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# AN IMPLANT SUPPORTED MAXILLARY FIXED PROSTHESIS WITH A SUBSTRUCTURE/SUPRASTRUCTURE DESIGN: A CLINICAL CASE

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## Abstract

This article describes a clinical case in which a moderately compromised maxillary arch is restored with a fixed implant supported prosthesis with a substructure/suprastructure design. The prosthetic rehabilitation of the edentulous maxilla can be achieved using different types of prostheses, including removable implant-retained, implant-supported, or fixed implant-supported prostheses. The treatment performed is presented step-by-step. The prosthetic design is discussed in detail and compared to other types of fixed implant supported prostheses. Advantages and disadvantages of this type of design are also presented. The substructure/suprastructure design is indicated when the prosthesis must replace both soft and hard tissues. Although it involves multiple steps and it is costly, the substructure/suprastructure design represents a great alternative to any removable prosthesis and provides patients with great esthetics and function.

**Keywords:** implants, edentulous maxilla, fixed prosthesis

## Introduction

The predictability of successful osseointegration in the rehabilitation process of an edentulous arch, as described by Branemark et al (1), introduced an entire new concept of management of the edentulous patients. According to a study by Douglas and Watson, the actual number of individuals requiring complete denture therapy by the year 2030 will not decrease, and maxillary edentulism may represent up to a third of the denture market (2).

A 2006 study by Jemt showed that implant treatment in the edentulous upper jaw functioned well in a long time perspective. The 15-year implant and fixed prosthesis cumulative survival rate was 90.9 and 90.6%, respectively (3).

This is important for us as practitioners as more edentulous patients will present for implant reconstruction.

Implant treatment of the edentulous maxilla can be a complex scenario and the outcome does not always fulfill the expectations in terms of esthetics and function (4).

The maxillary arch presents multiple potential challenges for both the surgical and the restorative providers. Implant therapy for the maxillary arch is often compromised by reduced bone quantity and quality and by the presence of higher biomechanical forces (5).

Maxillary implants are often angled facially due to resorptive patterns, while the replacement teeth are usually arranged anterior and inferior to the residual ridge (6). Thicker masticatory mucosa on the maxilla often necessitates longer implant abutments increasing the lever arm length. Unlike the mandible, with its shock absorbing effect and buttressing lingual bone, the thin buccal bone of the maxilla may not tolerate the applied forces as well (7).

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**Figure 1.** Initial presentation (frontal view)



**Figure 2.** Initial presentation (profile view)



**Figure 3.** Intraoral frontal view



**Figure 4.** Initial panoramic radiograph (the shadow is due to the screws)

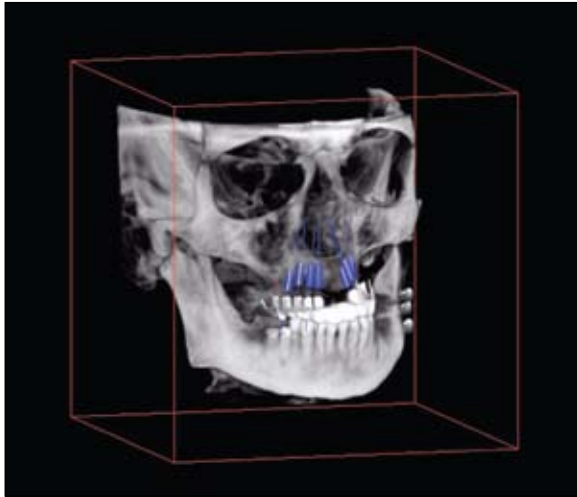
The design of the final maxillary implant supported prosthesis is influenced by the following:

1. The Anatomy of the residual ridge. The degree of ridge resorption can significantly alter the size and position of future implants and can determine whether teeth, or teeth and other tissues must be replaced (8).
2. Some functional considerations include the opposing dentition, whether the patient has natural teeth or a removable prosthesis. Also, the maxillo-mandibular relationship is very important, as an increased vertical space and horizontal discrepancies create greater lever arms and complicate the design of the final prosthesis (9).
3. Esthetics plays a crucial role in prosthesis design. Careful assessment of the patient's smile line and necessity for a buccal flange must be performed before the final treatment plan decision is made (10).
4. Altered speech can occur when patients cannot adapt to the new contours of the prosthesis. Implants placed too far palatally often require bulky restorations, which in turn can significantly alter speech (11).
5. To promote favorable oral hygiene, access must be provided for effective removal of plaque and food debris from around the abutments and underneath the framework (12).
6. Lastly, cost plays a significant role in selecting a prosthesis design. Usually suprastructure/

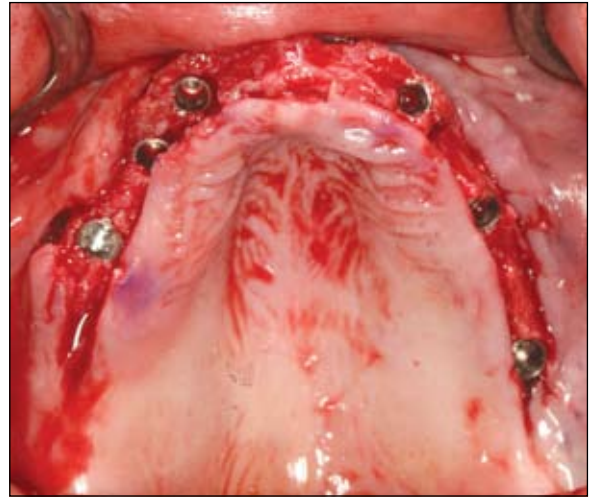
substructure cases require complex laboratory procedures and tend to be more costly.

