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MOLAR 2ND CANAL: FREQUENT CAUSE OF ENDODONTIC FAILURE

МЕЗИО-БУКАЛЕН ВТОР КАНАЛ – ЕДНА ОД ПРИЧИНИТЕ ЗА НЕУСПЕШЕН ТРЕТМАН КАЈ ГОРНИ МОЛАРИ

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Abstract

Endodontics is a branch of dentistry in which new challenges emerge every day. A particularly interesting and challenging topic for every endodontist are the upper molars, especially locating and shaping the second mesiobuccal canal or commonly known as the MB2. The main goal of this case report is to emphasize the frequent representation of the MB2 canal in upper molars and also the most common techniques for locating, shaping and filling of this canal, presented in two clinical cases.
Keywords: Maxillary molars, second mesiobuccal canal, MB2.

Апстракт

Ендодонцијата е гранка во стоматологијата во која секојдневно се среќаваме со нови предизвици. За секој ендодонт посебно се интересни горните молари, особено лоцирање и инструментација на вториот мезио-букален канал. Овој труд има за цел да ја потенцира големата застапеност на вториот мезио-букален канал (МБ2) кај горните молари како и техники за лоцирање, обработка и обтурирање со современи материјали преку приказ на клинички случаи.
Клучни зборнови: горни молари, втор мезио-букален канал, МБ2.

Introduction

Due to their complex canal morphology, the treatment of the upper molar teeth is challenging for every endodontist. A crucial factor in planning and administering root canal therapy is the knowledge of internal dental morphology[1]. The canal system in the mesiobuccal root, commonly presented with two canals, requires special attention and treatment, the main reason for that being the MB2 canal. Neglecting this canal may lead to endodontic treatment failure, even if the other canals are perfectly shaped, cleaned and filled. The maxillary molar is one of the teeth which require root canal therapy (RCT) quite often. RCT on the maxillary 1st molar has the tendency to fail because of the complicated root morphology and its internal anatomy such as buccally curved palatal root which cannot be assessed with radiographic examination, significant number of accessory canals at the apex of the palatal root, additional canals such as MB2 in the mesiobuccal root, radix entomolaris etc[2,3].

In 1917, Dr. Hess filled the canal system of an upper first molar with vulcanized rubber and found that apart from the three commonly known canals there is a fourth one, in the mesiobuccal root, and pointed out to the existence of different kinds of anomalies such as anastomosis, ramifications and lateral canals[4].

The biggest study on this topic was the one carried out by Dr. John Stropko who over a period of 8 years, implemented endodontic treatment on 1700 upper molars and established that 90% of all treated first molars had MB2 canals, whereas the respective ratio for all second molars was 60% and 20% for all third molars[5]. In some studies it was found that the frequency of the MB2 canal is higher in male patients compared to the female ones[6].

To determine the type of the canal system, we used the classification by Vertucci, according to which the most common type for the mesiobuccal root is type II (two canals with two separate orifices where one of the canals merges with the other and they exit the root from

one apical foramen). Also, type IV is present (two canals with two separate orifices and foramina)[7].

Clinical cases

In this clinical study, two different clinical cases are presented, both of them being the result of the authors' day-to-day experience with patients. By elaborating the facts and circumstances for each case individually, conclusions are drawn and recommendations are given for successful treatment and procedures to be undertaken in identical or similar situations.

Clinical case 1

A 35-year old patient was referred to our dental office for an endodontic treatment of an upper first molar (fig.1). The patient had a previously initiated endodontic therapy on the same tooth. During the clinical examination the access was observed, and there was a minor swelling included. The percussion and cold tests were negative and Pulp Necrosis with Asymptomatic Apical periodontitis (AAP) was diagnosed.

Figure 1. *Control X-ray*

The endodontic therapy was done in two sessions.

During the first session, after proper rubber dam isolation, access was made and all four canals were discovered (fig.2). Consequently, working length was measured using #10 and #15 hand files with the help of an apex locator (Schlumbohm). The shaping procedure started with the largest canal, the palatal, proceeding with the mesiodistal and mesiobuccal canals. The shaping of the canals was done by using an endomotor (Schlumbohm) and Protaper Gold rotary files (Dentsply). During the instrumentation phase the canals were constantly flushed with 3% NaOCl and 16% EDTA using side vented needles. After shaping these three canals, what followed was the instrumentation of the MB2. Negotiation was made using #8 D-finder hand files (Mani) to working length. The Gutta percha point was placed in the mesiobuccal canal to the working length and by using a #10 hand file with the rubber stop

Figure 2. *Access preparation*

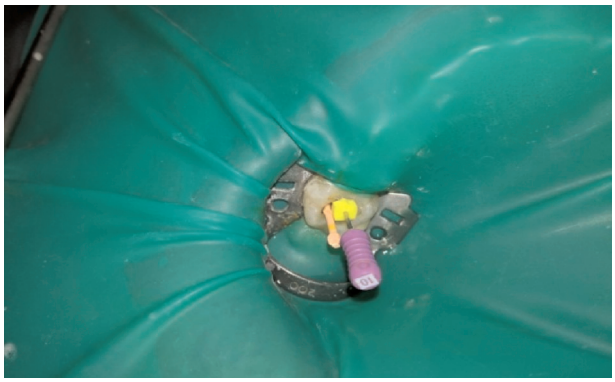

Figure 3. *Merging of two canals*

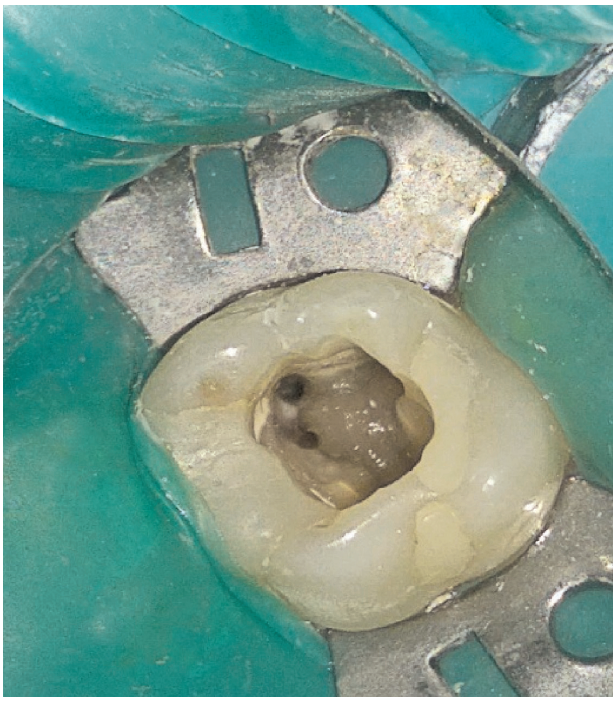

Figure 4. *After shaping of MB2*

Figure 5. *NaOCl in action*

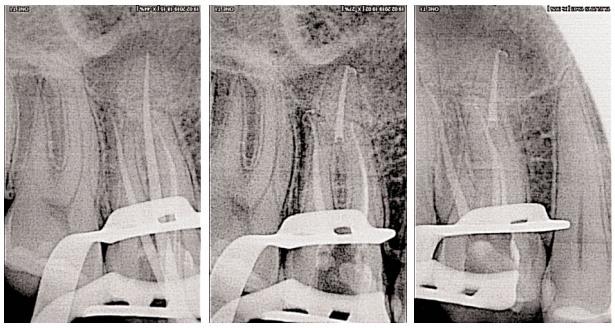

Figure 6. *Master cone and Final X-ray*

placed by the previously measured working length of the MB2, we moved the file all the way until contact was made with the gutta percha. The rubber stop was then moved and that length was measured as a new working length for the MB2 (fig.3). Also, the merging point of these two canals can be checked by viewing the gutta percha under magnification and search for the notch made by the hand file. Before pulling the gutta percha we had to take out the file first, avoiding the risk of accidentally leaving the apical part of the gutta percha cone in the canal. This procedure is particularly important considering the fact that the most risky place for file separation is the one where two canals merge. After measuring the new working length, the MB2 was shaped by using Mani Silk (Mani) rotary files with smaller a taper (fig.4). When the shaping procedure was completed, all four canals were filled using calcium hydroxide (Calcipast) and Phosphate Cement was placed as provisional filing. The patient was instructed to come back in 2 weeks.

During the second session, after rubber dam isolation, the calcium hydroxide was flushed from the canals, master cones were placed in all four canals and x-ray was performed. After checking the master cones on the x-ray image, the irrigation protocol was next in line. First, 16% EDTA was placed using side vented needles for better control and activated with ultrasonics for 1 min per canal using U-files (Mani). The canals were flushed with saline afterwards and 3% NaOCl was used in all canals, also activated ultrasonically for 1 min per canal. Final flushing with saline was made; the canals were dried using paper points and then filled (fig.5). The buccal canals were obturated using the single cone technique, and the palatal, due to its bigger taper, was filled by implementing the Continuous Wave of Condensation (CWC) technique, after previously cutting 1 mm from the tip of the cone. An epoxy resin sealer Syntex (Cerkamed) was used in this case (fig.6). After obtura-

tion, flowable composite (Slow flow, Pentron) was used to seal the orificiums, and for final restoration Charisma Diamond nanocomposite was applied.

Clinical case 2

During a routine check-up, a big carious lesion was discovered on the upper-right second molar of a patient (fig.7). The patient was not responsive either on palpation or percussion tests. The cold stimuli test was also negative. According to those clinical findings Pulp Necrosis was diagnosed.

Figure 7. *Control x-ray*

Figure 8. *Master cone x-ray*

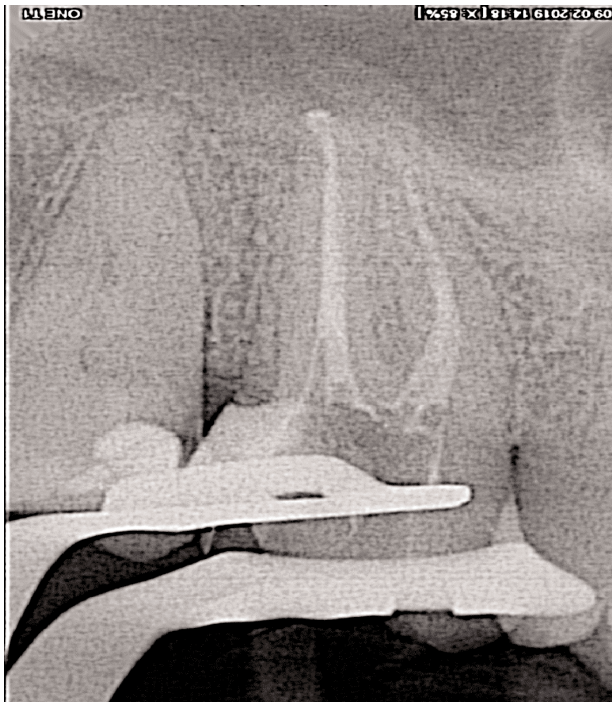

Figure 9. *After obturation*

Figure 10. *Final x-ray*

While cleaning the decay, the distal side of the tooth was lost below the margin level so appropriate steps were taken for better rubber dam isolation before the

treatment was started. Using Thermacut burs (Dentsply), deep margin elevation was made after which composite build up (Evetric) of the distal side followed. After forming all four walls of the crown, rubber dam isolation was performed and the treatment was initiated. Similar to the previous case, the access was made and all canals were shaped by using Protaper Gold (Dentsply) rotary files. Negotiation of the MB2 was made using #08 D-finders (Mani) and then shaping was done using Mani Silk (Mani) rotary files until 20.04 taper. Master cone x-ray was performed and the position of the cones was observed (fig.8).

After instrumentation, irrigation was made using EDTA, saline and NaOCl in the same sequence as above and then activated with ultrasonics. The canals were dried using paper points and filled using epoxy resin based sealer, Syntex (Cerkamed) (fig.9). After obturation, the pulp floor was cleaned of excess sealer and gutta percha, and filled with flowable composite (Slow Flow, Pentron). For final restoration, Evetric (Dentsply) nanocomposite was used (fig.10).

Discussion

Locating canal orifices through the pulp chamber is challenging for endodontists since orifices may have been shifted, there may be calcification or additional canals in an unusual location. (8)

For better locating and instrumenting of the MB2, in addition to good access, better knowledge of the pulp floor map is even more important. Additional tools may help in this procedure like ultrasonic tips, long shank carbide burs, dental loupes or operative microscope and CBCT.

