Professor Anil Govindrao Ghom published this textbook in order to facilitate the understanding of basic diagnostic oral radiology. This book has nineteen chapters and starts with a brief overview of the history of radiology. The next two chapters describe the physical principles of the radiology and x-ray machines. Throughout the book, the author refers to radiation biology and protection, as well as the projection of the geometry base in the processing of X-ray films. It is to be noted that the book approaches a subject like infection control which is not considered in practice. Intraoral and extraoral radiographic techniques, specialized intraoral techniques and normal anatomical landmarks are presented in the following chapters. TMJ and salivary gland imaging are referred to in separate chapters. References to the principles of radiographic interpretation and undiagnostic radiography are clarified. This textbook achieves its purpose and is an excellent guide that helps students, doctors and teachers to acquire the fundamentals of oral radiology.

The Books Review is drafted in the reviewer's sole wording and illustrates his opinions.

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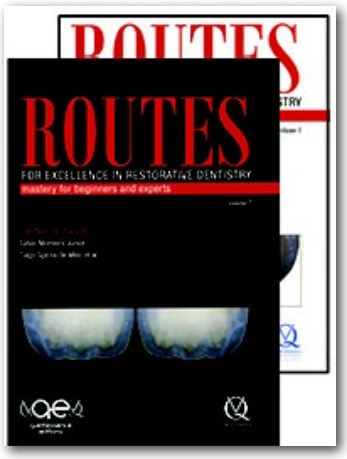

Author(s)/Editor(s): Luiz Narciso Baratieri / Sylvio Jr Monteiro / Tiago Spezia de Melo
Publisher: Quintessence Editora - Sao Paulo, Brazil
Language: English
ISBN: 978-85-7889-039-1
Edition: 1/e
Publish Year: 2014
Pages: 761, illustrated
Price: $ 150.00

DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).bookreview.5

Professors Luiz Narciso Baratieri and Sylvio Jr Monteiro from the Federal University of Santa Catarina, Florianopolis, SC Brasil and their team drafted a two-volume compendium which is addressed to student clinicians and experts in restorative dentistry. The 761 pages of this textbook are divided into thirty chapters. Volume one starts with the nomenclature and classification of cavities and then presents the basis of restorative dentistry: principles of cavity preparation, instruments and materials, isolation, adhesion, composites, polymerization, light, color and characterization and dental amalgam. It also describes the direct composite restoration from class I to class V, and tooth fragment reattachment, diastema closure, composite veneers and finishing and polishing. The second volume describes direct restoration using amalgam and indirect restoration as anterior crowns porcelain laminate veneers, inlays and onlays and posterior crowns. The authors of this comprehensive clinical textbook succeeded to present the fundamental concepts of restorative dentistry and to illustrate the procedures step-by-step to ensure precision in aesthetics, biomechanics, and function in clinical practice.

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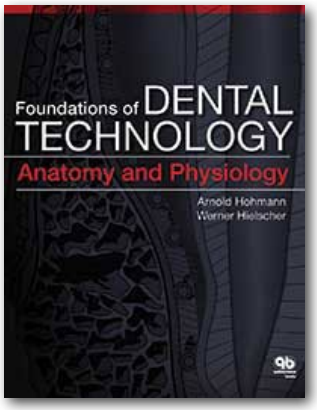
Foundations of Dental Technology: Anatomy and Physiology



Author(s)/Editor(s): Arnold Hohmann / Werner Hielscher
Publisher: Quintessence Publishing Co Inc
Language: English
ISBN: 978-0-86715-612-6
Edition: 1/e
Publish Year: 2014
Pages: 400, illustrated
Price: $ 98.00

DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).bookreview.6

The authors of "Foundations of Dental Technology: Anatomy and Physiology" have turned this book into an essential guide for dental technicians. The book focuses on the relationship between anatomical form and function in dental technologies. It has eleven chapters. The first chapter describes the fundamental concepts of dental technologies. The next two chapters discuss cells and tissues as independent functional units as well as the development and structure of dental tissues. Chapters four and five present and richly illustrate teeth and dentition morphology. The following chapter provides information about cranial anatomy. Chapters seven and eight cover the physiology of mandibular movement and how to transfer it into mechanical articulator devices. Chapter nine investigates the causes, physical changes and origin of diseases as well as their clinical appearance. The last two chapters speak about the methodology of orthodontic appliances and splint therapy. This book covers all necessary knowledge required by dental technicians to successfully complete their high-level technical work.

The Books Review is drafted in the reviewer's sole wording and illustrates his opinions.

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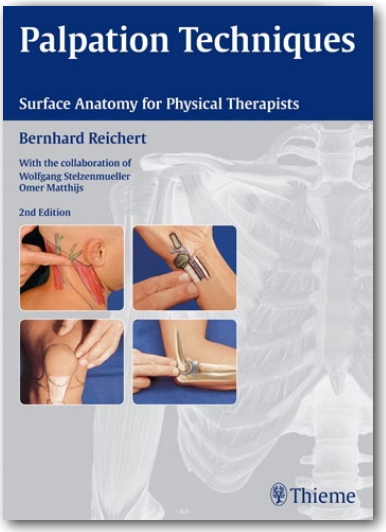
Palpation Techniques

Author(s)/Editor(s): Bernhard Reichert
Publisher: Georg Thieme Verlag KG
Language: English
ISBN: 978-31-3146-342-5
Edition: 2/e
Publish Year: 2015
Pages: 464, illustrated
Price: €79.99

DOI: https://doi.org/10.25241/stomaeduj.2016.3(3-4).bookreview.7



The second edition of "Palpation Techniques" provides detailed sources for anatomical, biomechanical and pathological information. The author divided the book in thirteen chapters. Chapter one covers the basic principles of surface anatomy and the characteristics of palpation. Each of the following chapters describes one region of the body at a time. The author talks about significance and function, common applications of treatment, required basic anatomical and biomechanical knowledge, local palpation of the shoulder complex, elbow complex, hand, hip and groin region, knee joint, foot, posterior pelvis, lumbar spine, thoracic spine and cage, cervical spine, and head and jaw. This revised edition is an excellent reference book for students, clinicians and therapists; it is very well presented and richly illustrated with over 800 illustrations and helps them to optimize patient care.

