

# Stomatološki vjesnik

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Dear Readers,

This is the third issue of Stomatološki vjesnik /Stomatological review that we bring to you according to the scheduled timeline. In the previous year we published twenty-two scientific and professional papers which were positively evaluated in the review process. In this issue we bring you another ten papers. All of them are, as in the previous issue, published fully in English language.

In addition to the printed edition of our scientific journal, all accepted papers are available on the website [www.stomatoloskivjesnik.ba](http://www.stomatoloskivjesnik.ba) with the possibility of free downloads. That is the way of expanding the information gained by scientific work of the authors, making it available to all those who are involved in dentistry in a professional and scientific terms.

In this issue we present the book "Aesthetic, Periodontal, Plastic and Implant surgery: A Microsurgical concept" by Otto Zuhre and Marc Hürzeler that is translated into Croatian language thanks to Quintessence Publishing and Professor Andrej Aurer.

We hope that you will read this issue of Stomatološki vjesnik / Stomatological review with pleasure and that you will find here interesting and useful information.

editorial

Poštovani čitatelji,

Ovo je treći broj Stomatološkog vjesnika koji vam stiže u predviđenom terminu. U prethodnoj godini objavili smo dvadeset i dva naučna i stručna rada koji su pozitivno ocijenjeni u recenzentskom postupku. U ovom broju vam donosimo novih deset radova. Svi radovi su, kao i u prethodnom broju, na engleskom jeziku.

Osim u štampanom izdanju našeg časopisa svi radovi su u cjelosti, kao i do sada, dostupni i na web stranici [www.stomatoloskivjesnik.ba](http://www.stomatoloskivjesnik.ba) s mogućnošću besplatnog preuzimanja. Na taj način širimo informacije dobivene naučnim spoznajama autora, čineći da one postanu dostupne svima koji se bave stomatologijom u stručnom i naučnom smislu.

U ovom broju predstavljamo i knjigu "Estetska, parodontna, plastična i implantološka hirurgija: mikrohiruski koncept", autora Otta Zuhra i Marca Hürzelerera koja je zahvaljujući Quintessence Publishingu i Prof.dr.sc Andrej Aureru prevedena na hrvatski jezik.

Nadamo se da ćete ovo izdanje Stomatološkog vjesnika čitati sa zadovoljstvom i da ćete u njemu naći intresantne i korisne informacije.

uredništvo

## GROWTH INDICATORS IN ORTHODONTIC PATIENTS: CERVICAL BONE AGE VS CHRONOLOGICAL AGE

INDIKATORI RASTA KOD ORTODONTSKIH PACIJENATA:  
SKELETALNA DOB NASPRAM HRONOLOŠKE DOBI

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### ABSTRACT

Many maturational indexes are used in order to evaluate the growth or physiologic maturation of orthodontic patients. Given wide variations among patients in the chronological timing of pubertal growth spurt, chronological age is unreliable in predicting the pubertal spurt. Currently, cervical vertebrae analysis is widely used by orthodontists to evaluate skeletal bone age. The aim of the present study was to investigate the association between chronological and skeletal bone age of orthodontic patients.

**Material and methods:** This investigation included 100 examinees (50 males and 50 females) aged from 9-17 years. The lateral cephalogram was made for all examinees. In cervical spine region we traced the second, third and fourth cervical vertebrae followed by evaluation of the bone maturity CVMS I to V performed according to original Bacceti et al method. The obtained data were compared to known chronological age. Accuracy was tested by Pearson coefficient of correlation. On 15 lateral cephalograms, within two weeks time distance, CVM stadium from 1-5 was determined again by the same examiner. Results: The greatest difference between chronological and bone age was recorded at female examinees aging from 10-11 and 12-13 years. At male examinees, the greatest difference aged from 12-13 and 14-15 years respectively. The Pearson correlation coefficient between two measurement periods was .893.

**Conclusion:** Chronological age is not an accurate indicator of developmental status of orthodontic patients. Determination of the cervical vertebrae level of maturation is better indicator of biological age.

**Keywords:** chronological age, skeletal age, orthodontics

### SAŽETAK

Za procjenu rasta i fiziološkog sazrijevanja ortodontskih pacijenata, koriste se brojni indeksi maturacije. Zbog velike razlike među pacijentima u hronološkom vremenu postizanja pubertetskog ubrzanja rasta, hronološka dob je nepouzdan indikator za predviđanje nastupajućeg puberteta. U posljednje vrijeme se među ortodontima sve više upotrebljava analiza vratnih pršljenova za procjenu koštane zrelosti. Cilj ove studije bio je ispitati povezanost između hronološke i skeletne dobi kod ortodontskih pacijenata.

**Materijal i metode:** U istraživanju je učestvovalo 100 ispitanika (50 muških i 50 ženskih) dobi od 9 do 17 godina. Za svakog ispitanika urađen je lateralni cefalogram. U području vratne kičme, na cefalogramu su iscrtani drugi, treći i četvrti vratni pršljen, te je procjena koštane zrelosti CVMS I do V, urađena prema originalnoj metodi Bacceti i sar. Dobiveni podaci su komparirani sa poznatom hronološkom dobi. Pouzdanost mjerenja testirana je Pearsonovim koeficijentom korelacije. Na 15 lateralnih cefalograma, sa razmakom od dvije sedmice, ponovno je određen CVM stadij od 1 do 5, od istog ispitivača.

**Rezultati:** Najveća razlika između hronološke i koštane dobi uočena je kod ženskih ispitanica u dobi 10-11 i 12-13 godina. Kod muških ispitanika najveća razlika između hronološke i koštane zrelosti je u dobi 12-13 i 14-15 godina. Pearsonov koeficijent korelacije između dva perioda mjerenja iznosio je 0,893

**Zaključak:** Hronološka dob nije dovoljno precizan indikator razvojnog statusa ortodontskih pacijenata. Određivanje stepena maturacije vratnih pršljenova je bolji pokazatelj biološke dobi.

**Ključne riječi:** hronološka dob, skeletalna dob, ortodoncija

## Introduction

Understanding of growth is important in the practice of clinical orthodontics. Maturation status has considerable influence to diagnosis, treatment goals, treatment planning, and the possible outcome of orthodontic treatment. Prediction of both, the times and the amounts of active growth of the craniofacial complex, would be useful to the orthodontist. This is especially true for treatment considerations based strongly on the facial growth such as the use of extra oral traction, functional appliances, selection of orthodontic retention and orthographic surgery [1, 2, 3].

Many researchers indicated that chronological age is not a reliable indicator to evaluate maturity of a child. As such, maturity of a child is best estimated in relation to specific stages of physiologic maturity [4, 5]. Physiologic age can be estimated by somatic, sexual, skeletal, and dental maturity [6, 7, 8, 9].

Skeletal bone age refers to the degree of ossification development in bone. During the growth, each bone passes through a series of changes that can be seen radiological. The ossification in the cervical vertebrae begins during the fetal life and continues until adulthood. Therefore, maturational changes can be observed in the vertebrae during this period coinciding with the start of orthodontic treatment.

