IMPACTION OF TEETH - FREQUENCY AND MOST OFTEN USED TREATMENT PROTOCOLS

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ABSTRACT

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Introduction: Tooth impaction is a biological phenomenon that can affect every tooth group, but most often third molars, canines and second premolars.
Methodology: The aim of our survey is to find out the prevalence of impacted teeth in different tooth groups. Another aim is to prove the following hypothesis, namely that there is a relationship between impaction teeth and treatment protocols using the method of distalization of the upper molars with the Pendulum appliance and also releasing space in the arc by the extraction of permanent teeth. The study analyzed 182 patients diagnosed with impacted teeth and excluded patients with impacted third molars. The analysis used the statistics packet SPSS version 13.0.
Results: The most common impacted teeth are the upper canines - 137 teeth, followed by upper second premolars - 50 teeth, the lower second premolars - 27 teeth, the lower canine - 20 teeth, the lower second molar - 11 teeth, the upper central incisor - 8 teeth, the lower lateral incisor - 3. Significant statistical relations were found between tooth agenesis, odonthoma collections and tooth transposition with impaction. Patients in the early growth period stand a better chance not to undergo non-extraction treatment than those for whom the formation of the constant dentition has been finalized and who have passed the peak of their puberty growth.
Conclusion: The early diagnosis of the problem is an important factor for a successful treatment. The growth potential of the patient is the leading factor that supports the processes.
Keywords: impaction teeth, tooth agenesis, tooth transposition, odontoma.

1. Introduction

Tooth impaction is a biological phenomenon that can affect every tooth group. Impaction is the process of tooth retention in the bone after its period of eruption and even a change in its position and location. The space for the impacted teeth in the dental arch is often small and even missing. This is the reason why teeth move and what most often occurs is mesial movement of the posterior teeth. The incisive point is mismatched to the middle line. There are also tooth discrepancies in the opposite side of the impacted tooth. Tooth eruption itself is a sequence of biological processes that are largely genetically guided and changed by the action of external factors. The reasons for impaction are researched by many authors. Here are some of them: genetic influence (enamel hypoplasia, aplasia of the second premolars, peg-shaped lateral incisors or their absence and others),[1] supernumerary teeth, changed position or shape of the roots of adjacent teeth (dilacerations), odonthoma collections, lack of space, crowding of the adjacent teeth, persistent or ankylosed primary teeth, cysts or bone formations that are obstacles to the eruption path, clefts and syndromes, bone or root resorption process, childhood traumas and others.[2]

Impaction diagnosis is based on clinical and x-ray examination. Orthodontic examinations are usually supported by 2D X-ray images. In case impaction is observed, a CBCT is assigned. There are a lot of prognosis methods[3,4,5,6] techniques and factors for the probability of impactions of canines[7] which allow early prognosis and assessment. One of the factors for a successful treatment is the age of the patients. The management of the treatment[8,9] of an impacted tooth should go as follows: localization of the impacted tooth according to the planes (vestibule-oral, and central alveolar position of the germ), depth in the bone, prognosis for surgical access and technique. In case of cysts and other collections, what comes first is to determine the urgency of the case and whether orthodontic or surgical treatment is necessary. With respect to shaping and space gaining for the impacted teeth, the following solutions are possible: alignment of the teeth and space distribution; space gaining due to transversal expansion, distal movement, teeth proclination or slenderizing; space gaining due to tooth extraction; surgical exposure and orthodontic traction of the impacted tooth; finishing and retention of the case.

The treatment plan often includes the extraction of the impacted canine. This decision is taken after assessing

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Table 1. Relationship between retention and other dental phenomena.