While performing appropriate conservative access of the upper molars, we need to keep more to the mesial side of the occlusal surface. The first canal to be located is the palatal, especially in calcified treatments. The next step is to move buccally, applying care so we do not perforate the floor of the area with grey dentin, but remove from the white dentin, also known as tertiary or reparative dentin (9). Here we can use the Munce burs which have a long and thick shaft and small working head to precisely cut from one area of the pulpal floor. Equally good for performing this task are the ultrasonic tips. The key for locating the MB2 is magnification and illumination. Statistically speaking, using any kind of magnification is three times better than the naked eye (10, 11).

In almost all cases, the MB2 is located more palatally and mesially of the mesiobuccal canal. This way, if we cross the line from the mesiobuccal to the palatal in approximately 2-3 mm in palatal and mesial direction we should find the orifice of the 4 canal. First and foremost, we need to cut the overlaying dentin that is covering the MB2, which may be the biggest reason for not being able to locate this canal. This may be done with the above mentioned diamond coated ultrasonic tips. In the attempt to locate the MB2, we can follow the isthmus starting from the mesiobuccal canal, in palatal direction, until we reach the fourth canal. We must always be careful following this isthmus since it is not always complete, sometimes it can be interrupted and then proceed to the MB2 (12). To achieve precision in this process, magnification is highly recommended.

A tip for locating the MB2 canal: If we cross the line from the mesiobuccal canal to the palatal and then draw an imaginary line from the distobuccal canal moving perpendicular to the previous line, the place where they converge may be the orifice of the MB2 canal. (13)

After finding the canal, the next step is negotiating and shaping, a procedure that is not so easy to perform due to its distally angled entry and the different type of canal morphology. In some situations, even after good access, negotiation may not be possible.

For negotiation of this canal, stiff hand files must be used like D-finders (Mani) or C-files (Dentsply). After negotiation with hand files, we may proceed with rotary.

Thus, endodontists should carefully explore the floor of the pulp chamber to prevent missing a canal and prevent perforation of the floor of the pulp chamber due to overzealous preparation in search of additional canals.

Conclusion

The ability to locate an extra canal in the canal system is an important factor in the success of every endodontic treatment. The occurrence of a second mesiobuccal canal in the maxillary molars is very high. This paper highlights the importance of finding additional canals in the root canal system. A clinician should be aware of the variations in the canal anatomy, preoperative assessment, careful examination of the pulpal floor and use of advanced diagnostic aids like loupes, CBCT and ultrasonics for a successful practice.

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CHANGES IN THE BUCCAL CORRIDOR SPACE IN PATIENTS WITH CLASS II DIVISION 1 MALOCCLUSION BEFORE AND AFTER ORTHODONTIC THERAPY

ПРОМЕНИ НА БУКАЛНИОТ ПРОСТОР КАЈ ПАЦИЕНТИ СО МАЛОКЛУЗИЈА II КЛАСА 1 ОДДЕЛЕНИ ПРЕД И ПОСЛЕ ОРТОДОНТСКАТА ТЕРАПИЈА

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Abstract

Malocclusions except changes in dental and skeletal structures, cause changes in the soft tissues, too. In Class II Division 1 Malocclusion, maxillary incisions are proclinated, lips are often incompetent, and the buccal corridor is enlarged. It affects the aesthetics of the smile and the appearance of patients. **The purpose** of this study is to determine the changes that occur before and after orthodontic therapy at patients with Class II/1 Malocclusion with respect to: the exposure of the maxillary incisions at rest position of the lips and when smiling, to determine the height of the upper lip at rest position of the lips and while smiling and to determine the size of the buccal space on the left and right side. For this purpose, a total of 60 patients with Class II/1 Malocclusion were examined before and after orthodontic therapy. From the obtained **results** it can be concluded that after orthodontic therapy, the length of the upper lip increases and the size of the buccal space decreases both, on the left and on the right side. **Keywords:** Malocclusion Class II Division 1, smile, buccal corridor space.

Апстракт

Малоклузиите освен промените на денталните и скелетните структури, даваат промени и на меките ткива. Кај малоклузија од II класа 1 одделени максиларните инцизиви се протрудирани, усните најчесто се инкомпетентни, а букалниот просто е зголемен. Тоа влијае на естетиката на насмевката и изгледот на пациентите. **Целта** на оваа студија е кај пациенти со II/1 класа да се одредат промени кои настануваат пред и после ортодонтската терапија во однос на: експозицијата на максиларните инцизиви при мирување на усните и за време на насмевка, да се одреди висината на горната усна при мирување на усните и за време на насмевка и да се одреди големината на букалниот простор од левата и десната страна. За таа цел испитани се вкупно 60 пациенти со малоклузија II класа 1 одделение, пред и после ортодонтска терапија. Од добиените **резултати** може да се заклучи дека после ортодонтската терапија се зголемува должината на горната усна и се намалува големината на букалниот простор и од левата и од десната страна. **Клучни зборови:** Малоклузија II класа 1 одделение, насмевка, букален простор.

Introduction

The face and eyes are mirror of the soul, while the smile is a reflection of the character of people[1]. Often, people who are open and communicative have a wide smile, showing most of the teeth in the lateral region, while those who are closed, introverted, rarely show their teeth during smiling.

Bones of the skull and of the face are a foundation, covered by soft tissues. These two components should be in a harmonious relationship if we want to have satisfactory facial aesthetics.

Lips are made of soft tissues, muscles and glands. The outer part of the lips is covered with skin, and the inner part with mucosa.

The border of the upper lip is actually the base of the nose, and in relation to the cheeks, the border is the nasolabial furrow[1].

The lower lip borders the beard with sulcus mentolabialis. The depth of the sulcus depends on the thickness of the lips, the depth of the bite and the age of the patient[1].

The connection between the upper and lower lips is in the corners of the lips. Canines are located between the frontal teeth of the lateral region, and play a major role in the aesthetics of the lips. They hold the corner of the lips so as not to collapse.

Any irregularity of the occlusion causes a deviation from normal intercuspidation and has its own repercussions on dento-facial correlation and structures.

Class II malocclusion is manifested by changes in the anteroposterior direction, with a distal position of the mandible in relation to the maxilla. In this malocclusion, there is a proclination of the maxillary incisions, incompetent lips, and convex profile of the face.

Angle (1907), considered to be the father of orthodontics, thought that the position of the lips is an important criterion for the facial aesthetics.

Arnett, Bergman, Proffit[2] emphasized the importance for perceiving aesthetics from a frontal point of view. Patients should not only be seen from a static position, but also pay attention to the dynamics of lips during conversation and smiling. In their examination, 92 adult patients were treated with fixed orthodontic appliances. They came to the conclusion that the buccal space is a multifactorial phenomenon. In order to control it and to get a better aesthetic smile, it is necessary to perceive the vertical facial features and the degree of exposure of the maxillary incisions. Whether the extraction will be carried out or not during orthodontic therapy will not affect the size of the buccal space[2,3].

The purpose of this study is:

To determine the size of exposure to maxillary incisions in patients with Class II Division 1 Malocclusion, at a resting lips position and during a smile, before and after orthodontic treatment;

To determine the height of the upper lip at a resting position and during the smile, before and after treatment in patients with Class II Division 1 Malocclusion;

To determine the size of the buccal space on the left and right side before and after orthodontic treatment in patients with Class II Division 1 Malocclusion.

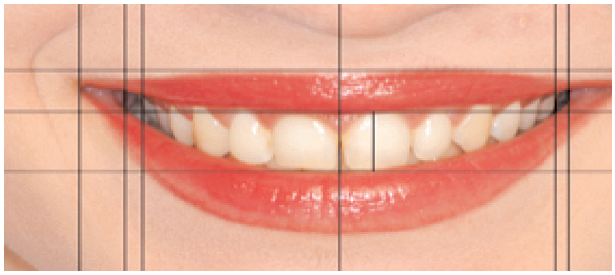
Material and methods

A total of 60 male and female patients with Class II Division 1 Malocclusion were examined, before and after orthodontic treatment. They were treated with fixed orthodontic appliances.

All patients were between 12 and 18 years of age.

Every patient was photographed an-face, in a resting lips position and during a smile. The following parameters were examined (Picture 1):

- Length of upper left permanent maxillary incision - from the incisal edge of the maxillary incision to the highest point of the marginal gingiva;
- Height of the upper lip at rest - when the mandible is in physiological motion, the distance from Sn to the lower edge of the upper lip is measured (mm);
- The height of the upper lip during a smile;
- Buccal space on the left side - a space that appears between the buccal side of the maxillary posterior teeth and the mucosa of the lips on the left side;
- Buccal space on the right side - a space that appears between the buccal side of the maxillary posterior teeth and mucosa of the lips on the right side.



***Picture 1**. Measuring the smile*

Results

Table 1 presents the obtained mean values found in the total number of examinees (male and female) with Class II Division 1 Malocclusion before the orthodontic

Table 1. Presentation of values of patients with Class II Division 1 Malocclusion before orthodontic treatment

	x	SD	SE	Min.	Max.
Length of 21	9.63	0.95	0.18	7.00	12.00
Upper lip length in a resting position	17.17	2.16	0.41	13.00	22.00
Upper lip length during a smile	13.67	2.45	0.46	9.00	19.00
Buccal space right	5.97	0.95	0.18	4.00	8.00
Buccal space left	5.83	0.93	0.18	5.00	8.00

Table 2. Presentation of values of patients with Class II Division 1 Malocclusion after orthodontic treatment

	x	SD	SE	Min.	Max.
Length of 21	9.70	0.90	0.17	7.00	11.00
Upper lip length in a resting position	20.30	1.99	0.38	17.00	24.00
Upper lip length during a smile	16.50	1.84	0.35	12.00	20.00
Buccal space right	2.70	0.64	0.12	1.00	4.00
Buccal space left	2.73	0.51	0.10	2.00	4.00

Table 3. "t" test in patients with Class II Division 1Malocclusion before and after orthodontic treatment

	II/1 before th		II/1 after th			
	x	SD	x	SD	T-test	P
Length of 21	9.63	0.95	9.70	0.90	0.78458	P > 0.05 -
Upper lip length in a resting position	17.17	2.16	20.30	1.99	0.00000	P < 0.001 ***
Upper lip length during a smile	13.67	2.45	16.50	1.84	0.00001	P < 0.001 ***
Buccal space right	5.97	0.95	2.70	0.64	0.00000	P < 0.001 ***
Buccal space left	5.83	0.93	2.73	0.51	0.00000	P < 0.001 ***

treatment: Length of 21 is with an average value of 9.63 mm ± 0.95. The height of the upper lip in resting position is 17.17mm ± 2.16. The height of the upper lip during a smile is 13.67 mm ± 2.45. Buccal space to the right is 5.97mm ± 0.95. Buccal space to the left is 5.83 mm ± 0.93.

Table 2 presents the obtained mean values found in the total number of patients with Class II Division 1 Malocclusion after orthodontic treatment: Length of 21 is with an average value of 9.70 mm ± 0.90. The height of the upper lip in resting position is 20.30mm ± 1.99. The height of the upper lip during a smile is 16.50mm ± 1.84. Buccal space to the right is 2.70mm ± 0.64. Buccal space to the left is 2.72mm ± 0.51.

From the values obtained for the "t" test, we can see that there is a marked significant difference in relation to the height of the upper lip in resting position and during a smile. The values for the size of the buccal space on the left and right side also have significant differences before and after treatment.

P > 0.05 (-) has no significance
0.05 > P > 0.01 (*) has significance
0.01 > P > 0.001 (**) high significance
P < 0.001 (***) expressed significance

Discussion

Orthodontic treatment has an impact on dento-facial structures, because soft tissues most often follow the movements of the bones and teeth[4]. This allows the orthodontists to have an influence on the formation of facial aesthetics, during the correction of occlusion.

Lips and teeth are parts of the face that attract attention during conversation. That's why people are striving more to correct the position of the teeth, their ratio and get better function and aesthetics.

In our examination we found that there is a significant difference in relation to the length of the upper lip in resting position and during a maximum smile before and after the orthodontic treatment. It was 17.17 mm before treatment and 20.30 mm after treatment, in a resting mouth position. During a maximum smile this value was 13.67 mm before and 16.50 mm after orthodontic treatment. Our values match the values of Shay Desai[5]. Shorter upper lip before therapy results in greater exposure of the incisions, not only during a smile but also in the resting position. After orthodontic treatment, there were changes in the length of the upper lip in resting lips position and during a smile, which is the result of the

retraction of the incisors. This shows that soft tissues follow the movements of the teeth. This results in a significant improvement of the aesthetic component.