The aim of the study was to investigate correlation between skeletal bone age (determined by CVM method) and the chronological age of orthodontic patients.

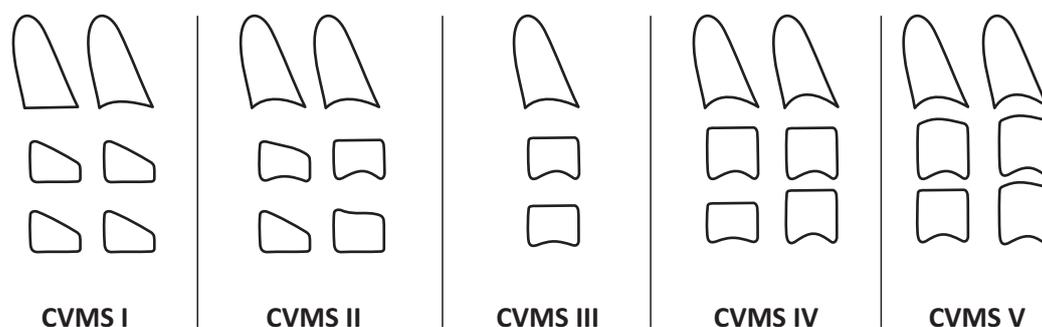
## Material and methods

This study was conducted in Department of Orthodontics (Faculty of Dentistry, University of Sarajevo). Study is approved by Ethical Committee approval number 09-53-3/2012. This examination included 100 examinees (50 males and 50 females) aging 9-17 years. All examinees were of the Bosnian origin, and were not previously treated orthodontic. All examinees were divided into 5 stages of chronological age: stage 1(8-9 years), stage 2 (10-11 years), Stage 3(12 -13), stage 4(14-15) and stage 5(16-17).

The chronological age of each examinee was calculated as: date of examination – date of birth.

The lateral cephalogram was made for each of examinee. During the exposure, all examinees were properly protected, wearing protective collar. Radiographs of high resolution and good contrast were used. The lateral cephalograms were traced on matte acetate foil with 0.5 mm diameter pencil, using radiographic illuminator. In cervical spine region, we traced three cervical vertebrae: the second, third and fourth as recommended by original method of Baccetti et al. [10] (**Figure 1.**)

Cervical vertebrae development of the sample was evaluated by the Baccetti and associates method. Baccetti *et al.* (2002) presented new CVM method with five maturational stages: Cervical Vertebral Maturation Stage (CVMS) I through (CVMS) V, instead of CVMS I through CVMS VI in the former CVM method (Original Lamparski method, modified by Hassel and Farman).



**Figure 1.**  
Five stages of cervical vertebral maturation

According to the Baccetti, definition of five cervical vertebral maturation stages is as it follows:

#### CVMSI:

The lower borders of the vertebrae C2, C3 and C4 are flat, with possible exception of a concavity at the lower border of C2 in almost half cases. The bodies of the both C3 and C4 are trapezoid in shape. The peak in mandible growth will occur only one year after this stage.

#### CVMSII:

Concavities at the lower borders of C2 and C3 are present. The bodies of C3 and C4 may be either trapezoid or rectangular horizontal in shape. The peak in mandible growth will occur within one year after this stage.

#### CVMSIII:

Concavities at the lower borders of C2, C3 and C4 now are present. The bodies of the both C3 and C4 are rectangular horizontal in shape. The peak in mandible growth occurred within one or two years before this stage.

#### CVMSIV:

The concavities at the lower borders of C2, C3 and C4 still are present. At least one of the bodies of C3 and C4 is squared in shape. If not squared, the body of the other cervical vertebrae is still rectangular horizontal. The peak in mandible growth occurred one year before this stage.

#### CVMSV:

The concavities at the lower borders of C2, C3 and C4 still are evident. At least one of the bodies of C3 and C4 is rectangular vertical in shape. If not rectangular vertical, the body of the other cervical vertebra is squared. The peak in mandible growth occurred two years before this stage.

On the lateral cephalograms of 100 examinees we determined the maturity stage (1-5) of cervical vertebrae, by the Baccetti and associates method [10]. The obtained data were compared with known chronological age (**Figure 2.**).



**Figure 2.**  
Lateral cephalogram

## Results

In this study, we compared chronological age of examinees with their individual cephalometric measurements on the cervical vertebrae as the indicator of skeletal bone age. Our results show a wide variation between chronological age and skeletal age. The chronological age showed large differences in comparison to CVMS.

Examinees in all aged groups demonstrated wide variation in their maturational status, especially in the group aging from 10-11 and 12-13 at females (Figure 3.).

At males group, the largest differences between chronological age and CVMS was in the groups aging from 12-13 and 14-15 (Figure 4.).

## Discussion

In the female examinees, chronological age and CVM stage showed very good similarity in the group aging from 8-9. At this stage, 80 % of female examinees showed CVM stage I, and 20% of them showed CVM stage II. In the group aging 10-11 and 12-13 of female examinees, we found wide range of variations between chronological and skeletal age: In the group aging 10-11, 30% girls showed CVMS I, 40% girls showed CVMS II, and 30% girls showed CVMS III. In the group aging 12-13, 10% girls showed CVMS II, 40% girls showed CVMS III, 40% girls showed CVMS IV and 10 % girls showed CVMS V. In older female aging groups: 14-15 and 15-16, similarity was increased. In the age group 14-15, 50% girls showed CVMS IV and 50 % of them showed CVMS V. In the age group 16-17, congruence between chronological and skeletal age was complete thus 100% girls shows CVMS V. Similar results were seen in the study of Mito et al., done among Japanese girls [11].

In male examinees, congruence between chronological and skeletal age was complete in the group aging 8-9. At this stage 100% male subjects showed CVMS I. At other male age groups, we noticed wide range of variations between chronological and skeletal age, with general tendency to chronological age exceeding biological (skeletal) age. In the age group 10-11, 50% male subjects show CVMS I and the other 50% CVMSII respectively. Large discrepancy was found in the group aging from 12-13. At this stage, 10% boys showed CVMS I, 70% CVMS II and only 20% CVMSIII respectively. At the next age groups, similarity between chronological and skeletal age was increased, in the group aging from 14-15, 50% boys showed CVMS III and 50% CVMS IV. In the group aging from 16-17, 80% of male examinees showed CVMS V, and only 20% CVMS IV. These results are in accordance to the results of similar examinations

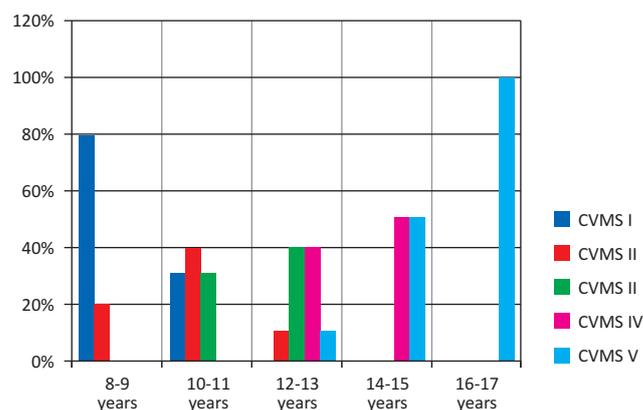


Figure 3.  
Distribution of CVMS according to age group among female examinees (N=50)