Index		Patients without impacted teeth	Patients with impacted teeth	Total	*p*
Patients without	N	1405	175	1580	
supernumerary teeth	%	98,8	96,2	98,5	
Patients with	N	17	7	24	
supernumerary teeth	%	1,2	3,8	1,5	*0,014*
Patients without	N	1420	177	1597	
Odonthoma	%	99,9	97,3	99,6	
Patients with	N	2	5	7	
Odonthoma	%	0,1	2,7	0,4	*<0,001*
Patients without	N	1413	177	1590	
transpositions	%	99,4	97,3	99,1	
Patients with	N	9	5	14	
transpositions	%	0,6	2,7	0,9	*0,015*
Patients without	N	1400	176	1576	
cysts	%	98,5	96,7	98,3	
Patients with	N	22	6	28	
cysts	%	1,5	3,3	1,7	*0,122*
Patients without	N	1395	176	1571	
microdontia	%	98,1	96,7	97,9	
Patients with	N	27	6	33	
microdontia	%	1,9	3,3	2,1	*0,259*
	N	1422	182	1604	
Total	%	100,0	100,0	100,0	

its localization and coherence with the neighboring compact structures (ankylosis zone, compacta of the sinus wall et cetera). The treatment procedure can continue with the transplantation of the canine in the alveolar rugae or placing an implant[10]. This problem is frequently met among modern patients and many authors report similar occurrence percentages.

2. Materials and methods

2.1. Aim. The aim of our survey is to find out the prevalence of impacted teeth, which tooth group is most likely to be affected, gender ratio, multiple impaction and the relation among them as well as to find out if the hypothesis that there is a relation between the treatment protocol and the group of impacted tooth holds true.

2.2. Material and methods. We analyzed the documentation (clinical and X-ray) of 182 patients treated in our practice for the last 8 years. These 182 patients have been selected out of all 1604 patients. They are patients diagnosed with impaction of various tooth groups, while the excluded patients cover the group with impacted third molars. The average patient age is 14.7±3.5 years, this youngest patient being 9 years old and the oldest 32 years old. The gender ratio is the following: 62 males (14.4±3.1 years) and 120 females (14.8±3.7 years), which means male/female - ½ or 34.1% males and 65.9% females.

Three clinical protocols have been used in the treatment of these patients:

The first group - in the area reserved for the impacted tooth in the tooth arc, the supporting teeth are leveled, the impacted tooth is exposed surgically and then it is orthodontically puled out and the inserted one is positioned on its place in the tooth arc.

The second group - if there is lack of space in the upper tooth arch, the first step is to create space by distalization of the upper molars using the Pendulum appliance. After insuring the space, the protocol of group one is used.

Third group – if there is a lack of creating a space using the conservative means in the tooth arch, the impacted or the neighboring tooth of the arch is extracted in order to open the space and then protocol one is applied, or after the extraction of the impacted tooth, the arch is level and the occlusion is normalized without it.

In our study, we compare the second and third group treatments because for the first group routine treatments have been used, which do not require individual approach. Patients with impacted teeth and a reserved space for them in the dental arch are rarely found.

To process the data we used the special statistics packet SPSS version 13.0 was used. The critical level of significance of $\alpha = 0.05$ was used. The relevant zero hypotheses are rejected when P value is lower than α. The used Chi-square test or Fisher's exact test were used to analyze the relation between the categorical data. Independent Samples T-test were used when the distribution is normal for the variable researched. The one-Sample Kolmogorov-Smirnov test was used to check the frequency distribution.

3. Results.

The most common impacted teeth are the upper canines, namely 137 teeth (68 – 37.9% in the right and 69 – 37.4% in left) followed by the upper second premolars – 50 teeth (25 – 13.7% in right and 25 – 13.7% in left), then the lower second premolars 27 teeth (6 – 3.3% in the right and 21 – 11.5%), the lower canine 20 teeth (10 – 5.5% on the right and 10 - 5.5% on the left), the lower second molar – 11 teeth

(4 – 2.2% on the right and 7 – 3.8% on the left), the upper central incisor – 8 teeth (4 – 2.2% on the right and 4 – 2.2% on the left), the lower lateral incisor 3 - 1.6% cases on the left. We observed single cases of impacted upper lateral incisors, lower first molar and upper second molar. The impaction of a single tooth is observed in 117 (64.3%) of the patients. The impaction of two teeth we observed in 56 (30.8%), the impaction of three teeth in 5 (2.7%), the impaction of four teeth in 3 cases (1.6%), the impaction of 5 teeth in one case (0.5%).