The buccal space is determined by the buccal surface of the teeth and the oral surface of the cheeks. There are a number of examinations related to the influence of this space in relation to the formation of aesthetics of the smile[6,7]. Some authors consider that the size of the buccal space does not affect the aesthetics of the smile (Daltro Eneas Ritter[7,8]), while others (Sanja Manhar Parkha and all[9,10]) consider it is important in order to minimize the black spaces in the corners of the lips. Some studies[11,12,13] suggest that the smiles showing a larger number of teeth in the posterior segment are more pleasant and more attractive than those showing less posterior teeth.

Hideki Ioia and all[14] came to the conclusion that a wide smile is more attractive and desired, where the arc of the smile is parallel to the lower lip and the buccal space is minimal.

In our examination, the size of the buccal space in patients with Class II Division 1 Malocclusion was 5.97 mm on the right side and 5.83 mm on the left. These values coincided with the values obtained by Catherine McLeod and all[15]. After the orthodontic treatment, the values for this area were 2.70 mm on the right side and 2.73 mm on the left. This decrease of the values for the buccal corridor on the left and right side after the orthodontic treatment has shown that with orthodontic treatment there was correction of the maxillary dental arch from the "V" shape in the normal shape for maxillary arch - parabola. This also corrects the smile in terms of reducing the size of the buccal space and patients have a wide smile full of teeth. Our findings are in accordance with the findings of Daltro Eneas Ritter and all[7,8].

Conclusion

Orthodontists should follow beauty and wellness standards so they can respond to their patients' demands.

From the analyzed 60 patients with Class II Division 1 Malocclusion before and after orthodontic treatment, we made the following conclusions:

- The height of the upper lip in a resting position shows a lower value before orthodontic treatment in patients with Class II Division 1 Malocclusion;
- The height of the upper lip during a maximum smile significantly increases after orthodontic treatment in patients with Class II Division 1 Malocclusion;
- The size of the buccal space significantly decreases in both the left and the right side in patients with Class II Division 1 Malocclusion after orthodontic therapy.

The use of orthodontic appliances in correcting the present Class II Division 1 Malocclusion has a significant influence in the correction of the facial aesthetics and the aesthetics of the smile.

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ORAL-HYGIENE PRACTICES IN STUDENT POPULATION IN SKOPJE AND OSLO

ОРАЛНО-ХИГИЕНСКИТЕ НАВИКИ И СТАВОВИ НА СТУДЕНТСКАТА ПОПУЛАЦИЈА ВО СКОПЈЕ И ОСЛО

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Abstract

Objective: The purpose of this study was to draw a comparison between the oral-hygiene practices and attitudes among dental students and students studying at other faculties in Skopje and Oslo. **Material and method:** For the purpose of this study, 200 students were surveyed, of which 50 students from the Faculty of Dentistry in Skopje, 60 students from other faculties in Skopje, 50 students from the Faculty of Dentistry in Oslo and 40 students from other faculties in Oslo. The students were surveyed using a questionnaire which consisted of 9 questions, adequate for this type of survey. Data collected from the survey were statistically analyzed. **Results:** We have recorded a statistically significant difference in responses among all student groups from the four education centers. Significance was also found in the responses between dental students in Skopje and Oslo due to differences in the educational systems. **Conclusion:** We believe that the results obtained from our study are due to inequalities in the socio-economic statuses, the living standards, the educational systems and the preventive measures taken to improve the oral health status. Due to their awareness of oral health problems as well as knowledge of preventive measures, students of dental medicine could positively contribute to the oral health of people living in communities by opening education centers for increasing overall oral health. **Keywords:** oral-hygiene practices, student population, oral health, preventive measures, survey.

Апстракт

Целта на овој труд: беше да се направи споредба на орално-хигиенските навики и ставови кај студентите по стоматологија и студентите на другите факултетски институции во Скопје и Осло. **Материјал и метод:** За реализација на ова истражување беа анкетирани вкупно 200 студенти од кои 50 студенти од Стоматолошкиот факултет во Скопје, 60 студенти од други факултети во Скопје, 50 студенти од Стоматолошкиот факултет од Осло и 40 студенти од други факултетски институции во Осло. Студентите беа анкетирани врз основа на прашалник составен од 9 прашања. Податоците добиени од анкетата беа анализирани и соодветно обработени. **Резултати:** Регистриравме статистички сигнификантна разлика во одговорите кај студентите од четирите едукативни центри. Сигнификантност постоеше во одговорите помеѓу студентите стоматолози во Скопје и Осло, како резултат на разликите во системот на едукација. **Заклучок:** Сметаме дека добиените резултати се должат на разликите во социо-економскиот статус, стандардот на живеење,разликите во едукативниот систем како и нивото на превентивните мерки кои се превземаат за подобрување на оралното здравје. Поради свесноста за проблемите поврзани со оралното здравје, како и познавањето на основните превентивни мерки, студентите по стоматологија треба позитивно да делуваат во општеството преку едукативни центри за унапредување на оралното здравје во целост. **Клучни зборови:** орално-хигиенски навики,студентска популација, орално здравје,превентивни мерки.

Introduction

The term oral health does not exclusively convey the presence of healthy teeth in the mouth. Oral health is an integral part of the general health and acts as the foundation for the individual's wellbeing. The same includes absence of craniofacial pain, absence of oral and pharyngeal carcinoma, absence of oral mucosal lesions, absence of congenital anomalies, as well as absence of other diseases that may affect the oral, dental and craniofacial tissues[1]. Good oral health enables the individual to speak, eat and socialize without problems, discomfort or embarrassment.

A number of factors have a strong impact on oral health. The nature of the key factors may be economic, psychosocial and behavioral. Individuals with low socio-economic status, who live in a rural area and maintain a poor lifestyle have insufficient dental care, do not maintain oral hygiene on a regular basis, rarely visit a dentist and have more lost teeth, compared to individuals with high socio-economic status[2]. The most vulnerable population are young individuals, as they are prone to experimenting with alcohol and cigarettes, and also have poor hygiene practices in the process of maturation, increased caries presence and gingival-periodontal diseases[3]. Therefore, there are three main reasons for investing in

young people's health: health benefits (better health and prolongation of generations), economic benefits (improved productivity, return on investment and avoidance of future health costs) and human rights (right to the highest possible degree of health).

Dentists play an important role in improving health education, and therefore, it is important for students to gain knowledge on prevention, control and treatment of oral diseases during their studies[4]. The professional upgrading of dental students should create stable patterns of behavior towards one's own oral health[5,6,7]. Unlike dental students, students from other faculties do not have such extensive knowledge of oral diseases which could lead to poor oral hygiene, that could in turn result in a higher incidence of cavities, periodontal disease and a larger number of extracted teeth. In addition, cultural differences in the areas in which they live can contribute to building different practices and attitudes towards oral health[8].

Purpose of the paper

The purpose of our research was to compare the oral hygiene practices and attitudes of dental students and students studying at other faculties in Skopje and Oslo.

Material and methods

TIn order to respond to the set objective, a total of 200 students were surveyed, of which 50 students from the Faculty of Dentistry in Skopje, 60 students from other faculties at the Ss. Cyril and Methodius University in Skopje, 50 students from the Faculty of Dentistry in Oslo and 40 students from other faculties in Oslo. Students were surveyed using a questionnaire. The questionnaire consisted of nine questions related to the subjects' attitudes regarding oral health, as well as their oral hygiene practices. Prior to completion of the questionnaire, the students were informed about the importance of their participation in this research and were asked to provide relevant responses to the questions asked. The results of the answers to the questions are expressed as a percentage, shown in tables and compared between different groups of students.

Results

Table no. 1 shows the views of the students regarding oral health. It can be seen from the table that dental students from Skopje and Oslo are more likely to visit a dentist (52% of dental students and 48% of dental students in Skopje visit a dentist twice a year) than students

Table 1. An outline of students' attitudes regarding oral health

		Faculty of Dentistry - Skopje	Faculty of Dentistry - Oslo	Other Faculties - Oslo	Other Faculties - Skopje
How frequently do you visit a dentist?	Sometimes	15 (30%)	3 (6%)	6 (15%)	32 (53.3%)
	Not regularly	2 (4%)	12 (24%)	14 (35%)	16 (26.7%)
	Once a year	9 (18%)	9 (18%)	7 (17.5%)	7 (11.7%)
	Twice a year	24 (48%)	26 (52%)	13 (32.5%)	5 (8.3%)
Reason for dental visit?	Due to tooth ache	8 (16%)	2 (4%)	14 (35%)	49 (81.7%)
	Control check up	42 (84%)	48 (96%)	26 (65%)	11 (18.3%)
What action will you take if you experience toothache?	I will extract it	0 (0%)	0 (0%)	8 (20%)	0 (0%)
	I will restore it	50 (100%)	50 (100%)	32 (80%)	60 (100%)
Do you think you brush your teeth properly?	Yes	47 (94%)	49 (98%)	35 (87.5%)	54 (90%)
	No	3 (6%)	1 (2%)	5 (12.5%)	6 (10%)
Who showed you how to brush your teeth?	Parent	17 (34%)	29 (58%)	9 (22.5%)	21 (35%)
	Dentist	33 (66%)	18 (36%)	25 (62.5%)	39 (65%)
	Educator or teacher	0 (o%)	3 (6%)	6 (15%)	0 (0%)
What will you do if you notice gum bleeding?	I stop brushing	0 (o%)	0 (0%)	2 (5%)	33 (55%)
	I brush them more gently	17 (34%)	8 (16%)	29 (72.5%)	5 (8.3%)
	I brush the thoroughly	12 (24%)	41 (82%)	7 (17.5%)	0 (0 %)
	I seek dental help	21 (42%)	1 (2%)	2 (5%)	22 (36.7%)

Table 2. An outline of the student population's oral hygiene practices

		Faculty of Dentistry - Skopje	Faculty of Dentistry - Oslo	Other Faculties - Oslo	Other Faculties - Skopje
Do you use additional oral hygiene products?	No	7 (14%)	2 (4%)	8 (20%)	32 (53.3%)
	Dental floss	39 (78%)	26 (52%)	22 (55%)	5 (8.3%)
	Interdental brushes	1 (2%)	9 (18%)	0 (0%)	0 (0%)
	mouthwashes	3 (6%)	13 (26%)	10 (25%)	23 (38.4%)
How frequently do you brush your teeth?	I never brush my teeth	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Not regularly	0 (0%)	0 (0%)	2 (5%)	10 (16.7%)
	Once a day	10 (20%)	10 (20%)	4 (10%)	30 (50%)
	Twice a day	32 (64%)	35 (70%)	28 (70%)	15 (25%)
	Several times a day	8 (16%)	5 (10%)	6 (15%)	5 (8.3%)
How long do you use the same toothbrush?	Less than 3 months	7 (14%)	6 (12%)	5 (12.5%)	5 (8.3%)
	From 3 to 6 months	35 (70%)	39 (78%)	32 (80%)	22 (36.7%)
	More than 6 months	8 (16%)	5 (10%)	3 (7.5%)	33 (55%)

from other faculties (35% of students from other faculties in Oslo do not visit a dentist regularly, while the majority (53.3%) of students from Skopje sometimes visit a dentist). However, the reason for visiting a dentist differs between the student population from Skopje and Oslo. Namely, dental students from Skopje and Oslo, as well as the students from other faculties in Oslo, usually go to the dentist for control check-ups, while the student population from other faculties in Skopje most often visits the dentist because of pain present in the orofacial region (81.7%).

The majority of the students from Skopje and Oslo, in the case of a toothache, think that it would be best to have the tooth restored rather than extracted. Only 20% of students from other faculties in Oslo think it would be best to extract the tooth. Students believe that the tooth is in such bad shape that it cannot be repaired and should inevitably be removed.

We also received a similar response to the question of students' subjective opinion about their proper tooth brushing. About 90% of all subjects in Skopje and Oslo think they brush their teeth properly.

The dentist plays a major role in the techniques and the way of maintaining oral hygiene for the student population in Skopje. Namely, about 65% of dental students in Skopje and students from other faculties in Skopje stated that it was the dentist who showed them how to brush their teeth. Unlike the student population in Skopje, Oslo parents and dentists play a major role in tooth brushing in Oslo student population (in 58% of Oslo dental students, the parent showed them how to brush their teeth, while in 62.5% of students from other faculties, the dentist is the one who explained the proper brushing technique).