Some of the design options for a fixed maxillary implant supported prosthesis include the following:

1. Ceramo-metal cement retained on custom abutments;
  2. Ceramo-metal screw retained prosthesis;
  3. Fixed-detachable or "hybrid" prosthesis;
  4. Suprastructure/Substructure design which can be achieved either by:
    - spark erosion technique
    - milled/ cast bar, cast suprastructure with set screws
    - milled bar with individual abutments and single crowns cemented on the abutments (13,14).
- The substructure/suprastructure design has its advantages and disadvantages.
- Some of the advantages of this type of design include providing the patient with a fixed prosthesis when no other designs are feasible. It also has the ability to replace both missing hard and soft tissue and improve unfavorable biomechanics seen in off-ridge relations (15). Esthetics and phonetics are usually very good with this type of design.
- However, there are also disadvantages to this design.
- The cost is usually very high due to precise and complicated laboratory procedures that are required and it unfortunately can be prohibitive for some patients. Passive fit of the bar and framework is also difficult to achieve. Long span frameworks



**Figure 5.** Cone Beam CT scan



**Figure 6.** Occlusal view of maxillary arch during implant placement



**Figure 7.** Tooth arrangement in wax without the buccal flange



**Figure 8.** Esthetic try-in to determine the necessity of a buccal flange

are difficult to apply porcelain to and porcelain fracture is challenging and costly to repair. Also, loss of a strategic implant may compromise the entire prosthesis. Hygiene can be challenging for some patients, especially those with limited dexterity (16).

## Case Report

A 45-year-old female patient presented to the Advanced Education Program in Prosthodontics at the Baltimore College of Dental Surgery, with the following chief complaint: "I would like to have my teeth fixed." Patient said that she never had pretty teeth and now she is ready to do something to improve her smile. Patient had lost her teeth mainly due to periodontal disease.

She showed some facial asymmetry, scarring on the left corner of the mouth, pronounced labio-nasal folds and lip asymmetry during smiling (Fig. 1). Patient had a convex profile with adequate lip support (Fig. 2).

Intraoral examination revealed missing posterior teeth, retained root tips and periodontally involved maxillary anterior teeth (Fig. 3). Mandibular range of motion was restricted, especially maximum

opening which was 30mm and right laterotrusive, which was 1-2 mm.

Patient's radiologic examination revealed multiple root tips, periodontally involved teeth and a horizontal root fracture of tooth #11. Panoramic radiograph showed abnormal temporomandibular left joint due to a car accident during early age, with otherwise normal trabecular bone pattern. (Fig. 4).

A problem list was put together before establishing the final treatment plan.

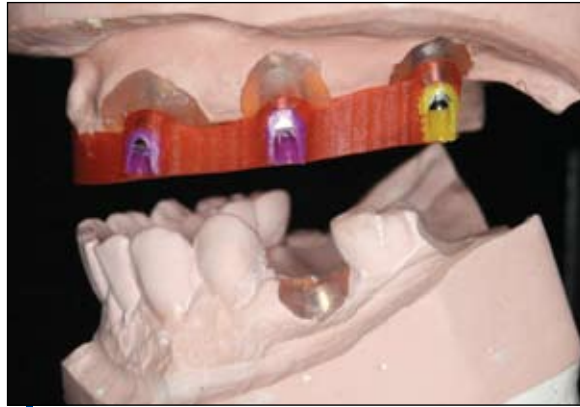
The patient's maxillary arch anatomy represented a challenge especially on her left side, where she had a pronounced horizontal discrepancy between the maxillary and the mandibular alveolar ridge crest and also an increased inter-arch distance.

The patient's desire was to have a fixed final prosthesis, however she refused any grafting procedures. She was educated about the complexity of her treatment plan and was explained that a fixed prosthesis might not be possible in her case.

All maxillary teeth were extracted atraumatically and an immediate maxillary complete denture was fabricated. The patient was very pleased with the esthetics of the denture, which allowed



**Figure 9.** Screw retained acrylic provisional



**Figure 10.** GC pattern substructure before casting



**Figure 11.** Substructure bar tried in the mouth



**Figure 12.** Full contour wax-up of the metal suprastructure

proceeding by duplicating the immediate denture and fabricating a radiographic guide based on the immediate denture's tooth arrangement.

The patient was sent for cone beam CT scan wearing the radiographic guide. Based on bone availability, six maxillary implants were planned in areas: 15,14,13, 22,14, 27 (Fig. 5).