The impaction of two teeth in the dentition is most often observed as a combination of the upper left and right canine, 24 cases (13.2%). The analysis showed 11 (6%) cases with impacted upper left and right premolars, four cases (2.2%) of impacted lower second premolars, three cases (1.6%) with both upper and lower canines impacted. The impaction of both of the lower canines is observed in 2 (1.1%) cases and impaction of the second premolars in 4 cases (2.2%). Four patients (2.2%) have one upper and one lower impacted canine. The following rare clinical cases were diagnosed and treated: unilateral impaction in the upper jaw of the canine and central incisor; canine and second premolar; canine and second molar in the lower jaw, two upper central incisors. An impaction of the upper teeth 132 (72.5%) is most likely to occur rather than of the lower teeth 36 (19.8%). The impaction in both jaws is observed in 14 (7.7%) patients. The distribution of the impacted teeth in the left part 72 (39.6%) and in the right part 55 (30.2%) is without any significant statistical difference as well as the mixed impaction on both sides 55 (30.2%) of the patients.

The statistical data show that the problem is observed most often in permanent (163 - 89.6%) rather than in the mixed dentition (19 -10.4%). If patients are classified in groups: out of the 9 -13 year olds (developing of the permanent dentition), there are 71 patients (39%) included. In the14 - 17 year old group (the age of bone growth), there are 82 (45.1%) patients included. In the 18 -21 years old group (the group of young adults), there are 26 (14.3%) patients included. In 21+ years old group there are 3 (1.6%) patients.

The hypothesis of the dependence between the impaction of teeth and other orthodontic phenomena and deformations was also studied. Fisher's exact test allowed the detection of a statistically significant relation between tooth agenesis and impaction for p=0.014. A relation between odonthoma collections and impaction has also been identified. Another orthodontic problem, which was related to impaction was tooth transposition for p=0.015. The results are shown in Table 1.

Another hypothesis studied is related to the management of the orthodontic treatment itself in patients with impacted teeth and then in the area with the freed up space for extrusion and arrangement of an impacted tooth in the dental arch. The study tried to see if there is a relationship when the treatment used the method of distalization of the upper molars with the Pendulum appliance and also released space in the arc by the extraction of permanent teeth (Table 2). What was also reviewed was the linkage between the numbers of extractions when treating patients with impacted and non - impacted teeth.

The link is statistically significant (p=0.035) in both groups of patients. With the patients without impacted teeth, the extraction percentage of treatments is 11.88%, while with those with impacted teeth 10 (98%). These are roughly similar values. The table clearly shows that most often symmetrical extractions of two or four teeth are conducted, which is a principle for maintaining good occlusal proportions and symmetry. A statistically significant

Table 2. Relationship between the treatment of impacted teeth and the treatment approach for distalization of the upper molars by the Pendulum appliance or by tooth extraction.

Extraction treatment: acc. to the number of the extracted teeth		Patients with non-impacted teeth	Patients with impacted teeth	Total	p
	N	1253	162	1415	
Without extraction	%	88.1%	89.0%	88.2%	
	N	14	2	16	
With extraction of 1	%	1.0%	1.1%	1.0%	
	N	53	13	66	
With extraction of 2	%	3.7%	7.1%	4.1%	
	N	12	1	13	
With extraction of 3	%	0.8%	0.5%	0.8%	
	N	90	4	94	
With extraction of 4	%	6.3%	2.2%	5.9%	
	N	1422	182	1604	
Total	%	100.0%	100.0%	100.0%	*0.035*
Patients non treated	N	1187	140	1327	
with Pendulum	%	83.5%	76.9%	82.7%	
Patients treated	N	235	42	277	
with Pendulum	%	16.5%	23.1%	17.3%	
	N	1422	182	1604	
Total	%	100.0%	100.0%	100.0%	*0.028*

Table 3. Relationship of the treatment of the impacted upper canines or second premolars and their dependence on the treatment plan with distalization of the upper molars using the Pendulum appliance.