When bleeding from gingivitis, the highest percentage of students from Skopje (42%) consider that dental assistance is necessary, while 55% of students from other faculties in Skopje stop brushing their teeth. Unlike the student population in Skopje, Oslo students continue to brush their teeth. Namely, 82% of Oslo dental students brush their teeth more thoroughly when bleeding from gingivitis and 72.5% of Oslo students from other faculties brush their teeth more gently.

Table no. 2 shows the practices of the student population for maintaining oral hygiene. It can be seen from the table that the majority of the dental students from Skopje and Oslo, as well as students from other faculties in Oslo, use additional products for maintaining oral hygiene. The percentage of students from other faculties in Skopje who use only a toothbrush is 53.3.

The answer to the question of how frequently they brush their teeth is similar. Namely, 64% of dental students from Skopje, 70% of dental students from Oslo and students from other faculties in Oslo brush their teeth twice a day. In contrast, 50% of students from other faculties in Skopje brush their teeth once a day.

It can be seen from the table that 70% of dental students from Skopje, 78% of dental students from Oslo and 80% of students from other faculties in Oslo use the same toothbrush for 3 to 6 months. In contrast, 55% of the students from other faculties in Skopje have used the same toothbrush for more than 6 months.

Discussion

Most individuals do not make conscious and logical decisions every day about the regularity of their tooth brushing and diet. It is something that they have grown up with, a habit they continue to have, unless they employ active measures to change their behavior. The solution to this problem lies in a process known as socialization. Only a small number of people's habit patterns are instinctive, while the most human behavior is learned. Each society or social group has its own culture or set of separate values, norms and beliefs. Socialization is the process by which the culture of behavior is transferred to a separate unit of the group and the individual learns the rules and practices that are characteristic of the particular group. Socialization begins in the early years of life in the family. The mother, during this period of the child's development is the most responsible agent for preparing and teaching the child manners. This early teaching is known as primary socialization. During primary socialization, a number of attitudes and practices are formed that follow the individual throughout their lives. During the school period of the child's development, teachers and pupils have a significant impact on socialization. During adolescence, the young individual increasingly develops into an independent person and begins to define attitudes, beliefs and behaviors. This continuous process of adaptation to different environmental conditions is called secondary socialization[9].

The attitudes and habits acquired during primary and secondary socialization can have a significant impact on oral health. This is the reason why we set the goal of our paper - to determine the attitudes and practices of the student population related to oral hygiene. But the challenge was to compare the oral hygiene practices and attitudes of the student population of our country and of the student population of a highly developed country such as Norway.

The oral health of the population in Norway, unlike the population in the Republic of Macedonia, is at a much higher level. It can be deduced from the data on caries prevalence, expressed through the DMFT index (which we refer to as KEP index). This index in Norway was 1.7[10] in 2004, while in Macedonia it was 6.88 in 12-year-olds in 2007, which is considered high compared to WHO recommendations for oral health (KEP <3)[11]. Oral health is an essential component of general health and affects the quality of life of each individual in the community. The student population is part of the society that is expected to play a leading role in adopting appropriate measures in prevention and education of the population. During their studies, dental students further modify and develop their attitude towards oral health but can also contribute to the education of the general population, especially students from other faculties. Dental students should serve as role models to their colleagues from other faculties and educate them on the importance of oral hygiene, and the measures that should be implemented (tooth brushing, carbohydrate intake, and fluorides use) and regular dental check-ups.

Our research shows that dental students from Skopje and Oslo are more regular patients in dental practices than students from other faculties in Skopje and Oslo.

This indicates that dental students are more aware of individual preventive measures for preservation of oral health (regular plaque control, removal of tartar, etc.), unlike students from other faculties. Dental students regularly go to dental check-ups, unlike students from other faculties who visit a dentist after certain symptoms. However, the percentage of students from other faculties in Oslo (32.5%) who visit the dentist twice a year is significantly larger compared to students from other faculties in Skopje (8.3%). Similar data was obtained in a survey conducted in Croatia where 70.9% of dental students visit a dentist twice a year[12], as opposed to students from other faculties (27.8%).

This study confirmed the differences in the practices and attitudes between dental students from Skopje and Oslo and their colleagues from other faculties. Dental students brush their teeth more often, use oral hygiene products compared to students from other faculties. In addition, there is evidence that gingival bleeding is more common among students from other faculties, and if it occurs they do not take immediate actions. We believe that these data are a result of less developed awareness of hygiene preventive measures among students from other faculties.

Oral hygiene practices of the student population have been studied in a large number of studies in China[13], India[14], Japan[15] and Greece[16]. Dental students from the UK and China in 13% of cases, or 54%, visit a dentist due to symptoms, as opposed to dental students from Skopje and Oslo who visit a dentist for regular check-ups. In India, 50% of dental students visit a dentist when they experience pain, but this percentage declines in the fourth and fifth year (33%). The data suggests that education during college affects their thinking and behavior. Our dental students, in terms of how often they visit the dentist, are getting closer to Western European countries.

Conclusion

A large difference in oral-hygiene practices is noted in this survey, which allows us to conclude that dental

students maintain better oral hygiene, are less likely to have gingival bleeding and regularly attend dental check-ups compared to students from other faculties in Skopje and Oslo.

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PERIPHERAL OSTEOID LOOK LIKE CALCIFICATION OF THE BODY OF ZYGOMATIC BONE: CASE REPORT OF AN UNUSUAL LOCALIZATION

ПЕРИФЕРНА ОСТЕОИДНА-НАЛИК ФОРМАЦИЈА НА ТЕЛО НА ЗИГОМАТИЧНА КОСКА: ПРИКАЗ НА СЛУЧАЈ СО НЕСПЕЦИФИЧНА ЛОКАЛИЗАЦИЈА

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Abstract

Osteomas of zygomatic bone are especially rare benign osseous tumors. Although this tumour has a considerable incidence, there are few reports with large samples depending on this anatomical region. Three theories have been proposed and various possible etiologies have been discussed in the literature, but symptoms are not always apparent and specific. **The purpose** of this article is to present the clinical, radiographic, surgical finding and management of unspecific right zygomatic osteoma in a 35-year old woman following diagnostic dilemmas. The lesion was treated surgically without complications and the patient made a complete recovery.
Keywords: zygomatic bone, osteoma, jaw, osteoid osteoma

Апстракт

Остеомите на зигоматична коска претставуваат ретки и бенигни туморски формации. За инциденцата на овие коскени тумори и тоа на зигоматична регија, последните литературни податоци говорат за објавени само неколку статии и трудови за оваа патологија. Постојат три теории и повеќе етиолошки фактори за тоа како настануваат остеомите. Симптоматилогијата не секогаш ја презентира во целост почетната спорорастечка фаза на ваков бениген тумор со потекло од коскено ткиво. **Целта** на овој труд е да се прикаже клиничката слика, дијагностички методи и третман на избор кај зигоматичен остеом заедно со диференцијална дијагноза кај 35-годишна пациентка.
Клучни зборови: зигоматична коска, остеом, вилица, остеоиден остеом

Introduction

Osteoma is a slow growing benign osseous lesion that comes from well-differentiated mature bone tissue with three variants of central, peripheral and extra skeletal. They are often asymptomatic and usually continuously growing, and occur most often in adolescents and predominantly in females with a mean age at diagnosis of about 46 years, and rarely can be found in maxillary bones. However, osteoma of the zygoma is rare[1-5].

The etiology of osteomas remains unknown. The first author who recognized this pathological entity was Jaffe in 1935 1. Osteoma in craniofacial skeleton is detected on routine x-ray examinations or when they reach a large size, they can produce swelling and asymmetry, pain, dysfunction, jaw deviation etc[5-7]. Radiologically, osteomas are presented as a well-defined radiopaque mass with density similar to the normal bone. Genetic testing and colonoscopy are indicated in adolescents and young adults, because of the Gardner's syndrome (GS) and the development of colorectal adenocarcinoma[2-5].

Differential diagnosis should include osteomyelitis (e.g. Brodie abscess), osteoblastoma: >2 cm in size, fibrous dysplasia, cortical desmoid, fibroma, osteitis, odontoma, enostosis (bone island), reactive sclerosis around with osteolytic lesion.

Surgical removal of osteomas depends on the location, extent, and existence and is indicated when the lesion is symptomatic, actively growing, or causing esthetic disfigurement, trismus, malocclusion and functional impairment.

We present a rare case of a peripheral osteoma of the right zygomatic bone in an elderly woman.

Case presentation

A 35-year-old female was referred to our clinic presented with a painless firm mass in the right malar area in April 2019, firstly noticing this lesion 3 years earlier and she became concerned as it slowly enlarged. There was no trauma or infection, and her medical history did not contain any known pathology of the intestines.

Extra orally, we revealed solitary, smooth, firm, bony asymptomatic mushroom-like mass over the right zygoma, with deformity of the face measuring approximately 3.5 cm in diameter (Figure 1). The overlying skin was normal in color with no signs of inflammation. There were no opthalmologic symptoms, headache or facial pain in our patient. The routine blood investigations were also within the normal limits. The regional lymph nodes were non-palpable. The lesion was bony-hard on palpation.

A computed tomography (CT) scan revealed unilateral well - defined lobulated mass protruding from the outer cortex of the right zygoma to the adjacent anterior cheek

Figure 1. *Clinical preoperative view showing swelling on the right side of the face*

about 2.01cm×1.57cm×2.32cm in antero-posterior, transverse and cranio-caudal dimensions respectively. Due to increasing cosmetic and asymmetry reasons of the face, a decision was made to remove the tumor under general anesthesia with preservation of nearby structures. After incision, a complete view of the lesion was obtained (Figure 2a, 2b). The tissue was reflected by blunt dissection above the right zygomatic bone with skin flap and nerve stimulator to detect the branch of facial nerve during surgical procedure (Figure 2c, 2d). The tumor was completely removed (Figure 3). No elevation of temperature at the affected site and no pus discharge were observed. The patient was discharged home 3 days after surgery. Histopathologic examination revealed a well-circumscribed mass composed of dense lamellar bone with osteoclastic activity. Histological examination assessed an

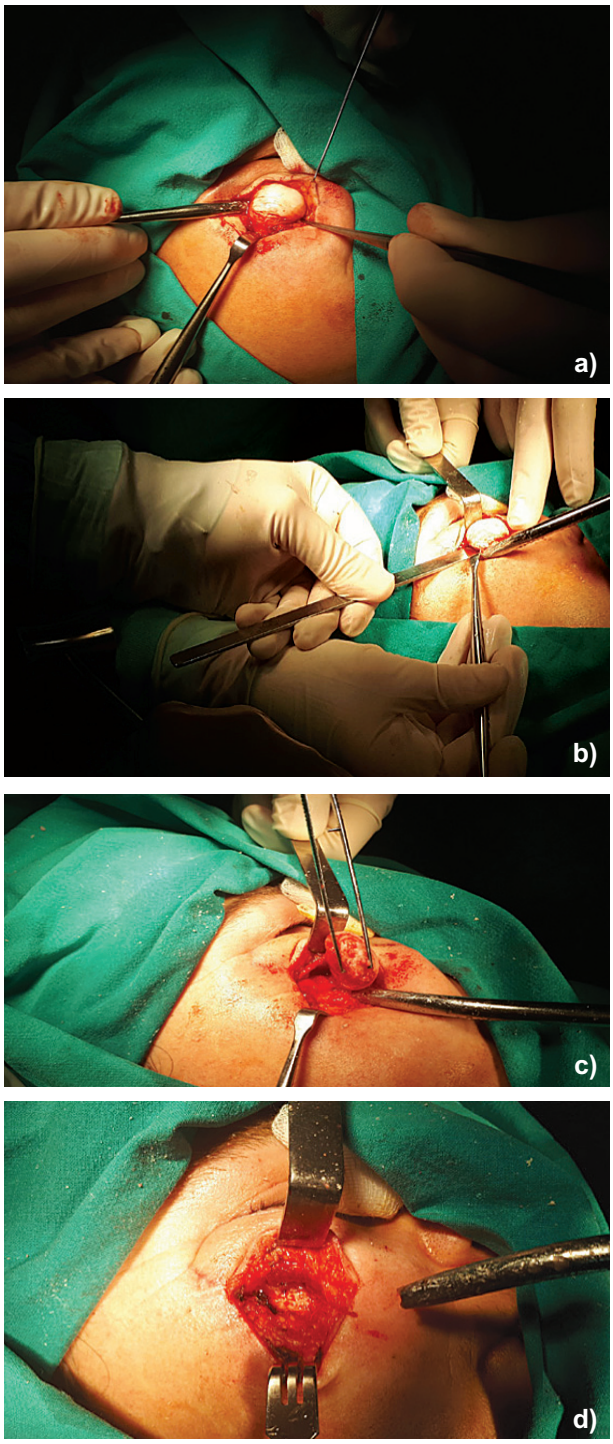

Figure 2. *Intraoperative view showing various steps in removal of the osteoma followed by a clinical photo after resection and recontouring the cortical bone*

osteoid osteoma with normal bone architecture. The postoperative 6 month follow up period was uneventful without complications or recurrence and the patient made a

Figure 3. *Macroscopic pathologic specimen excised showing the lobulated bony mass*

complete recovery. Prognosis is excellent except for the rare cases of malignant transformation.