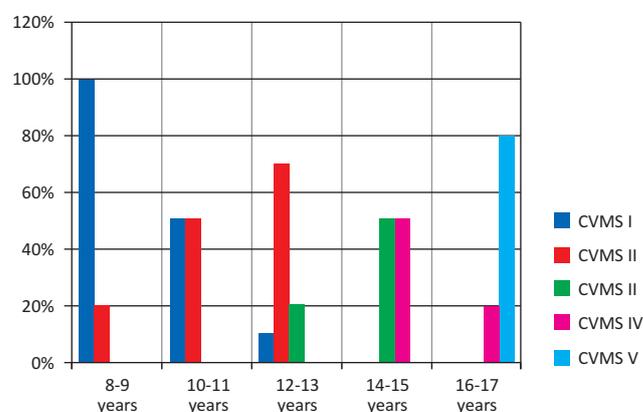


Figure 4.  
Distribution of CVMS according to age group among male examinees (N=50)

among Saudi boy. They concluded that boys achieve their skeletal maturity later than is their chronological age [12].

Orthodontic management of skeletal discrepancies often includes growth modification therapy. Correction of skeletal discrepancies and treatment prognosis are strongly influenced by growth, and it is crucial to know the stage of growth and development in orthodontic patients. Cervical vertebral analysis is valid as the hand wrist bone analysis, with advantage of reducing the radiation exposure of examinees still growing. When CVMS I diagnosed in the individual patient with mandible deficiency, the clinician can wait at least one additional year for a radiographic reevaluation aimed to start treatment with a functional appliance. CVMS II represents the ideal stage to begin functional orthopedics [4, 10].

## Conclusion

On the basis of the results of this study, we can conclude that the chronological age is not an accurate indicator of developmental status of orthodontic patients. Determination of cervical vertebrae maturity provides reliable data about actual biological age of the orthodontic patients. The advantage of CVM method is in the elimination of additional radiation exposure for orthodontic patients, because lateral cephalograms are routinely used in daily orthodontic praxis.

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# CARIES PREVALENCE IN BOSNIA AND HERZEGOVINA SCHOOLCHILDREN – FINDINGS OF FIRST NATIONAL SURVEY

UČESTALOST KARIJESA KOD ŠKOLSKE DJECE U BOSNI I HERCEGOVINI - REZULTATI PRVOG NACIONALNOG ISTRAŽIVANJA

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## ABSTRACT

The World Health Organization (WHO) recommends conducting periodic national oral health surveys. Similar research was conducted in some parts of Bosnia and Herzegovina's territory.

**Objective.** The objective of this research was to investigate and present the oral health status of six-year and twelve-year old children in Bosnia and Herzegovina according to the WHO indicators.

**Methods.** The research was conducted using the model of observational, descriptive (cross-sectional) study. The examinations were carried out in the period from April to July 2004. The survey was performed in nine cities throughout Bosnia and Herzegovina, namely: Sarajevo, Banja Luka, Sanski Most, Tuzla, Visoko, Gorazde, Vitez, Siroki Brijeg and Mostar. A total of 1,120 six- and twelve year old children were examined. The dental examinations were carried out in schools according to the WHO criteria.

**Results.** In 12-year-olds the DMFT was 4.16 (S.D.± 2.92), out of which decayed teeth constituted the major part of the index (45.43%), followed by 42.07% of filled teeth and 12.50% of extracted teeth. In 6-year-olds the dmft was 6.71 (S.D.± 3.89), out of which decayed teeth constituted the major part of the index (88.79%), followed by extracted teeth (8.89%) and a small percentage of filled teeth (2.32%).

**Conclusions.** The imperative is to develop and implement a disease prevention program, based on education of parents and care providers, as well as to improve access to dental care and shift focus from curative to preventive procedures.

**Key words:** Oral health, schoolchildren, DMFT, dmft.

## SAŽETAK

Preporuka Svjetske zdravstvene organizacije (SZO) za sve zemlje je da se vrše periodična nacionalna epidemiološka istraživanja stanja oralnog zdravlja. Slična istraživanja su provedena sporadično u pojedinim dijelovima Bosne i Hercegovine. Jedinstvenog nacionalnog istraživanja nije bilo.

**Cilj.** Cilj istraživanja je bio da se ispita stanje oralnog zdravlja djece uzrasta 6 i 12 godina u Bosni Hercegovini prema kriterijima koje propisuje SZO, da se utvrde i prezentiraju indikatori oralnog zdravlja za ispitivane skupine.

**Metode.** Istraživanje je provedeno kao opservaciona, deskriptivna, epidemiološka studija, izvedena u periodu april-juli 2004 godine. Istraživanje je provedeno u devet bosansko-hercegovačkih gradova: Sarajevo, Banja Luka, Sanski Most, Tuzla, Visoko, Gorazde, Vitez, Siroki Brijeg i Mostar. Ukupno je ispitano 1120 ispitanika uzrasta 6 i 12 godina. Ispitivanja su vršena u školama prema metodologiji SZO za ovakvu vrstu istraživanja.

**Rezultati.** Vrijednosti KEP indeksa za ispitanika uzrasta 12 godina iznosile su 4.16 (S.D.± 2.92), od čega je u najvećem procentu zastupljena komponenta karijesa (K) sa 45.43%, zatim slijede plombirani zubi (P) sa 42.07% i zubi ekstrahirani kao posljedica karijesa (E) sa 12.50%. Kod ispitanika uzrasta 6 godina kep indeks bio je 6.71 (S.D.± 3.89), kariozni zubi su zauzimali najveći procenat od 88.79%, zatim su slijedili ekstrahirani zubi(e) sa 8.89% i veoma mali procenat plombiranih zuba (p) od 2.32%.

**Zaključak.** Kreiranje i uspostavljanje preventivnih programa za spriječavanje nastanka najučestalijih dento-oralnih oboljenja u dječijem uzrastu, je imperativ u našoj zajednici. Ovi programi moraju biti bazirani na edukaciji roditelja i staratelja, na poboljšanju dostupnosti zdravstvenoj zaštiti, te na usmjeravanju cijelokupnog sistema zdravstvene zaštite sa liječenja posljedice bolesti na prevenciju nastanka oboljenja.

**Ključne riječi:** oralno zdravlje, školska djeca, KEP, kep.

## Introduction

Oral health is an essential element of general health. It encompasses the integrity and health of specific parts of the oral cavity - teeth, oral mucosa, masticatory muscles, tongue, TMJ and salivary glands - which are used jointly to perform the functions of chewing, speaking and swallowing. The World Health Organization (WHO) recommends conducting periodic national oral health surveys including monitoring of ten oral health parameters by precisely defined age groups [1]. Most European countries conduct the above surveys. Thereby, obtained data enables planning of measures on improving oral health of the population of relevant countries. Similar research was conducted only in some parts of Bosnia and Herzegovina's territory. Ivankovic in 1997 carried out research in several cantons of the Federation of BH, in the West Herzegovina Canton, Herzegovina-Mostar Canton and the Posavina Canton pointed average DMFT ( $\pm$ SD) to  $6.2 \pm 4.0$  in twelve-year-olds while in six-year-olds it was  $4.8 \pm 3.9$  [2]. The above research conducted in BH indicates a poor state of oral health in our country, especially among children. Epidemiological data about the oral health status missing in our country are prerequisite for developing a program and measures for the improvement of oral health. Because of the above, it was necessary to conduct a study to gather epidemiological data about the oral health in Bosnia and Herzegovina.