The number of implants was based on the availability of bone and the patient's denial of any extensive bone grafting procedures. This was also in conjunction with the literature, as Beumer et al recommended a minimum of six implants to be placed with an anterior-posterior span of at least 20 mm for a fixed maxillary prosthesis (17).

Six implants were placed as planned with a second stage approach (Nobel Active Regular Platform [RP 4.3mm] and Narrow platform [NP 3.5mm], Nobel Biocare USA, Yorba Linda, CA) (Fig. 6). Following second stage surgery, an implant impression was made using pick-up copings in an open custom tray. A verification jig was fabricated on the master cast using GC pattern resin (GC America, Alsip, IL).

The maxillary master cast was articulated and at this point the treatment plan was re-evaluated and some implant factors were added to the problem list:

- Implant size: there were 2 regular platform and 4 narrow platform implants ;

- Implant distribution was fair on the right side and very good on the left side;

- Implants 22, 24, 27 were buccally angled.

Another very critical step was performed before committing to a final prosthesis design: determining the need for a buccal flange. A wax set-up was made excluding the buccal flange and tried in (Fig. 7).

Extraoral clinical examination addressed facial parameters such as facial support, lip support, smile line, and upper lip length. Facial support is a critical factor for decision making because soft tissue support can be obtained mainly by the buccal flange of a removable restoration and the position of the denture teeth. The thickness of the buccal flange of an existing complete denture can also be indicative of the necessary lip and cheek support. It was determined that an adequate esthetic result can be obtained without the buccal flange (Fig. 7, 8).

A fixed screw retained acrylic provisional on temporary abutments was fabricated. The abutments were contoured to allow for proper soft tissue profile and the patient was given oral hygiene instructions on how to adequately clean her new prosthesis (Fig. 9).

There are many advantages to providing a fixed provisional before placing the final ceramo-metal restoration. Evaluation of esthetics, reassessment of the occlusal scheme, adjustment of the vertical



**Figure 13.** Metal suprastructure



**Figure 14.** View of the left lateral set screw openings



**Figure 15.** Superfloss passing underneath prosthesis



**Figure 16.** Final prosthesis (frontal view)

dimension, and equilibration by addition or subtraction can be made in this manner. Occlusal harmony should improve the load distribution and reduce component failure. A mutually protected occlusal scheme was achieved in the provisional stage. The substructure was fabricated by first milling a GC pattern framework on non-engaging gold adapt cylinders (Nobel Biocare USA, Yorba Linda, CA) (Fig. 10).

A putty matrix of the cross-mounted provisionals was used by the laboratory technician for reference. The GC pattern was precision milled with a 3 degree taper on both sides, which provided frictional retention for the future metal suprastructure. The GC pattern was invested and cast in a noble alloy. The substructure was tried in the mouth (Fig. 11).

The passive fit of the substructure was assessed by performing the one screw test, the quarter turn test, by tactile and radiographic examination. The verification radiographs were taken to assess any fit discrepancies. A full contour wax-up was created prior to the fabrication of the metal suprastructure (Fig. 12). The full contour wax up was cut back to allow for adequate room for porcelain application. The wax pattern was invested and cast in noble metal alloy. The suprastructure was examined on the articulator for fit, proper contours and adequate interocclusal clearance (Fig. 13).

At this point, the master cast articulation was verified by making an interocclusal record on the articulator, then transferring it to the mouth and verifying the accuracy of the mounting.

The next step was the porcelain application on the suprastructure and delivery of the final prosthesis.

The final prosthesis was examined for adequate esthetics and fit. Four lingual set screws were drilled. Due to the patient's limited mouth opening, insertion of the set screws was a tedious and challenging process (Fig. 14).

The substructure was inserted and torqued to 35 Ncm. The suprastructure was placed over the substructure, the set screws were carefully manipulated in position.

The patient was educated on proper oral hygiene and maintenance of her new prosthesis (Fig. 15).

The mutually protected occlusal scheme established in the provisional was replicated in the final prosthesis. A mandibular occlusal guard was fabricated.

During an exaggerated smile there is a fair display of pink porcelain, however, the junction between patient's soft tissue and pink porcelain is not visible. The patient was very pleased with the result (Fig.16).

### Summary

With edentulism on the rise, patients seeking replacement of their upper denture with an implant-

supported restoration are most interested in a fixed restoration. Accompanying the loss of supporting alveolar structure due to resorption is the necessity for soft tissue support in order to achieve optimum esthetic results. The substructure/suprastructure design can replace missing both hard and soft tissue and improve unfavorable biomechanics seen in off-ridge relations. However, this design is very difficult to achieve due to the high precision required for the substructure and the suprastructure, challenging laboratory steps and it is very costly. It does however provide the patients with a prosthesis that offers optimum esthetics and function.

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Dr. Kempler obtained her DDS degree from the University of Maryland Baltimore College of Dental Surgery in 2008. She graduated Summa Cum Laude and received multiple awards.

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