Discussion

Osteomas of cranio-maxillo-facial region are extremely uncommon, especially in the malar bone anatomical side with unclear etiology[3-6]. They are composed of mature compact or cancellous bone and sometimes may be found in association with other diseases such as polyps, fibromatous lesions of the connective tissue and the Gardner's syndrome (familial adenomatous polyposis) 7-10. Its incidence is rare in the jaws and the mandible is more affected than the maxilla. A literature review identified only few previously documented cases of zygomatic bone osteoma. Osteoma can arise at any age, but is more frequently seen between the fourth and fifth decade of life.

N. Larrea-Oyarbide et al.,[3] in their retrospective study of 106 patients reported that 132 osteomas of the craniomaxilofacial region were found to be diagnosed between 1986 and 2003, with mean age of 50 years.

Several authors proposed that osteomas are often asymptomatic and usually slow growing and may cause different complications depending on the part of the central nervous or visual systems[2, 5-7].

On the other side Johann AC et al.,[5] showed 69 well-documented cases of peripheral osteoma with peripheral type and the mandible was the most frequently affected side. The radiopaque focal mass with rarefaction and reactive bone formation is typical for this type of tumors, but even diagnostic tools (CT scan or MRI) von Chamier G et al.,[7] suggested that the initial changes are often uncharacteristic and can cause further delay in proper diagnosis because of the dense lamellae arranged in layers, and clinically should be differentiated from several pathologies.

Radiographic x-ray investigations such as occlusal radiograph, panoramic radiograph or Computed Tomography (CT) with 3D reconstruction are proposal.

We believe that the intraoral approach has lower risks of facial injury and scarring, and because of the poor visibility, we decided to use direct extraoral facial incision required osteotomy for adequate surgical exposure, a good view of the lesion, complete tumor resection with satisfactory esthetic results and normal bone architecture. The patient is under follow – up and no signs of recurrence have been observed so far.

Conclusion

Osteomas appear in patients older than 35 years, and usually do not present clinical symptoms of pain, headache, neuralgia or paresthesia. The present case was not part of the Gardner syndrome, but association of osteoma with the Gardner's syndrome must always be kept in mind. Proper history, physical and radiological examination is necessary to identify the location and extent of the osteoma. Complete surgical excision is the treatment of choice. Positioning of a titanium plate was not necessary, and the tumor was completely removed from the anterior wall of the zygoma. The postoperative result provided good morphological, functional and aesthetic outcome with no evidence of recurrence.

Conflict of interest

The authors declare that they have no conflicts of interest.

Source of Support:
Nil.

Ethical disclosures

Protection of human and animal subjects: The authors declare that no experiments were performed on humans or animals for this investigation.

Confidentiality of data: The authors declare that they have followed the protocols of their work centre on the publication of patient data and that the patient included in the study have received sufficient information and have given their informed consent in writing to participate in that study.

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PRF SUPPORTED SOCKET PRESERVATION - A PREDICTABLE IMPLANT OUTCOME

ПРЕЗЕРВАЦИЈА НА ПОСТЕКСТРАКЦИОНА АЛВЕОЛА СО ТРОМБОЦИТНО ЗБОГАТЕН ФИБРИН ЗА ПРЕДВИДЛИВ ИМПЛАНТЕН УСПЕХ

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Abstract

After the extraction of teeth due to cavities, trauma or periodontal disease, the subsequent healing of postexstraction alveolar socket results in bone irregularities of the residual alveolar ridge (reduction of height and width). The factors of bone resorption can be divided into: anatomical, metabolic, functional and prosthetic factors. Postextraction alveolar resorption is significantly higher in the buccal aspects of both jaws. **The process** of bone remodeling will be more pronounced in clinical cases with present dehiscence and fenestration of the buccal lamina. The extent of bone resorption of the residual ridge is proportional to the time elapsed after the dental extraction. Deformities of the residual alveolar ridge are classified according to morphology in three consecutive classes. A case of 50-year-old male patient is presented with new regenerative protocols with PRF and a sticky bone for socket preservation. Using a combination of a sticky bone and PRF membranes for socket preservation is a simple and cost-effective source of growth factors that increase the predictability and success outcome of implant supported prosthodontics solutions.
Key words: socket preservation, bone resorption, PRF protocol, immediate loading, dental implants.

Апстракт

По загубата на забите поради кариес, траума или пародонтално заболување, последователното заздравување на алвеолата по екстракција, резултира со неправилности на резидуалниот алвеоларен гребен (намалување на коскениот квантум во вертикална и хоризонтална насока). Факторите на ресорпција на коските може да се поделат на: анатомски, метаболитички, функционални и протетски фактори. Алвеоларната ресорпција на постекстракционата алвеола е значително поизразена во предел на букалните аспекти на двете вилици. Процесот на ремоделирање на коската ќе биде поизразен во клиничките случаи на присутна дехисценција и/или фенестрација на букалната ламина. Обемот на ресорпција на резидуалниот алвеоларен гребен е пропорционален со времето поминато по денталната екстракција. Деформитетите на резидуалниот алвеоларен гребен се класифицираат според морфологијата во три класи. Во трудот е презентиран клинички случај на 50-годишен пациент каде е претставена современа техника на презервација на постекстракционата алвеола со помош на најнови регенеративни протоколи (PRF мембрана и т.н.,,леплива коска" за зачувување на коскениот волумен и квалитет). Користењето на комбинирана техника на ,,леплива коска" и PRF мембрана е едноставен и економичен извор на фактори на раст кои јаподобруваат прогнозата и успехот на имплантно-носената протетска реставрација. **Клучни зборови:** презервација на постекстракционa алвеола, коскена ресорпција, PRF протокол, имедијатно оптеретување, дентални импланти.

Introduction

After the tooth extraction resulting from caries, trauma or periodontal disease, the subsequent healing of the alveolar socket results in bone irregularities of the residual alveolar ridge (reduction of height and width). Unfortunately, many routine extractions are performed without paying attention to the alveolar ridge. Therefore, while performing the extractions in modern dentistry, an enormous attention is paid to minimizing trauma during the oral surgery procedure.

After the extraction, the socket is filled with blood containing proteins and damaged cells that initiate the formation of a fibrin network with adhered platelets (blood coagulum in the next 24 hours). Coagulum is taken as a physical matrix that initiates the movement of mesenchymal stem cells with their coagulation factors. Later in the wound, neutrophils and macrophages digest tissue debris and bacteria. Afterwards, fibrinolysis of the blood coagulum occurs. The proliferation of mesenchymal cells leads to a gradual replacement of the coagulum with granulation tissue (2-4 days). Within a week, the

vascular network is formed, while in the two weeks the marginal surface of the extraction wound is covered with young connective tissue rich in inflammatory cells and blood vessels. In 4-6 weeks, the majority of the socket is filled with young bone tissue without a trabecular form, while the soft tissue is gradually keratinized. In 4-6 months, the mineral tissue in the socket is strengthened with new layers of lamellar bone[1,2].

The loss of the alveolar bone can be associated with various factors, such as endodontic pathology, periodontology, trauma or aggressive manipulation of the therapist during routine extraction. The anatomical pre-existing conditions, the metabolic status of the patients and the functional load could also play an important role considering the bone remodeling patterns. Mechanical stimulation of the alveolar bone during mastication is crucial in maintaining the bone volume[3].

The resorption pathway is different in the maxilla and the mandible. As a result, after a few years, the maxilla progressively becomes smaller while the mandibular arch becomes wider. There is a tendency to create a class III intermaxillar ratio. Postextraction alveolar ridge resorption is significantly higher in the buccal aspects of both jaws. Bone remodeling is of greater significance if dehiscence and fenestrations are present, resulting in a larger buccal concavity of the residual alveolar bone. The extent of bone resorption of the residual ridge is closely related to the time elapsed after dental extraction. The loss of tissue contours is higher in the early postextraction period (the first 6 months). The wound healing in the maxilla occurs more rapidly, and therefore, resorption in the maxilla is faster.

Preservation of the alveolar ridge with the guided bone and tissue regeneration technique should be carried out at the time of tooth extraction, in order to control bone resorption, to preserve the original dimensions and contours of the alveolar ridge and create conditions where the implant placement would be easy predictable.

Contemporary trends in regenerative procedures include using autologous blood derivates (second generation of platelet rich fibrin –PRF) combined with various graft materials as a gold standard in postextraction alveoli (sticky bone). Sticky bone presents bone graft material entrapped in fibrin mesh.

Case description

A 50-year-old male patient, nonsmoking, without any history of systemic disease was referred to our Department for oral surgery, after several episodes of dentoalveolar abscesses related to the tooth 14. The clinical examination presented a remaining, not endodontically treated root. Vitality tests on the tooth were negative and on vertical percussion, slight pain was present. Retroalveolar radiographic examination showed a diffuse, radiolucent chronic periapical lesion (Figure 1).

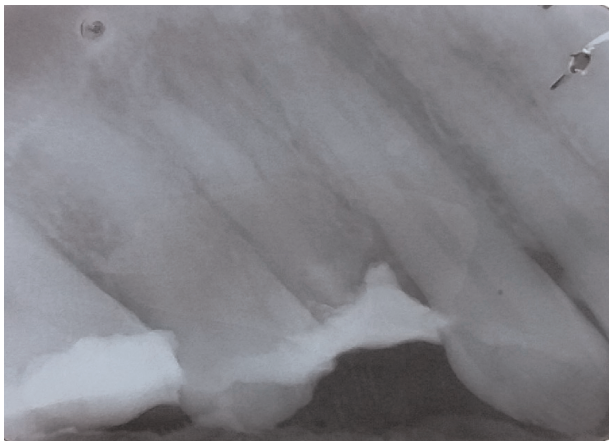

Figure 1. *Retroalveolar rtg evaluation of tooth 14*

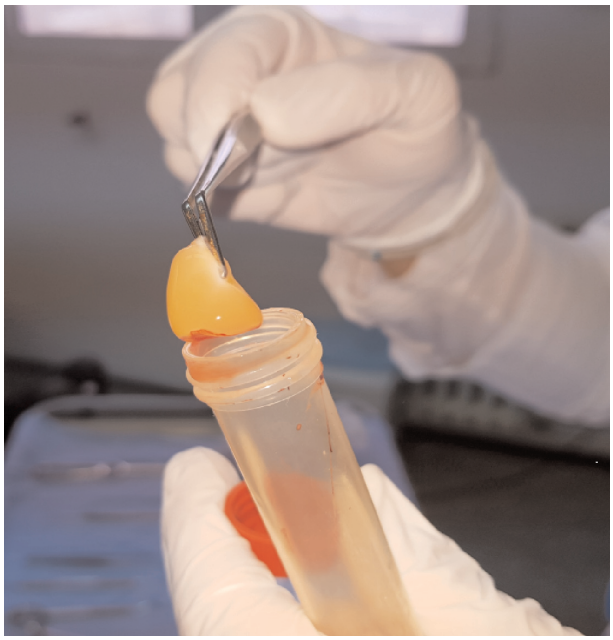

Figure 2. *Advanced platelet rich fibrin (A-PRF) preparation*

Extraction and socket preservation using „sticky bone“ was planned. A prophylactic antibiotic regimen was used. Prior to the procedure of socket preservation, a procedure of „sticky bone“ preparation was done that included venepunction and fast drawing of blood into A-PRF red tubes. Immediate centrifugation protocol for A-PRF was done according to Dr. Choukroun’s instructions, 1300 rotations per minute during 8 minutes. At the end of the spin, tubes were removed from the centrifuge

and placed in the metal holder. Caps were removed and after a period of 5 minutes for enhanced clot formation, clots were removed. A-PRF can be used as a barrier membrane; extraction socket plugs may be cut into pieces and combined with bone grafts, they can also be punched and sutured (Figure 2.).