## Objective

The objective of this research was to investigate and present the oral health status of six-year and twelve-year old children in Bosnia and Herzegovina according to the WHO indicators and to discuss oral health care system approaches in different locations of examination.

## Methods

The research was done using the model of observational, descriptive (cross-sectional) study. The examinations were carried out in the period from April to July 2004. Methodology was based on the WHO recommendations for this type of surveys [1]. Two

age groups, six and twelve year olds, were included by the research. Six-year-olds were targeted in order to determine the status of primary teeth, which is proven to be an important predictor of the permanent teeth health. Twelve years age is of extreme importance and has been recommended by WHO as the age of the earliest permanent dentition, when all teeth other than third molars are present in the oral cavity. The condition of twelve-year-olds' permanent teeth determines their future oral health, being the reason for this group to be selected for international comparisons and observation of disease trends. The survey was performed in ten cities throughout Bosnia and Herzegovina, namely: Sarajevo, Banja Luka, Sanski Most, Tuzla, Visoko, Gorazde, Vitez, Siroki Brijeg and Mostar. A total of 1,120 children were examined (560 twelve-year-olds and 560 six-year-olds). Selection of locations and dental examinations were done according to the WHO criteria for countries with high caries prevalence. The dental examinations were carried out in schools according to WHO criteria under natural light using dental mirrors and the periodontal probe. Clinical examinations to record dental caries were carried out in schools by one examiner. The examiner had been previously trained on 25 twelve-year-olds to use DMFT index. Kappa statistics was used to present intra-examiner reliability [1]. The kappa values estimated from repeated examination for the intra-consistency of the fieldwork examiner were  $k=0.91$ . Obtained results were recorded on special oral health assessment form, prescribed by the WHO for this type of research.

The Statistical Package for Social Science, version 13.0 (SPSS Inc., Chicago, IL, SAD) was used. Research results were analyzed by means of descriptive statistic

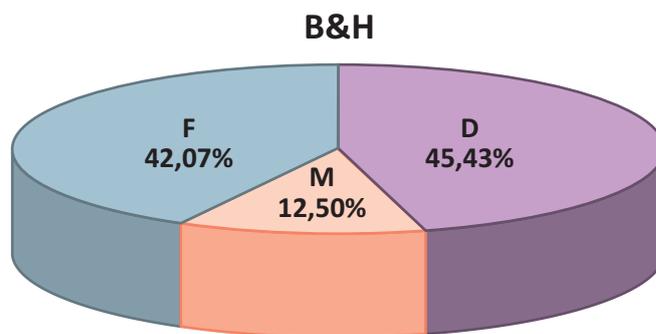
(Frequencies, percentages, arithmetic mean value, standard deviation) following the WHO guidelines for presenting results of survey for this population groups [1].

## Results

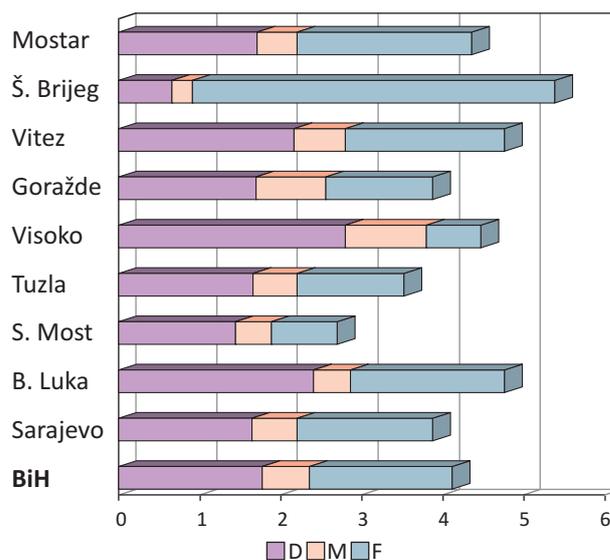
The study of caries prevalence has shown that the disease is wide-spread among twelve and six year old children in Bosnia and Herzegovina. Gender based differences were not analyzed in this survey. In 12-year-olds the DMFT was 4.16 (S.D. $\pm$  2.92) out of which the D-component constituted the major part of

the index (45.43%), followed by 42.07% of filled teeth and 12.50% of extracted teeth (**Figure 1.**). Percentage of children without active decay was 36.54%. In different locations recorded DMFT was ranging from 2.70 (S.D.± 2.25) in Sanski Most to 5.38 (S.D.± 2.76) in Siroki Brijeg, but average value for DT component of index was the lowest in Široki Brijeg (0.88±0.80) while the FT component was highest (4.33±2.34) for the same location. In Sanski Most with the average values for component DT were 1.53 ±1.57 and FT 0.68 ±1.44. The highest percent of children without active caries lesions (DT=0) was recorded in Široki Brijeg (60%), followed by Mostar (41.46%), Sarajevo (41.24%) Sanski Most (37.50%), Tuzla and Goražde (32.50 %), Banja Luka (31.25%) , Vitez (30 % ) and Visoko with only 17.50% were DT component was 65.73 % of DMFT, FT component was 14.04% and ET with 20.22%. This kind of distribution reveals the fact that in this cities both preventive and curative dental care is insufficient. There were 60% children without active caries in Široki with FT component of index 80.47% followed by DT component with 16.28% and ET only 3.26%. This distribution revealed that curative dental care is developed in Široki Brijeg but there is a lack of preventive care. Results for all examined locations are presented in **Table 1.**

Different values of DMFT and its components were registered in different survey locations (**Table 1. Figure 2.**).



**Figure 1.**  
Percentages of DMFT components for twelve-year-olds BH children.



**Figure 2.**  
DMFT index of twelve-year-olds in Bosnia and Herzegovina and by cities.

	dmft index	d (%) X±SD		m (%) X±SD		f (%) X±SD	
Sarajevo	3.90 ±2.88	43,91	1.71±2.21	12,66	0.49±0.84	43,43	1.69±2.11
B. Luka	4.79 ± 2.87	50,91	2.44±2.72	10,44	0.50±0.95	38,64	1.85±1.99
S. Most	2.70 ± 2.25	56,48	1.53±1.57	18,52	0.50±0.87	25,00	0.68±1.44
Tuzla	3.51 ± 2.63	46,26	1.63±1.71	16,37	0.58±0.88	37,37	1.31±1.89
Visoko	4.45 ± 2.65	65,73	2.93±2.48	20,22	0.90±1.09	14,04	0.63±1.22
Goražde	4.03 ± 3.13	45,96	1.85±2.10	16,77	0.68±0.96	37,27	1.50±2.27
Vitez	4.85 ± 2.99	45,36	2.20±2.54	11,34	0.55±0.71	43,30	2.10±1.83
Š. Brijeg	5.38 ± 2.76	16,28	0.88±1.54	3,26	0.18±0.38	80,47	4.33±2.34
Mostar	4.32 ± 2.96	42,37	1.83±2.83	9,04	0.39±0.82	48,59	2.10±1.88

**Table 1.**  
DMFT index and its components of twelve-year-olds in Bosnia and Herzegovina in different survey locations.