		Treatment type			
Teeth	**Statistic**	**Non-tretated by Pendulum**	**Tretated by Pendulum**	**Total**	***p***
Impacted teeth without	N	61	13	74	
upper canines	%	43.6	31.0	40.7	
Uni- and by-lateraly	N	79	29	108	*0.144*
impacted upper canines	%	56.4	69.0	59.3	
	N	140	42	182	
Total	%	100.0	100.0	100.0	*0.005*
Impacted teeth without	N	118	27	145	
upper second molars	%	84.3	64.3	79.7	
Uni- and by-lateraly impacted	N	22	15	37	
upper second premolars	%	15.7	35.7	20.3	
	N	140	42	182	
Total	%	100.0	100.0	100.0	

relationship was found between the impacted teeth and the treatment by Pendulum. According to the findings, in 23.1% of the patients with impacted teeth we have used this method to achieve the necessary space in the upper jaw for the teeth alignment. In patients without impacted teeth the percentage is significantly lower - 16.5%.

Canines and second premolars are the most frequently impacted teeth in the upper jaw. That is why the analysis looked at which of them have been treated more often with the method of distalization of the upper molars (Table 3). The analysis was based on the use of the Chi-Square test which shows that in the upper jaw the unilateral and by-lateral form of retention of the upper canines are present in 79 patients and 29 of them are treated with the Pendulum appliance. The retention of the second premolars in the upper jaw was found in 22 patients. Fifteen of all patients were treated with Pendulum appliance.

The table presents statistically significant results. It creates the ground to say that distalization of the upper molars using the Pendulum appliance is a good and effective method to generate space in the arch and for the successful extrusion and introducing of the impacted or ectopic moved second premolars. There was no significant association found in the distalisation stage of the impacted upper canines during the treatment of the upper molars.

Reasonably, what could be raised is the question whether the age when the patient is diagnosed and treated is relevant to the choice of the treatment method. Therefore, we examined the hypothesis whether there is a correlation between the age when the treatment starts and the type of therapeutic approach used. The Independent Samples *t*-test used showed that the difference in age was statistically significant t (58)=2.64, p=0.011. (Table 4)

Patients in the early growth period have a better chance of Non-extraction treatment than those who have finished with the formation of the constant dentition and have passed the peak of their puberty growth. In the second category of patients the extraction therapeutic approach is applied more frequently.

There are greater opportunities in the distalization of the upper molars to include the second premolar tooth in an arc because of the open distal relocation site which coincides with the shortage of space in an impacted premolar. Such a therapeutic approach in an impacted canine is less successful because the location of the distal movement of the upper molars is opened in the area of the second premolars. To achieve space in the canines' zone what is necessary is the distal displacement of the two premolars, and this is associated with the loss of space in the bearing region and also at the molar area.

4. Discussion

Gisakis,[11] carried some research among the Greek in 2011 and found that in 82.7% of the patients with impaction there is related orthodontic deformation. All patients studied by us also have a concomitant orthodontic problem, most often its cause is impacted teeth. Gündüz[12] published a report on research carried out among the Turks in which he states that the prevalence of impacted teeth is 9.2% and the ratio male/female is 1:1.4. The upper canines are most likely to be impacted (71.5%) followed up by lower premolars (8.6%). Topkara et al.[13] researched orthodontic patients and found out that the canines are the most likely teeth to be affected by impaction (5.24%), followed by the lower second premolars (2.23%), the upper lower premolars (1.11%), lower canines (0.92%), molars (0.72%) and incisors (0.65%). Our findings show that the retention of the upper second premolar is second (27.4%) in frequency to the upper canines (75.3%). This result differs from the data of these authors, whose results show that second in frequency are the lower second premolars (our result – 14.8%). Clinically, this result can be explained by the higher frequency of the caries damage in the second temporary molars and the shorter time needed for medial movement of the upper first permanent molars. The Spee curve eases the medialization of the upper first permanent molar, while the more compact structure of the lower jaw slightly delays the medialization of the lower first permanent molar. That is why the second premolar

Table 4. Choice of the treatment approach and its relationship to the patient's age and growth period.