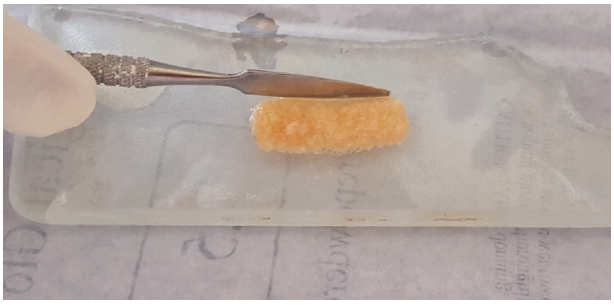

Figure 3. *Sticky bone process*

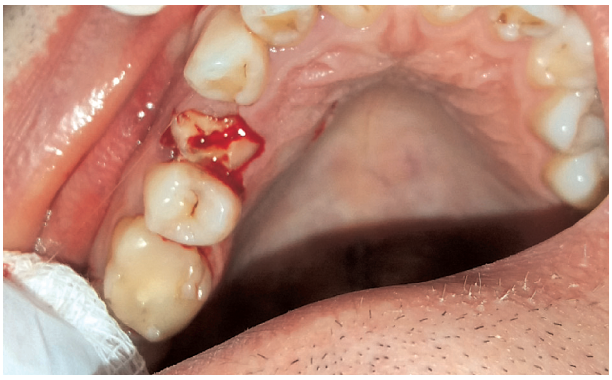

Figure 4. *Atraumatic extraction*

Figure 5. *Sticky bone graft material was placed in the postextraction alveoli*

Figure 6. *A-PRF membrane placement*

Figure 7. *Stabilization suture placement*

The i-PRF protocol includes using i-PRF orange tubes for centrifugation with 700 rpm and centrifugation time of 3 minutes. At the end of the spin, an orange supernatant is formed on the surface. I-PRF remains liquid for about 10-12 minutes, and then it clots. The aspiration of the supernatant is done with the needle.

In the PRF box special compartment, the „sticky bone" was created. The fibrin membrane was cut into small pieces and mixed with a bone grafting material

Figure 8. *Clinical view of healed site after 5 months*

Figure 9. *Implant placement*

Figure 10. *Immediate loading and a temporary crown*

(xenograft granules). The exudate of PRF was used to hydrate the graft granules. Afterwards, the i-PRF was poured drop by drop onto the bone graft material, in order to avoid overflow of i-PRF from the bone graft (Figure 3).

The extraction was performed completely atraumatically, by using atraumatic elevators (Figure 4). The flapless technique was first described by Landsberg and

Figure 11. *Final implant supported prosthodontic restoration*

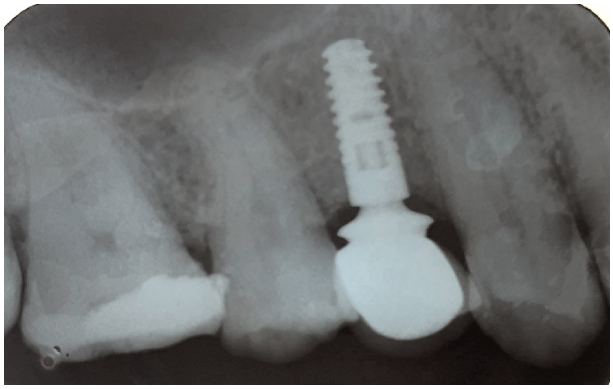

Figure 12. *Two year follow- up*

Bichacho in 1994. This technique does not damage the papillae; they remain attached to the cement of adjacent teeth. Atraumatic extraction was carried out without damaging the surrounding remaining bone and the site was thoroughly debrided by curettes and excessive irrigation in order to remove any granulated tissue. Then, the sticky bone graft material was placed in the post-extraction alveoli with a slight pressure and adaptation (Figure 5). Above the graft, the biological membrane (A-PRF membrane) was applied, whose ends were placed under the previously created underlying places. The edges of the postextraction soft tissue were approximated with stabilization suture using silk suture. (Figure 6,7). After the intervention, anti-inflammatory drugs and analgesics were administered and frequent rinsing with chlorohexidine solution was recommended. The postoperative period was uneventful.

The patient was evaluated after 5 months and an endosseous implant with immediate loading protocol was performed (Figure 8,9,10). Three months after the implantation surgery, the patient was recalled for definite prosthodontic solution (Figure 11, Figure 12).

Discussion

The bone is a living tissue that is constantly remodeling or changing its geometry, density (degree of calcification) and structure (orientation) under different factors such as biomechanical load, metabolic and hormonal effects, nutrition and neuronal influences.

Biomechanical laws defined by Wolff (1892) and Frost (1983) explain that the bone remodeling process depends on different characteristics of the masticatory forces such as the quantum of strength, the change in the size of the force, the number of cycles (mastication cycles) and the change in force distribution[4].

Canullo et al. claim that the degree of resorption is individual and depends on the osteoclast activity and they describe two kinds of individual trends in patients: individual resorptive and individual anabolic trend. The latter responds to dental extraction with intense bone apposition due to individual anabolic constitutions[5].

During the first 3 months after tooth loss, vertical bone resorption is around 2 mm. Horizontal resorption is 3-6 mm in the first 6 months. For a period of 3 years, the bone volume is reduced by 40-60%. Resorption of the vestibular lamina in both jaws is greater[6].

The resorption pathways described by Carl Misch and Randolph Resnik (2017) consider that the extent of bone resorption of the residual ridge is closely related to the time after dental extraction. The loss of tissue contours is greatest in the early postextraction period (the first 6 months). After several years, the maxilla progressively becomes smaller, while the mandibular arch becomes wider. There is a tendency to create a class III intermaxilar ratio. The degree of resorption is individual and depends on the osteoclast activity[7].

The Cologne Classification of Alveolar Ridge Defects (2013) uses three part codes to describe the effect of the alveolar ridge as comprehensively as possible with a view to existing therapeutic options[8]:

Part 1: Orientation of the defect

h: horizontal
V: vertical
C: combined
S (or +S): sinus area

Part 2: Reconstruction needs associated with the defect

1. low: < 4 mm
2. medium: 4-8 mm
3. high: > 8 mm)

Part 3: Relation of augmentation and defect region

i: internal, inside the contour
e: external, outside the ridge contour

The simplest and most predictable way to preserve the width, height, and position of the alveolar ridge is the preservation of the alveolar ridge at the time of extraction[9]. Only two thirds of the alveolar space that spontaneously heals after the extraction will be supplied with new bone[10]. Alveolar ridge preservation is guided bone regeneration (GBR) application at the time of tooth extraction to control bone resorption and to preserve original ridge dimensions and contours (hard and soft tissues)[11].

The first techniques of preserving the alveolar bone were presented in 1980, using a hydroxyapatite in the form of a dental root cone[12,13].

The key to successful alveolar bone preservation was described by Carl Misch that included: atraumatic extraction; evaluation of the walls of the socket and the size of the defect; asepsis and complete removal of granulation tissue; providing adequate blood supply to the graft; correct selection of graft material and ensuring adequate recovery time[14].

Classical technique for socket preservation is carried out in the following order: atraumatic extraction, placement of graft material and primary closure of the postextraction wound. It is recommended to raise the mucoperiosteal flap prior to the extraction. To secure the graft material, a barrier membrane is used, while the closing flap is displaced coronary to allow primary closing[15]. The potential problems could be associated with loss of interdental papilla height if the papillary attachment is involved in incision line, a recession of adjacent teeth, difficulty in coronary displacement of the flap and sequential inability to achieve primary closure, cicatrix formation along the vertical incisions, coronal dislocation of keratinized tissue and reduction of the level of keratinized tissue on the vestibular aspect.

The technique without any flap is also called the flapless technique. In the original procedure described by Landsberg and Bichacho in 1994, a small free autogenous gingival graft with adequate dimensions is stabilized using suture. Once the graft from the donor site has been cut off, there is a minimal shrinkage of the soft tissue graft and a reduction in its primary dimensions[15].

Future therapies with autologous stem cells and recombinant growth factors may have the potential to reduce the need for autologous bone harvesting in the future. However, until now, these therapies are limited to designated medical centers[8].

The various regenerative biomaterials used for socket preservation are bone grafts, membranes, biologic modifiers, and platelet concentrates[16]. Platelet rich plasma (PRP) and plasma rich in growth factors (PRGF) are the first generation of platelet concentrates.

Compared to PRP, PRF has many advantages over PRP. First, PRF can be squeezed to form a membrane and can be used as fibrin bandage serving as a matrix to accelerate the healing of wound edges[16]. Second, PRF does not use bovine thrombin or other exogenous activators in the preparation process[17]. Its natural fibrin architecture seems responsible for a slow release of growth factors and matrix glycoproteins during 7 days[18].Third, the chair side preparation of PRF is quite easy and fast, and simplifies processing without any artificial biochemical modification. Fourth, this produces an inexpensive autologous fibrin membrane in few minutes and eliminates the cost of membrane.

PRF (platelet-rich fibrin) which belongs to a new second generation of platelet concentrates[19,20], and was first developed in France, by Choukroun et al.[21] for specific use in oral and maxillofacial surgery. Fibrinogen is converted into an insoluble fibrin during enzymatic cascades of coagulation in the presence of thrombin, factor XIII, fibronectine, and calcium ions[22]. The polymerized fibrin gel constitutes the first cicatricial matrix of the injured site[23,24].

The biochemical analysis of the PRF composition analyzes that it consists of an intimate assembly of cytokines, glycanic chains, and structural glycoproteins enmeshed within a fibrin network[21]. The PRF matrix enmeshes glycosaminoglycans (heparin, hyaluronic acid) from blood and platelets. Glycosaminoglycans have great capacity to support cell migrations and healing processes[23].

Platelets are discoidal, anuclear structures formed in the bone marrow from megakaryocytes. Activation and degranulation of the platelets releases the cytokines that stimulate the cell migration and proliferation within the fibrin matrix.

PRF platelet cytokines remain trapped in the fibrin meshes, and probably even in the fibrin polymers (intrinsic cytokines)[25]. They stay trapped in the PRF fibrin matrix even after serum exudation, which necessarily implies an intimate incorporation of these molecules in the fibrin polymer molecular architecture. These cytokines have increased lifespan and they will be released at the time of initial cicatricial matrix remodeling (long-term effect).

A newly developed product of fabricating PRF-enriched bone graft matrix (also known as “sticky bone”) using autologous fibrin glue has been introduced. As an alternative to titanium mesh or block bone procedure, sticky bone was introduced in 2010 by Sohn DS[26]. Sticky bone is a bone graft material entrapped in fibrin mesh. Particulate bone powders are strongly interconnected to each other by a fibrin network. Sticky bone has numerous advantages: 1) It is flexible, well adapted over various shape of bony defect; 2) The stability of the grafted bone is granted against any motion and bone loss during the healing period is minimized. Since the volume of augmentation is maintained during the healing period, it reduces the need for ti-mesh membrane; 3) Fibrin network entraps platelets and leukocytes to release growth factors, so bone regeneration and soft tissue healing are facilitated; 4) No chemical additives are needed to fabricate the sticky bone[27].

Fibrin rich gel is known to release slow growth factors[28,29] such as platelet-derived growth factor (PDGF), transforming growth factor-β (TGF-β), fibroblast growth factor (FGF), vascular endothelial growth factor (VEGF) and insulin-like growth factor (IGF), which stimulate cell proliferation, matrix remodeling, and angiogenesis[30].

PRF poor mechanical properties have resulted in promotion of a new entity ”sticky bone” that has found a place in the regenerative field owing to its advantages over the solo use of PRF[31].

The “sticky bone“ acts like a mineral scaffold for orientation and organized migration of the bone forming cells. Moreover, it also contains growth factors necessary for the stimulation, differentiation and migration of cells[32]. The use of bone substitute with fibrin, platelets and leukocytes have shown a better histological evidence of hard bone and soft tissue formation than the use of PRF as a single filling material for the extraction socket[32].

Conclusion

The socket preservation technique conserves the alveolar architecture and prevents hard and soft tissue collapse that minimizes the necessity for further augmentation procedures in implant placement. The use of new innovative PRF autologous products transforms simple socket preservation into a more effective procedure. Using a combination of a sticky bone and PRF membranes for socket preservation is a simple and cost-effective source of growth factors that increase the predictability and success outcome of implant supported prosthodontic solutions.