In 6-year-olds the dmft was 6.71 (S.D.± 3.89) out of which the dt-component constituted the major part of the index (88.79%), followed by extracted teeth (8.89%) and a small percentage of filled teeth (2.32%) (Figure 3). Percentage of caries free participants aged six was 6.8% The highest mean value of dmft was recorded in Goražde 8.58 ±3.20, followed by Banja Luka 7.06 ±4.02, Visoko 6.9 ±3.27, and the lowest was in Mostar with 5.05 ±2.95. Mean values of dmft for other locations were in between this range. The highest mean value of component dt was in Goražde 7.90 ±3.38, and the lowest was in Mostar 3.95 ±2.75. Mean values of components et and ft were less than 1 for all locations revealing that dental care is insufficient in primary dentition. When analyzing descriptive statistics for this group of examinees, it was obvious that dt component was dominant, making more than 80% of dmft in all examined locations. Percentage of ft was very low with the highest value in Mostar (11,35%), but with no filled primary teeth registered in Gorazde and Široki Brijeg. Values for registered extracted teeth (et) ranged from 6.73% in Banja Luka to 15% in Široki Brijeg, meaning that in all locations primary teeth were rather extracted than filled if they had been treated at all.

In the group of 6 -year-olds first permanent molars were analyzed as well. In this group 81.7 % of examinees (N=455, mean 3.63 ±0.95 ) had all four FPM erupted in the time of dental status recording.

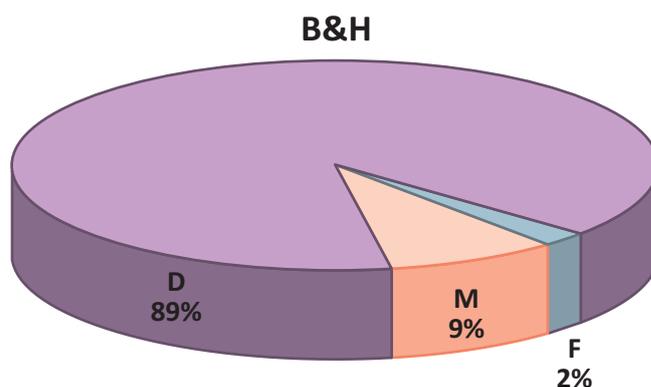


Figure 1. Percentages of DMFT components for twelve-year-olds BH children.

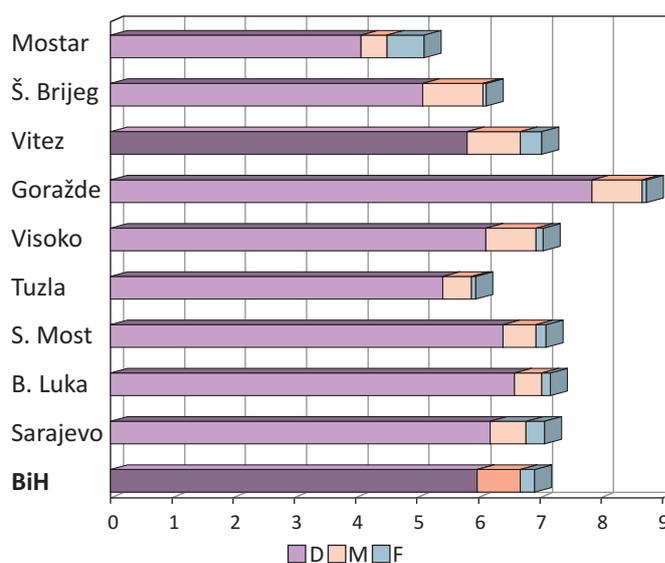


Figure 4. dmft index and its components in Bosnia and Herzegovina and by cities

	dmft index	d (%) X±SD		m (%) X±SD		f (%) X±SD	
Sarajevo	6,90 ± 4.17	89,31	6.17±4.20	7,16	0.48 ± 1.40	3,55	0.73 ± 0.50
B. Luka	7,06 ± 4.02	91,86	6.49±3.98	6,73	0.48 ± 0.90	1,42	0.40 ± 0.40
S. Most	6,87 ± 4.12	91,94	6.33±4.22	7,33	0.49 ± 1.21	0,73	0.32 ± 0.50
Tuzla	5,88 ± 3.92	90,21	5.30±3.91	9,15	0.54 ± 1.36	0,64	0.19 ± 0.21
Visoko	6,88 ± 3.27	88,00	6.15±3.07	11,64	0.78 ± 0.90	0,36	0.15 ± 0.24
Goražde	8,63 ± 3.20	92,17	7.90±3.38	7,83	0.69 ± 1.52	0,00	0,00
Vitez	7,00 ± 3.81	82,50	5.64±3.59	13,57	0.98 ± 1.47	3,93	1.69 ± 0.26
Š. Brijeg	6,08 ± 3.34	84,36	5.36±3.09	15,64	0.90 ± 1.56	0,00	0,00
Mostar	5,05 ± 2.95	79,21	3.95±2.75	9,41	0.50 ± 1.33	11,39	2.18 ± 0.35

Table 2. dmft index and its components of six-year-olds in Bosnia and Herzegovina in different survey locations.

Mean value of DMFT for FPM was  $0.61 \pm 1.08$  with highest value recorded in Goražde  $1.33 \pm 1.30$ , and the lowest value was in Banja Luka  $0.31 \pm 0.73$ . Mean values for other locations were within this range. Mean values of DMFT components for FPM in all examined locations were less than 1. Results of statistical analyzes for DMFT/dmft values and treatment needs between different locations were published in previous paper [3,4].

Different values of dmft and its components were registered in different survey locations (**Table 2. Figure 4**).

## Discussion

The 2004 value of DMFT index for twelve-year-olds in Bosnia and Herzegovina was 4.16 out of which the D-component constituted the major part of the index (45.43%), followed by filled teeth (42.0%) and a smaller percentage or 12.57% of extracted teeth.