Treatment	N	Age Mean	SD	Min	Max	p
Treated with Pendulum	42	13,4	3,6	9,0	29,0	
Treated with extractions	20	15,8	2,8	13,0	21,0	*0.011*

does not have enough space in the dental arch, which is a prerequisite for its retention. Celikoglu in 2010 reports prevalence of the impacted canines of 5.1% and transposition of canines of 0.3% which were impacted too. According to our findings 2.7% of the patients they had impaction teeth and transposition too. Gasymova[15] in 2014 found out prevalence of 12.53% of impacted teeth among the orthodontic treated patients. The treatment in these cases was done using low-frequency ultrasonic for their eruption stimulation. This is a treatment method that has not been used on our patients. Msgati et al.[16] found that the ratio among the male/female patients with impaction teeth is 1.2:1. Our study estimated that the male/female ratio is 1:2.

The hyperodontia and odonthoma collections are natural barriers in the path of the eruption of adjoining tooth germ and a prerequisite for the retention of teeth. Their detection is oftendone radiographically. Clinically, we often encounter the symptoms and signs suggestive of hyperodontia and odonthoma. They are the overdevelopment of the alveolar ridge in the area of the late tooth breakthrough tooth, diastemas or thremas, the dislocation of adjacent teeth, persistence of time teeth, and even the ectopic breakthrough of the tooth itself. These clinical findings are early signs to use the X-ray methods to diagnose problems and the transposition[17] of the hyperodontia.

Tooth impaction leads to disturbances in the harmony of the dental arch, occlusion and aesthetics. Often, the space for the impacted teeth in the dental arch is small and even missing. This is the reason why teeth move and what most often occurs is mesial movement of the posterior teeth. The incisive point is mismatched to the middle line. There are also tooth discrepancies in the opposite side of the impacted tooth.

5. Conclusion.

The early diagnosis of the problem is an important factor for the success of the treatment. There are conditions for the selection of treatment using options and techniques to change the dental arch in the transversal and sagittal direction. The growth potential of the patient is the leading factor that supports the processes, which makes this method not sufficiently effective in the treatment of the impacted upper canines, unlike the cases of impacted upper second premolars. One should not underestimate this treatment option that could be combined with other therapeutic methods and devices (protrusion, stripping) so that to achieve the necessary space for downloading and leveling of an impacted canine in the arch. These clinical techniques are preferable before extraction therapy in cases of patients with impacted teeth or without them.

Author contributions

Equal contribution to the paper.

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Greta Jordanova is an associate professor at the Department of Orthodontics of the Faculty of Dental Medicine - Sofia. She has published more than 85 scientific articles, including publications in specialized Bulgarian and foreign magazines. Dr Jordanova has a private practice for special orthodontic treatment of adults and adolescents. Her clinical and scientific works are focused on the non-extraction treatment, namely distalization as a method to gain space in the dental arch, avoiding extractions. Her interests also go towards the field of the aesthetic treatments using invisible appliances, such as lingual brackets, a clear aligner system and segmental treatments and working with 3D technology. Her research covers the field of problems related to the positions, number and eruption of teeth.

Questions

Which methods are used for the diagnostic of impacted teeth?

❑a. Clinical tests;
❑b. CBCT;
❑c. Anamnesis (Medical history);
❑d. Lab tests.

Which teeth are the most often impacted excluding the third molars?

❑a. Lower central incisors;
❑b. Upper first molars;
❑c. Lower first molars;
❑d. Upper canines.

Which other orthodontic problems accompanied the impaction of the upper canines?

❑a. Laterognatia;
❑b. Hypodontia of the upper incisor;
❑c. Progenia;
❑d. Diastema.

Using Pendulum appliance we achieve:

❑a. Provide support at extrusion of the impacted teeth;
❑b. Alignment of the dental arch;
❑c. Increasing the saggital size of the upper dental arch;
❑d. Retention after orthodontic treatment.

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