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THE DISTRIBUTION OF OCCLUSAL VERTICAL STRESS IN SHORTENED DENTAL ARCHS WITH CROSS-ARCH DENTAL BRIDGES

ДИСТРИБУЦИЈА НА ОКЛУЗАЛНИ ВЕРТИКАЛНИ СИЛИ КАЈ МАЛКУ СКРАТЕНИ ЗАБНИ НИЗИ СО МОСТОВНИ КОНСТРУКЦИИ

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Abstract

The **aim** of the research is to analyze the distribution of occlusal vertical forces of the abutment teeth in bridge constructions with slightly shortened dental arches. **Material and method.** Subject of research are bridge constructions in slightly shortened dental arches in the mandibula. The Finite Element Method (FEM) was applied, and the analysis was made with simultaneous both-sided loading on the distal three abutment teeth. The simulated loading forces are with strength between 0.5 to 512N. Distributed occlusal vertical forces are measured at the level of the periodontal ligament (PDL). **Results.** The results show a symmetrical distribution of forces on both sides of the bridge structure. The largest forces are distributed on teeth with applied force. The smallest forces are distributed in the apical part of PDL. There was no difference between the total distributed forces on teeth and the distributed forces on the lateral part of the PDL. The measured strength of the forces and the percentage are within the known values in the literature. **Conclusion.** The obtained results of the research are within the level of known functional values of the mastication forces. This means that the biomechanical aspect for bridge constructions with slightly shortened dental arches is not disputable, but the decision to make it should also be based on other individual and clinical conditions. **Keywords:** Occlusal vertical forces, bridge construction, shortened dental arches, finite elements method (FEM), periodontal ligament (PDL).

Апстракт

Цел на трудот е да се направи анализа на дистрибуцијата на оклузални вертикални сили на забите носачи кај мостовни конструкции кај малку скратени забни низи. **Материјал и метод.** Предмет на истражување е мостовна конструкција кај малку скратен забен низ во долна вилица. Применет е метод на конечни елементи (МКЕ) а анализата е направена со симетрично оптоварување на дисталните три заби носачи. Симулираните сили на оптоварување се со јачина од 0.5 до 512N. Дистрибуираните сили се мерени на ниво на пародонталниот лигамент (ПДЛ). **Резултати.** Резултатите покажуваат симетрична дистрибуција на силите и на двете страни на мостовната конструкција. Најголеми сили се дистрибуираат на забите на кои делува аплицираната сила. Најмали сили се дистрибуираат во апикалниот дел на ПДЛ. Не е најдена разлика помеѓу вкупно дистрибуираните сили на забот и дистрибуираните сили на страничниот дел на ПДЛ. Измерените сили по јачина и процент се во рамките на познатите вредности во литературата. **Заклучок.** Добиените резултатите од истражувањето се во ниво на познатите функционални вредности на џвакалните сили. Ова значи дека од биомеханички аспект изработка на мостовни конструкции кај малку скратени забни низи не е спорна, но одлуката за изработка треба да се донесе и врз база на другите индивидуални и клинички услови. **Клучни зборови:** Оклузални вертикални сили, мостовни конструкции, скратени забни низи, метод на конечни елементи (МКЕ), периодонтален лигамент (PDL).

Introduction

Until the seventies of the twentieth century, the goal of dental treatment was the maintenance of complete dental arches with 28 teeth. In 1981, the concept of the shortened dental arch (SDA) promoted by Käyser, suggesting that shortened dental arches with at least four occlusal units, preferably in a symmetrical position, have sufficient capacity to maintain an adequate oral function[1].

This claim caused a series of researches in which the concept of shortened dental arch was studied from all aspects, the functions of the masticatory system, the effect of dental treatment, the quality of life, as well as the economic and social aspects[2, 3, 4, 5, 6].

Based on the results of extensive surveys, the World Health Organization WHO in 1992 set the new goal of dental treatment, which is a healthy, natural, and function-

al dental arch with at least 20 teeth without the need for prosthesis[7, 8].

Anneloes and associates found that shortened dental arches can stay stable for more than 27 years, which justifies the dental concept for shortened dental arches[9].

However, certain teeth changes can disrupt the stability of the shortened dental arches and in that case, a prosthetic treatment would be needed. The most frequent changes are the migration of teeth by separation, aesthetical and functional needs, and especially the loss of bone support.

According to De Oliveira and associates, teeth in shortened arches show greater movement than teeth in intact dental arches[10].

According to Kourkout and associates, bridge constructions can provide a certain degree of rigidity and enable a more favorable distribution of the masticatory forces of all remaining cases in patients with an advanced degree of progressive changes in the periodont[11].

Measuring the the masticatory forces is important in order to assess the functional state of the masticatory system, but it is a complex problem. The values obtained depend on many factors in the masticatory system, in the body, as well as of the measurement methods. Therefore, we find differences in the values obtained in literature.

In the published results, prevailing data suggest that the occlusal forces in static occlusion range from 100 to 1000N, while the data of the functional masticatory forces range from 3.5 to 350N[12].

According to Waltimo and Kononen, the maximal occlusal forces between Europeans and Americas range from 600 to 750N, while the functional mastication forces are much smaller, around 60-100 N[13].

Veleski measured the maximal masticatory forces in intact dental arches in the lower jaw from 176.8 N to 380.9 N in women and from 193.7 N to 506.9 N in men[14].

Himmlová measured the approximate value of 135 N in masticatory forces in subjects with natural intact dental arches[15].

Laurell L. measured maximal masticatory forces of 320 N in circular dental bridge constructions with a healthy periodont and 264 N with weakened paradont[16].

In his research, Biswas found the mean values of the maximal masticatory forces for the front teeth to be 193N, for the canines 223 N, for the premolars 280 N and for the molars 350 N[17].

The mean value of the occlusal force is between 39-66 N for the premolars and 11-33 N for the front teeth[18].

According to Lundgren and Laurell, the maximal force that occurs during the chewing act is 280 N and the medium functional force is about 100 N. He thinks that, on average, about 37% of the total maximal occlusal force is used in chewing[19].

Sato too believes that the dynamic functional momentum is 35-45% of the measured static forces[20].

By electromyographic analysis of the masticatory muscles, Prochechel and Morneburg found a mean functional masticatory force of 220N[21].

Several authors noted that the strength of the masticatory forces increases in the distal direction of dental arches[16, 22, 23, 24, 25, 26, 27, 28].

Kondo measured higher values of the maximal masticatory force in slightly shortened dental arches and pressure on PDL on second premolars[29].

Guo and associates and André and associates proved that the deformation forces of the periodontal ligament increase in proportion to the increase of the loading[30,31].

According to Apostolov, there are no distinctive differences in the values of the maximal masticatory forces on the left and on the right side of the dental arches[32, 33].

Cai and associates and Zhou Shu-min and associates found out that in the initial teeth loading, a larger amount of the masticatory forces are distributed on the cervical and lateral parts of the periodontal ligament[34, 35, 36].

In Jayam's research, during vestibular, lingual and incisal loading, the distribution of force in the apical zone is from 0.75 to 0.80N[37].

Fratila, Oruć and Je J discovered that the greatest concentration of the forces is distributed at the site of force action[18, 38, 39].

Al-Zarea measured higher values of force on the side of the natural teeth in comparison to the bridge structure side, in same subjects, the difference was statistically significant ($p < 0.05$)[40].

According to literature data, the highest influence on teeth is inflicted by the occlusal vertical forces which are the largest and the base of mastication. They are one of the most important conditions for physiologically optimal occlusion, especially in prosthetic constructions where the tendency during modeling is to reduce the impact of side forces[24].

From this aspect, the interest of this research is the distribution of the occlusal vertical forces of bridge constructions made in small shortened sequences.

Aim of the research

The aim of this research is to analyze the distribution of occlusal vertical dental forces of bridge constructions in slightly shortened dental arches.

Material and methods

The analysis of the distribution of occlusal vertical forces is made by using the finite element method. The research was done on a three-dimensional computer

model, the computer analysis and the generation of the finite element network were done with SOFISTIK software package.

The basic model is Kenedy class I edentulous in the mandibula with end teeth 45 and 35, a slightly shortened dental arch (Figure 1.).

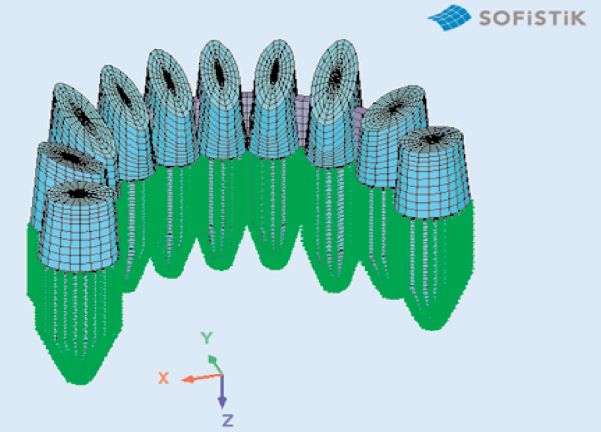

Figure 1. *Model of bridge construction in slightly shortened dental arch*

The discretization of the model is on finite elements with six sides and eight nodes.

The values needed for modeling teeth, periodontal ligament, component materials for bridge structures were taken from literature data.

The analysis was performed by symmetrical loading on the three distal abutment teeth of the bridge construction 45, 44, 43, 42, 41, 31, 32, 33, 34, 35 (Figure 2).

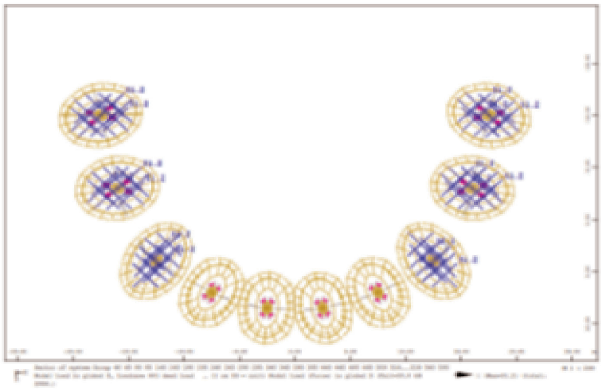

Figure 2. *Symmetrical loading of the three distal teeth*

Simulated vertical occlusal forces with a magnitude of 0.5N to 512N were applied in the research, respectively to the literature data for maximal and minimal masticatory forces.

The duration of the load force is not taken as a factor for the analysis.

The applied finite element method is a recognized and used method in dental researches, especially in dental biomechanics.

In this research, a three-dimensional (3D) finite element method (FME) is applied, based on the deformation method.

It is a numerical method that performs physical discretization of space. The continium (independent of its shape, shape, size) is divided into elements with finite dimensions. These elements are connected to each other in discrete points marked as nodes, and that way, a finite element network is formed. By analyzing the finite elements, actually the analysis of the continuum as a whole is carried out.

The data for teeth, periodontal ligament, materials used for bridge structures are taken from literature[41.42].

The problem being analyzed in this research is nonlinear. Nonlinearity is due to the anisotropic properties of the periodontal ligament. According to Kojima, PDL should be modeled as nonlinear[43].

By using the nonlinear analysis, a real response is obtained for the behavior of bridge structures and the distribution of forces.

Results

By carrying out the foreseen examinations in the research, we obtained the following results:

Table 1 shows the obtained values of the distributed occlusal vertical forces on the abutment teeth during simultaneous both-sided load of the three distal abutment teeth 45 44 43 and 33 34 35 in bridge construction at 45 44 43 42 41 31 32 33 34 35 with the slightly shortened dental arch.

Table 2 shows the percentage distribution of occlusal vertical forces on the abutment teeth during simultaneous both-sided load on the three distal abutment teeth 45 44 43 and 33 34 35 in bridge construction 45 44 43 42 41 31 32 33 34 35 with the slightly shortened dental arch.

Table 3 shows the obtained values of the distributed occlusal vertical forces in the apical part of PDL of abutment teeth during simultaneous both-sided load on the three distal abutment teeth 45 44 43 and 33 34 35 in bridge construction 45 44 43 42 41 31 32 33 34 35 with a slightly shortened dental arch.

Table 4 shows the percentage distribution of occlusal vertical forces in the apical part of PDL of abutment teeth during simultaneous both-sided load on the three distal abutment teeth 45 44 43 and 33 34 35 in bridge construction 45 44 43 42 41 31 32 33 34 35 with a slightly shortened dental arch.