When the above values are compared with DMFT index of the twelve-year-old children in the former Yugoslavia Register in 1985, which was 6.3 [5], and the results of the study conducted in some parts of Bosnia and Herzegovina which established the DMFT value of 6.1 [2], it becomes obvious that the oral health has significantly improved. It is difficult to explain the reasons for this improvement because all measures taken had been limited to local level. However, one of the possible explanations might be that this study used WHO methodology for caries diagnosis under which decayed teeth do not include teeth affected by changes preceding clinically detectable enamel lesions or conditions similar to the early stages of caries. Other explanation could be that the use of CPI periodontal probe lowers the number of diagnosed caries lesions. Based on the established decrease in caries prevalence in highly industrialized countries, Kunzel points to the existence of two European regions. West European region (low risk countries) with average DMFT index of 1.7 and 40% of twelve-year-olds without decayed teeth and East European region (high risk countries) with DMFT index of 4.1 and 10% of twelve-year-olds without decayed teeth [6]. It is obvious that BH is a country with high caries prevalence. WHO Oral health database for DMFT of 12-year-olds shows similar results for neighbouring countries such as Croatia 4.9, Serbia

7.8, Former Yugoslav Republic Macedonia 3.0 and Albania 3.1 [7]. A survey conducted in eight European countries (Belgium, Germany, Greece, Ireland, Italy, Scotland, Spain and Sweden) revealed that DMFT among twelve-year-olds varies from between 1.07 in Spain and 2.58 in Germany [8,9]. The values of DMFT in non-European countries also vary standing at 3.24 in Mexico [10] and 2.4 at Philippines [11]; the value registered in Israel is 1.66 [12], while the lowest values of 0.64 and 0.1 was recorded in Nicaragua [13] and India [14] respectively. The trend of increased DMFT index values was registered in some transitional countries, precisely in Czech Republic, Slovakia and Lithuania [7]. Although DMFT index for our country is decreasing, it is still far below the average 2.78 DMFT index value for the European region established by the WHO based on surveys conducted in 48 European countries in the 1996-2000 period [7].

DMFT index values by separate survey locations (Table 1) also revealed differences, with the highest values registered in Široki Brijeg (5.38) and Vitez (4.85) and the lowest in Sanski Most (2.70). However, proportional representation of separate DMFT index components (Decayed, Missing, Filled Teeth) also points to different approaches to dental protection. Data provided in the table indicates that the dental protection in Široki Brijeg is well organized but based on curative procedures supported by the fact that filled teeth constitute 80.47% and extracted teeth only 3.26% of the index. It is also obvious that untreated decayed teeth constitute 65.73% and extracted teeth 20.22% of the DMFT index in Visoko.

Among five-year-olds in eight European countries dmft index varies from between 0.8 in Sweden to 3.06 in Scotland [9]. The 2004 dmft index in 6-year-olds in Bosnia and Herzegovina was 6.71 out of which the d-component constituted the major part of the index (88.79%), followed by extracted teeth (8.89%) and a small percentage of filled teeth (2.32%). In the former Yugoslavia in 1986, the dmft index for the same age group was 7.4 [4] and in Bosnia and Herzegovina, according to Ivankovic's study, it was 4.8 in 1997 [2]. This shows that the dmft index for primary teeth varies. Comparisons of dmft index values by separate survey locations again reveal differences, with the highest values registered in Gorazde (8.63), Banja Luka (7.06) and Vitez (7.00) and the lowest in Mostar (5.05). As the results for Bosnia and Herzegovina show that decayed, missing and filled teeth constitute

88.79, 8.89 and 2.32 of the dmft index respectively, we can conclude that the care for primary teeth in our country is neglected. The pattern of proportional share of specific components of dmft index (decayed, missing, filled teeth) is the same in entire Bosnia and Herzegovina. Demographic features related to oral health indices were analyzed and published in previous articles [3,4]. Comparing those results with analyzing descriptives in this paper, we can conclude that despite of statistic significant differences between locations there are no satisfactory results for oral health in any of examined cities. Preventive and treatment dental care is the same and equally poor throughout the country. Having in mind that previous caries experience is considered as very serious and reliable predictor of future caries development [15], it is urgent to develop new approaches to dental care in the country.

When the results of research conducted so far in BH are compared with those obtained in other European countries it is easy to conclude that the oral health of our six and twelve year old children is in a dramatic state. There are probably numerous reasons for that, but most importantly, the difference is due to absence of oral disease prevention and oral health promotion programs in BH which are standard in most developed European countries with well-organized system of dental care.

## Conclusion

Results of national survey for two monitoring children population groups revealed insufficient preventive and curative dental care in entire Bosnia and Herzegovina. The imperative is to develop and implement a disease prevention program, based on education of parents and care providers, as well as to improve access to dental care and shift focus from curative to preventive procedures.

It is necessary to set realistic goals for improvement of oral health, which can be implemented within desired time frame, as well as to precisely define measures to be taken. Our national goals must be less ambitious than are those currently promoted by WHO and FDI, because oral health of our children is poorer than that of the children in most other European countries.

## Acknowledgements

Federal Ministry of Education has approved the study, while the Ministry of Education of the Canton Sarajevo provided funding. Ethical approval has been provided by Ethics Committee of Faculty of Dentistry in Sarajevo.

## Declaration of interest

All authors clearly state that there is no conflict of interest for any person or institution included in this research project.

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# PRESENCE OF CANDIDA SPECIES IN SUPRA-GINGIVAL DENTAL PLAQUE AND CARIOUS DENTINE AT CHILDREN WITH EARLY CHILDHOOD CARIES

PRISUSTVO CANDIDA VRSTA U SUPRA-GINGIVALNOM DENTALNOM PLAKU I KARIOZNOG DENTINU KOD DJECE S KARIJESOM RANOG DJETINJSTVA

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## ABSTRACT

**Aim:** The aim of this study was to assess the presence of *Candida* spp. in different stages of early childhood caries development, with special emphasis on the dentin matrix invasion and destruction momentum.

**Methods:** The sample for this study comprised of sixty-one 3-6 years old children. Control group consisted of 30 caries free children, whereas experimental group consisted of 31 patients, diagnosed with advanced early childhood caries (ECC).

Plaque was collected from surfaces of intact enamel both from caries free and from children with caries. From the later group plaque was also collected from the surfaces of white-spot lesions. Two dentine samples were also obtained: sample of necrotic dentin from the central part of the lesion and a sample of partially demineralised dentin from the advancing front of lesion.

Microbiological analysis of samples was done by cultivation using Sabouraud agar and API identification systems (API *Candida*)

**Results:** *C. albicans* was predominant species; *C. krusei* and *C. galabrata* were also identified in samples of ECC affected children. In plaque samples, *Candida albicans* was found in 10% of caries free children. In children with ECC *Candida albicans* was found in 16,1% of intact enamel plaque samples, 22,6% of white spot lesion plaque samples, in 61,3% of necrotic dentin samples and 48,3% of partially demineralised dentin samples.

**Conclusion:** This study showed that there is an association of *Candida albicans* with the development of early childhood caries, which suggests that it has an important role in its aetiology.

**Key words:** *Candida albicans*, *Candida* species, early childhood caries, children

## SAŽETAK

**Cilj** istraživanja je bio ispitati učestalost *Candida* specijesa u različitim stadijima razvoja lezije karijesa ranog djetinjstva, s posebnim naglaskom na momenat invazije i destrukcije dentinskog matriksa.

**Metod:** Istraživanje je realizirano na uzorku od 61 (šezdeset jednog) ispitanika od tri do šest godina. Kontrolnu grupu činilo je 30 pacijenata s intaktnom denticijom, a eksperimentalnu grupu, koja je brojala 31 pacijenata, djeca sa uznapredovalim karijesom ranog djetinjstva.