The Book Review is drafted in the reviewer's sole wording and illustrates his opinions.

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Bucharest, Romania
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dr.vladimir.constantinescu@gmail.com

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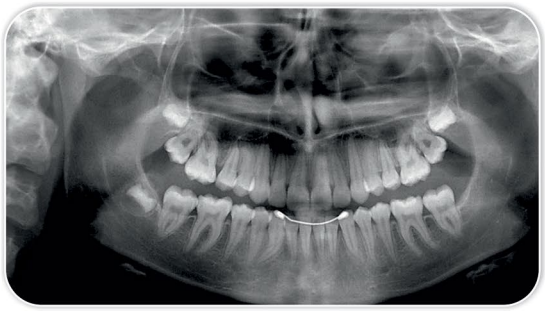

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TMJ CT scan
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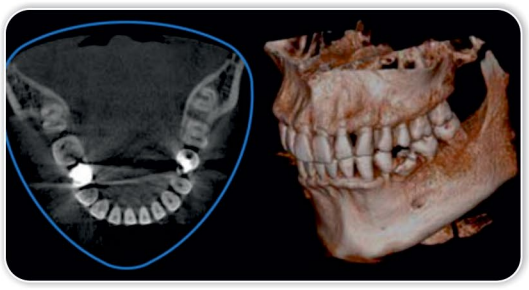

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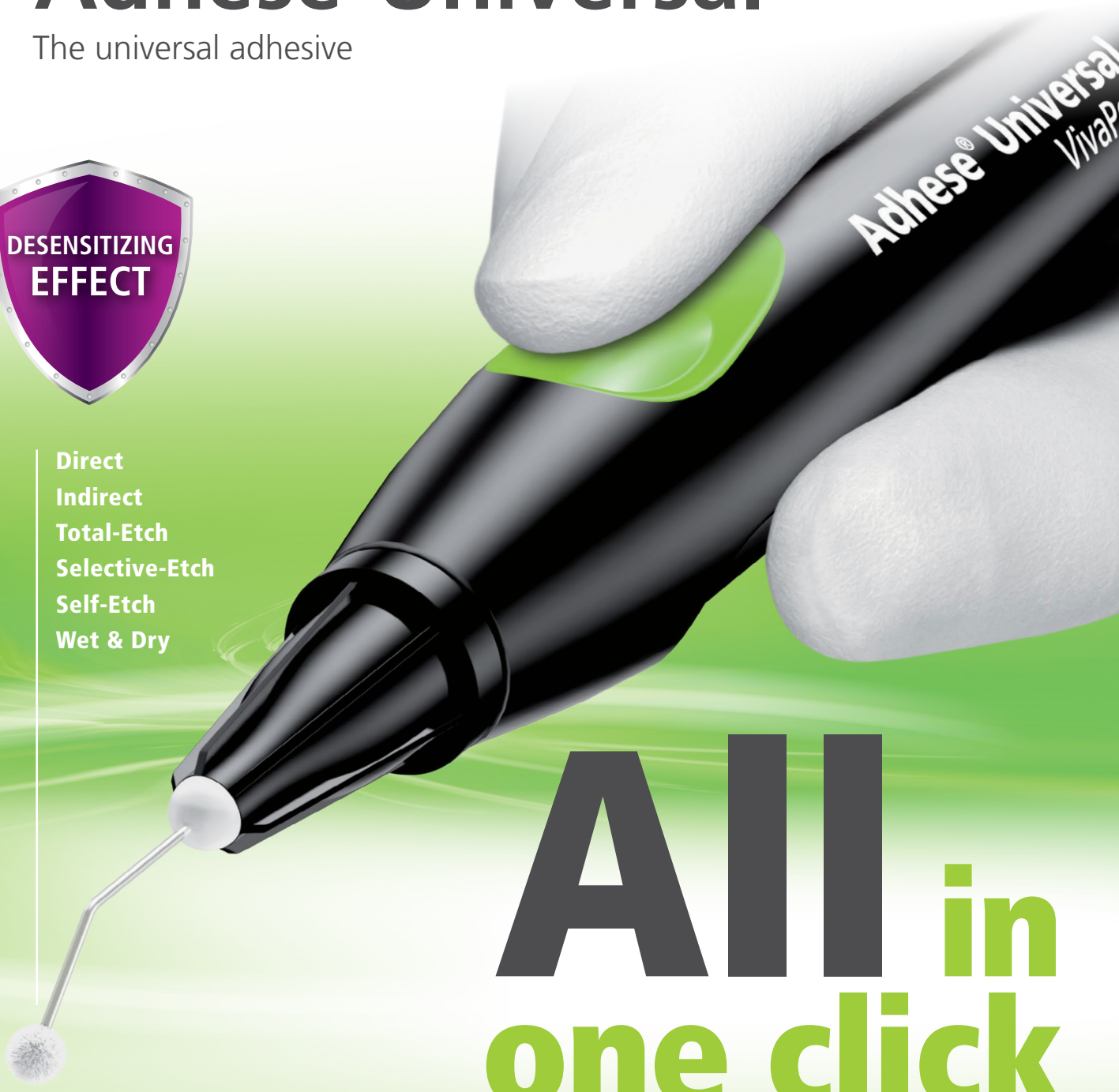

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