Table 1. Values of the distributed occlusal vertical forces on the abutment teeth during simultaneous both-sided load of the three distal abutment teeth 45 44 43 and 33 34 35

F / Tooth	0.5 N	1 N	2 N	4 N	8 N	1 6N	32 N	64 N	128 N	256 N	512 N
45	-0..17	-0..35	-0..69	-1.39	-2.92	-5.89	-13.58	-24.85	-49.91	-94.30	-186.09
44	-0..13	-0..26	-0..52	-1.05	-1.96	-4.24	-7.20	-18.52	-35.54	-79.09	-160.03
43	-0..10	-0..20	-0..40	-0.80	-1.56	-2.97	-5.53	-t1.27	-25.92	-52.13	-113.78
42	-0.05	-0..11	-0..21	-0.42	-0.84	-1.55	-3.05	-4.74	-10.24	-18.44	-31.18
41	-0.04	-0.08	-0..17	-0.34	-0.70	-1.32	-2.56	-4.09	-6.78	-11.80	-16.31
31	-0.04	-0.08	-0..17	-0.34	-0.69	-1.32	-2.56	-4.09	-6.74	-11.76	-16.28
32	-0.05	-0..11	-0..21	-0.42	-0.84	-1.54	-3.06	-4.74	-10.28	-18.49	-31.33
33	-0..10	-0..20	-0..40	-0.80	-1.56	-2.96	-5.54	-11.18	-25.86	-52.02	-113.56
34	-0..13	-0..26	-0..52	-1.05	-1.96	-4.24	-7.21	-18.49	-35.50	-79.11	-160.04
35	-0..17	-0..35	-0.70	1.39	-2.92	-5.89	-13.60	-24.87	-49.94	-94.37	-186.18
Total	-1.00	-2.00	-3.99	-7.99	-15.98	-31.94	-63.88	-126.83	-256.71	-511.51	-1014.78

Table 2. Percentage distribution of occlusal vertical forces on the abutment teeth during simultaneous both-sided load on the three distal abutment teeth 45 44 43 and 33 34 35

F / Tooth	0.5 N	1 N	2 N	4 N	8 N	1 6 N	32 N	64 N	128 N	256 N	512 N
45	17.40	17.36	17.40	17.37	18.30	18.44	21.26	19.59	19.44	18.44	18.45
44	13.12	13.10	13.12	13.10	12.29	13.29	11.27	14.6.60	13.84	15.46	15.77
43	10.04	10.04	10.03	10.03	9.79	9.31	8.66	8.88	10.10	10.19	11.21
42	5.25	5.27	5.24	5.26	5.27	4.84	4.78	3.74	3.99	3.61	3.07
41	4.20	4.24	4.21	4.24	4.35	4.15	4.01	3.22	2.64	2.31	1.61
31	4.20	4.24	4.20	4.23	4.35	4.14	4.00	3.22	2.63	2.30	1.60
32	5.24	5.26	5.24	5.25	5.27	4.84	4.79	3.74	4.01	3.61	3.09
33	10.03	10.02	10.03	10.02	9.78	9.27	8.67	8.82	10.07	10.17	11.19
34	13.12	13.09	13.13	13.10	12.30	13.27	11.28	14.58	13.83	15.47	15.77
35	17.42	17.37	17.42	17.38	18.30	18.45	21.29	19.61	19.45	18.45	18.35
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 3. Values of the distributed occlusal vertical forces in the apical part of PDL

F / Tooth	0.5 N	1 N	2 N	4 N	8 N	1 6N	32 N	64 N	128 N	256 N	512 N
45	-0.001	-0.002	-0.003	-0.006	-0.013	-0.026	-0.079	-0.151	-0.270	-0.443	-0.817
44	-0.001	-0.001	-0.002	-0.005	-0.009	-0.019	-0.031	-0.110	-0.205	-0.383	-0.704
43	0.000	-0.001	-0.001	-0.003	-0.006	-0.011	-0.031	-0.048	-0.126	-0.230	-0.429
42	0.000	0.000	-0.001	-0.002	-0.003	-0.006	-0.011	-0.018	-0.047	-0.091	-0.139
41	0.000	0.000	-0.001	-0.001	-0.003	-0.005	-0.009	-0.015	-0.020	-0.053	-0.074
31	0.000	0.000	-0.001	-0.001	-0.003	-0.005	-0.009	-0.015	-0.020	-0.053	-0.074
32	0.000	0.000	-0.001	-0.002	-0.003	-0.006	-0.012	-0.019	-0.049	-0.095	-0.145
33	0.000	-0.001	-0.001	-0.003	-0.006	-0.011	-0.020	-0.047	-0.125	-0.228	-0.425
34	-0.001	-0.001	-0.002	-0.005	-0.009	-0.019	-0.031	-0.110	-0.205	-0.383	-0.704
35	-0.001	-0.002	-0.003	-0.006	-0.013	-0.027	-0.079	-0.151	-0.270	-0.443	-0.818
Total	0.00	-0.01	-0.02	-0.03	-0.07	-0.13	-0.30	-0.68	-1.34	-2.40	-4.33

Table 4. Percentage distribution of occlusal vertical forces in the apical part of PDL on abutment teeth

F / Tooth	0.5 N	1 N	2 N	4 N	8 N	16 N	32 N	64 N	128 N	256 N	512 N
45	0.08	0.08	0.08	0.08	0.08	0.08	0.12	0.12	0.11	0.09	0.08
44	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.09	0.08	0.07	0.07
43	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.04	0.05	0.04	0.04
42	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.01
41	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
31	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
32	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01
33	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.04	0.05	0.04	0.04
34	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.09	0.08	0.07	0.07
35	0.08	0.08	0.08	0.08	0.08	0.08	0.12	0.12	0.11	0.09	0.08
Total	0.42	0.42	0.42	0.42	0.42	0.42	0.47	0.54	0.52	0.47	0.43

Table 5. Values of distributed occlusal vertical forces on the lateral parts of PDL of abutment teeth during simultaneous both-sided load on the three distal abutment teeth 45 44 43 and 33 34 35

F / Tooth	0.5 N	1 N	2 N	4 N	8 N	1 6 N	32 N	64 N	128 N	256 N	512 N
45	-0.17	-0.35	-0.69	-1.38	-2.91	-5.86	-13.50	-24.70	-49.64	-93.86	-185.27
44	-0.13	-0.26	-0.52	-1.04	-1.96	-4.22	-7.17	-18.41	-35.33	-78.70	-159.32
43	-0.10	-0.20	-0.40	-0.80	-1.56	-2.96	-5.51	-11.22	-25.80	-51.90	-113.35
42	-0.05	-0.10	-0.21	-0.42	-0.84	-1.54	-3.04	-4.73	-10.20	-18.35	-31.04
41	-0.04	-0.08	-0.17	-0.34	-0.69	-1.32	-2.55	-4.07	-6.76	-11.74	-16.23
31	-0.04	-0.08	-0.17	-0.34	-0.69	-1.32	-2.55	-4.07	-6.72	-11.71	-16.20
32	-0.05	-0.10	-0.21	-0.42	-0.84	-1.54	-3.05	-4.72	-10.23	-18.39	-31.18
33	-0.10	-0.20	-0.40	-0.80	-1.56	-2.95	-5.52	-11.13	-25.73	-51.80	-113.14
34	-0.13	-0.26	-0.52	-1.04	-1.96	-4.22	-7.18	-18.38	-35.29	-78.73	-159.33
35	-0.17	-0.35	-0.69	-1.38	-2.91	-5.87	-13.53	-24.72	-49.67	-93.93	-185.36
Total	-1.00	-1.99	-3.98	-7.95	-15.91	-31.80	-63.58	-126.15	-255.38	-509.11	-1010.45

Table 6. Percentage distribution of occlusal vertical forces on lateral parts of PDL in abutment teeth

F / Tooth	0.5 N	1 N	2 N	4 N	8 N	1 6 N	32 N	64 N	128 N	256 N	512 N
45	17.32	17.28	17.32	17.30	18.21	18.36	21.14	19.47	19.34	18.35	18.26
44	13.06	13.04	13.06	13.04	12.24	13.23	11.22	14.51	13.76	15.39	15.70
43	10.00	10.01	9.99	10.00	9.75	9.27	8.63	8.85	10.05	10.15	11.17
42	5.23	5.25	5.22	5.24	5.26	4.82	4.76	3.73	3,97	3.59	3,06
41	4.18	4.23	4.19	4.22	4.34	4.13	3.99	3.21	2.63	2.30	1.60
31	4.18	4.22	4.18	4.22	4.33	4.12	3.99	3.21	2.62	2.29	1.60
32	5.22	5.24	5.22	5.23	5.25	4.82	4.77	3.72	3.99	3.60	3.07
33	9.99	9.98	9.99	9.98	9.74	9.24	8.63	8.78	10.02	10.13	11.15
34	13.06	13.03	13.07	13.04	12.24	13.21	11.23	14.49	13.75	15.39	15.70
35	17.34	17.29	17.34	17.31	18.22	18.37	21.17	19.49	19.35	18.36	18.27
Вкупно	99.58	99.58	99.58	99.58	99.58	99.58	99.53	99.46	99.48	99.53	99.57

Table 5 shows the obtained values of the distributed occlusal vertical forces on the side parts of the PDL on abutment teeth during simultaneous both-sided load on the three distal abutment teeth 45 44 43 and 33 34 35 in bridge construction 45 44 43 42 41 31 32 33 34 35 with a slightly shortened dental arch.

Table 6 shows the percentage distribution of occlusal vertical forces on lateral parts of PDL of abutment teeth during the simultaneous both-sided load on the three distal abutment teeth 45 44 43 and 33 34 35 in bridge construction 45 44 43 42 41 31 32 33 34 35 with a slightly shortened dental arch.

Discussion

OThe obtained results for the distribution of the occlusal vertical forces on the abutment teeth of bridge constructions in slightly shortened dental arches during simultaneous both-sided loading of the three distal abutment teeth 45 44 43 and 33 34 35 (Table 1) have an approximately identical distribution of the applied force to the left and right side. Such results were also obtained by Apostolov[32].

All distributed forces have the same direction of action identical to the direction of action of the loading force.

The distributed force has a tendency to approximately double the rise with the increase in the strength of the applied force. That is in line with the results of Guo and associates and André and associates[30, 31].

For all applied loading forces, the strongest force is distributed to the distal abutment teeth that gradually decrease mesially. Fratila, Oruc and Ye Y. found this kind of force distribution[18, 38, 39].

On teeth not exposed to direct loading forces, smaller forces are distributed that reach values of 31.33 N for the strongest applied force (Table 1).

During the simultaneous both-sided load of the three distal abutment teeth 45, 44, 43 and 33, 34, 35 in bridge structures, there is approximately identical distribution percentage of distributed force on the left and right side. The percentage of distributed forces is approximately identical for small and large forces with a tendency of slight increase by increasing the strength of the applied force. The highest percentage of force is distributed to distal abutment teeth that gradually decrease to the mesial abutment teeth.

On teeth with no force applied, the greatest force is distributed during small loading forces and gradually decreases with the rise of loading force (Table 2).

The strength of the distributed forces on the apical part of the PDL on the abutment teeth is minimal, and is less than 1 N, which is in accordance with Jayam's research.37

The percentage of the distributed forces of the apical parts of the PDL of the teeth carriers is less than 0.5% (Table 4).

Distributed force on the side parts of the PDL on the abutment teeth has the same characteristics as the distributed forces on teeth. This means that the major part of the force is received by the lateral parts of PDL. This is consistent with the results of Cai and Associates and Zhou Shu-min and associates[34, 35, 36].

Over 99.5% of the applied force is distributed to the lateral parts of PDL of the abutment teeth and has the same characteristics as on the entire teeth (Table 6).

The greatest difficulty in this research was that there are many data in the literature, but the results are difficult to compare because different research methods have been used. The published clinical trials are often reduced to periodic analyzes.

Conclusion

Distributed occlusal vertical forces on all abutment teeth have the same direction of action that is identical with the direction of action of the loading force.

For all applied loading forces, the strongest force is distributed to the distal teeth.

The percentage of distributed occlusal vertical forces on teeth is approximately identical for small and large forces.

Distributed occlusal vertical forces on the lateral parts of PDL have the same characteristics as the distributed forces on teeth.

The strength and percentage of the distributed occlusal vertical forces on the apical part of PDL on the abutment teeth is minimal, and is less than 1N or 0.5%.

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