Uzorci supragingivalnog plaka sakupljeni su sa intaktne cakleni kontrolne i eksperimentalne grupe, te sa kredasto-bijele lezije djece sa karijesom. Također su uzeti uzorci karioznog dentina centralne nekrotične zone i djelomično demineraliziranog dentina iz napredujućeg dijela lezije.

Mikrobiološka analiza uzoraka vršena je: kultivacijom na Sabouraud agaru, te identifikacijom specijesa na API *Candida* sistemu.

**Rezultati:** *C. albicans* je bila dominantan specijes u svim uzorcima, dok su *C. krusei* i *C. galabrata* izolirane samo u uzorcima karijesne lezije. U uzorcima plaka zdrave djece *C. albicans* je identificirana u 10% uzoraka, intaktne cakleni eksperimentalne grupe u 16,1%, a plaka bijele mrlje u 22,6% uzoraka. U uzorcima nekrotičnog dentina učestalost je bila 61,3%, te 48,3% u djelomično demineraliziranom dentinu.

**Zaključak:** Studija je pokazala da postoji asocijacija *Candida* specijesa, posebno *Candida albicans*, s razvojem karijesa ranog djetinjstva, što sugerira da ona ima važnu ulogu u njegovoj etiologiji.

**Gljučne riječi:** *Candida albicans*, *Candida* species, karijes ranog djetinjstva, djeca

## Introduction

*Candida* species are common commensals of the mouth, which, under certain circumstances can opportunistically overgrow and cause acute or chronic forms of oral candidiasis, and furthermore, can spread through the bloodstream or upper gastrointestinal tract leading to systemic infection.

*Candida* spp. is able to colonize several surfaces of the oral cavity including the tongue, palate, buccal mucosa and hard surfaces of teeth. These species can be included among the components of dental plaque and are present in saliva [1].

A number of factors may cause the presence of *Candida* spp. in the mouth: birth infection, maternity hospital, bottle feeding, infected pacifiers, maternal skin, air, water and carious lesions [2]. Although *Candida albicans* is the most frequent fungal species in humans, other *Candida* species are also considered to be of clinical interest, such as: *C. tropicalis*, *C. krusei*, *C. parapsilosis*, *C. dubliniensis*, *C. glabrata* and *C. lusitaniae* [3]. In recent years, correlation between high prevalence of *Candida* spp. in supra-gingival plaque and the development of carious lesions became a subject of an increasing interest of clinical and microbiological research. A certain number of these studies have attempted to establish the significance of *Candida* spp. in the aetiology of early childhood caries (ECC), which is a chronic infectious oral disease with an early onset and rapid progression affecting toddlers and young preschool children.

A study by Marchant et al. demonstrated the frequency of *C. albicans* isolation of 89% in carious dentin of ECC, and at the same time, only 7% in biofilm of caries free children [4].

Similarly, a study of Akdeniz et al (2002) found that 69 % of children with caries and 5% of caries-free children were found to be *Candida* carriers [5].

According to the findings of de Carvalho et al., high frequencies of *Candida* spp. in supragingival plaque and dentine caries lesions in children with early childhood caries were recorded. In plaque samples *C. albicans* was present in 50% samples, *C. tropicalis* in 16.7% and *C. krusei* in 4,2%, whereas in dentine samples these species were identified in 70,8%, 4,2% and 8.3% samples respectively [6].

Ghasempour M et al, in their study performed in order to determine prevalence of *C. albicans* in dental

plaque and carious dentine of proximal and cervical lesions of early childhood caries, reported that this yeast was present in 20% of plaque samples and 60% of dentine samples of proximal lesions and in 80% plaque and 100% of dentine of cervical lesions as opposed to only 15% presence in plaque of caries free children [7].

In addition to studies reporting the frequency of occurrence of *Candida* spp. in plaque and infected dentine of ECC, some in vitro studies are revealing other possible cariogenic properties of these yeasts.

Back in 1986, results of the study of Samaranayake LP et al. showed large amount of acid production of oral isolates of *Candida albicans* and *Candida glabrata* in glucose supplemented saliva, mainly pyruvates and acetates, which lowered the pH of saliva down to a value of 3.2 [8]. Nikawa et. Al. demonstrated that *C. albicans* possesses the ability to dissolve HAP to a greater extent (approximately 20-fold) when compared with *S. Mutans* [9]. Additionally, in the study of Kinke et al., *Candida albicans* showed high acid tolerance secreting acid in significant quantities at pH 4.0, in contrast to acidification by *S. Mutans* which ceased at pH 4.2 [10].

Also there is strong evidence that *C. albicans* might favour the in vitro adherence of *S. mutants* in the dental biofilms, thus favouring its colonization [11].

The aim of this study was to assess the presence of *Candida* spp. in different stages of early childhood caries development, with special emphasis on the dentin matrix invasion and destruction momentum.

## Materials and methods

The sample in this study consists of 61 (sixty-one) children, aged three to six years, regular patients of the Clinic of Children and Preventive Dentistry, Faculty of Dentistry Sarajevo. Of the total number of patients control group comprised 30 caries free children (dmft = 0). The experimental group consisted of 31 patients, diagnosed with early childhood caries according to AAPD criteria [12]. The parents of patient received information about the objectives of the investigation and signed information consent form.

Inclusion criteria were: good general health, cooperative patient and presence of at least one carious lesion extending to the inner half of the dentine layer.

Children did not take antibiotics at least two weeks before study, nor were they treated with fluoride during the same period. All clinical work and samplings were done by one investigator.

Clinical examination for each child was performed in order to establish caries status, after which 24-hour-old supra-gingival plaque was harvested. To be able to do that, parents were instructed not to brush their children's teeth the night before examination. Children additionally refrained from taking any food and drink in the morning prior to plaque samples collection. Samples were pooled from a minimum of three sites (occlusal, vestibular, palatal), including anterior and posterior teeth using sterilized excavator. Plaque was collected from surfaces of intact enamel, both from caries free and from children with caries. From the later group, plaque was also collected from surfaces of white-spot lesions. Each sample was suspended in a sterile tube containing 1000µl sterile saline solution.

For the experimental group of children, two samples of carious dentin were also obtained. First of them, necrotic dentin sample, was collected at the centre of the lesion with sterilized small excavator. The second sample of partially demineralised dentin from the advancing front of lesion was collected with another sterile excavator, after all necrotic dentine from the cavity walls and most of it over the pulp was excavated by a sterile burr. Following sampling, remaining infected dentin was removed; cavity was lined with calcium hydroxide and restored with glass ionomer cement. Prior to cavity preparation local anaesthesia was administered.

Dentine samples were suspended in sterile tubes containing 5ml of Thioglycollate Broth and together with the plaque samples transported immediately to laboratory for microbiology analysis. Sabouraud agar was used as the primary culture medium.

Plaque samples in sterile saline solution were stirred using vortex mixer and spread on Sabouraud agar plates the same day, whereas dentine samples were incubated in Thioglycollate Broth at 37°C for 24 h prior to inoculation [6].

Inoculated plates were incubated for 48 hours at 37°C. Further species identification was done by means of Api Candida identification system (API 20C AUX, bioMérieux). The Api Candida consists of 10 tubes containing dehydrated substrates which enab-

le performance of 12 identification tests mostly relying on sugar acidification or enzymatic reactions. The strips are read after 24 and 48 hours of incubation at 30°C. A four digit numerical profile is obtained which is compared with those in a database with 26 yeast species [13].

## Results

A total of 61 children were included in the study. Out of them, control group (caries free children) consisted of 30 children, 14 females and 16 males, mean age of  $60,4 \pm 12,0$  months. Experimental group (ECC) comprised 31 subjects, 15 females and 16 males. Their mean age was  $54,5 \pm 12,7$ . There was no significant difference between the groups in terms of age (T test = 1.936; p = 0,058).

The most prevalent species identified in all of the sampling sites was *Candida albicans*. *C. krusei* and *C. galabrata* were not detected in any of the plaque samples of intact enamel both in control and experimental group, and, additionally, none of the white spot lesion plaque sample harboured *C. galabrata*. (Figure 1.)

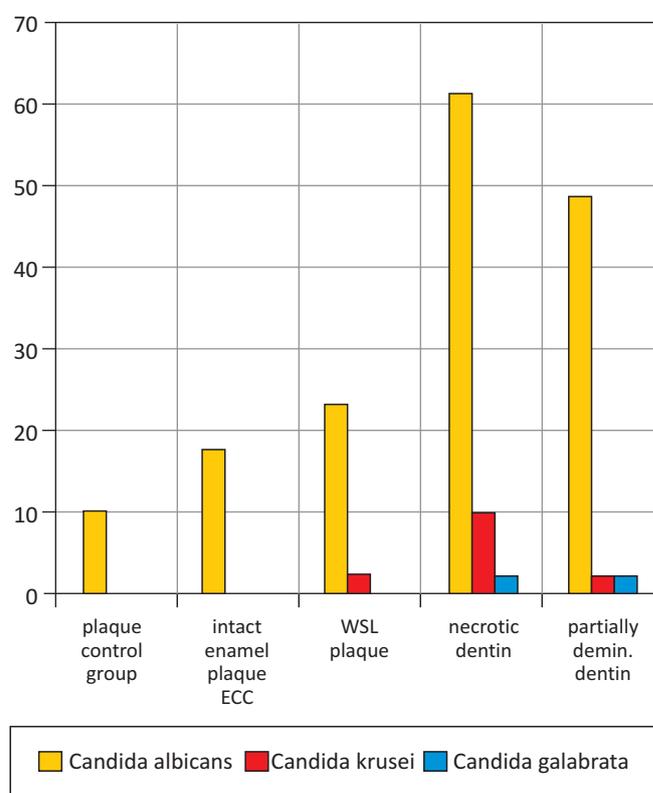


Figure 1.

Frequency of *Candida* species isolation according to sampling site

	GROUP			
	caries free (n=30)		early childhood caries (n=31)	
	%	n	%	n
Candida albicans	10	3	16,1	5 <sup>ns</sup>
Candida krusei	nd	nd	nd	nd
Candida galabrata	nd	nd	nd	nd

<sup>ns</sup> : values did not differ significantly (t test, p>0,05)  
 nd: not detected

**Table 1.**

Frequency of Candida species in supragingival plaque of intact enamel

	GROUP					
	white spot lesion (n=31)		necrotic dentin (n=31)		partially demineralised dentin (n=31)	
	%	n	%	n	%	n
Candida albicans	22,6	7	61,3	19*	48,3	15 <sup>ns</sup>
Candida krusei	3,2	1	9,7	3 <sup>ns</sup>	3,2	1
Candida galabrata	nd	nd	3,2	1	3,2	1

<sup>ns</sup> : values did not differ significantly (t test, p>0,05)  
 nd: not detected

\*: values differed significantly (t test, p<0,05)

**Table 2.**

Frequency of Candida species in plaque and dentin samples of carious lesion

C. albicans was isolated in 10% plaque samples of the control group and in 16,1% plaque samples of the intact enamel of the experimental group. (Table 1.)

The frequency of isolation of C.albicans in white spot lesion plaque, necrotic dentin from central part of the lesion and partially demineralised dentin from advancing part of the lesion was 22,6 %, 61,3% and 48,3% respectively. (Table 2)

The frequency of C.albicans in necrotic dentin was significantly greater than in the white spot lesion plaque (t= 3.303; p=0,002)

## Discussion

During the 80's and 90's of the last century, growing research interest on microflora of ECC was evident. Most of these studies focused on mutants Streptococci and Lactobacillus spp., although other microorganisms were isolated as well.

As previously mentioned, Marchant et al. found a high frequency (89%) of Candida albicans isolation in carious dentin of children affected with ECC [4]. Radford et al. showed in their study that Candida spp. were isolated more frequently from the saliva of infants with caries compared to those who were caries-free (23.7 vs. 10.4%) [14].

Study of de Carvalho et al. reported that Candida species frequency was significantly higher in plaque and dentine samples of children with ECC than in caries free children and in children with common

type of caries. Furthermore, C.albicans was the most prevalent Candida species in ECC group, in which C. krusei and C. tropicalis were also detected, but not in caries free and common caries type group [2]. Ghasempour et. al., determined the presence of C. albicans in 80% samples of plaque of cervical lesions in 2-5 year old children and only in 15% samples of caries free children of the same age. C. albicans was present in all of the dentine samples of cervical lesions (100%) [7]. Strong association of C. albicans and early childhood caries was seen in the study of Srivastava B. et al. Prevalence of the C. albicans was significantly higher in the group of caries affected children with deciduous dentition compared to permanent dentition group [15].

In our study, the frequency of isolation or Candida spp. in supra-gingival plaque and carious dentine samples in children suffering from early childhood caries has been analyzed and compared with those of caries-free children. In plaque samples of intact enamel of both ECC group and caries free children, C. albicans was isolated, but there was no statistical difference in frequency of isolation between groups. C. krusei and C.galabrata were not isolated in neither of the groups. As stated above, in the study of de Carvalho et al., the only Candida species isolated from plaque of caries free children (intact enamel) was C. albicans which is in accordance with our results [2].

Affected enamel plaque samples in our study harboured C. krusei and C. galabrata, whereas C. krusei and C. tropicalis were found in the same samples of de

Carvalho study [2]. This difference might be due to cultivation and identification method.

When analyzing isolation frequency in plaque and dentine samples of established lesion in ECC group (white spot lesion, necrotic dentin from central part of the lesion, partially demineralised dentin from advancing part of the lesion), it was found that the predominant species identified in all samples, again, was *C. albicans*. It is worth noting that significantly higher frequency of *C. albicans* presence was observed in necrotic dentine than in the plaque of the white spot lesion, which suggests that this yeast could have a more important role in the progression of caries lesion, rather than in its initiation.

This could be explained by the fact that *C. albicans* produces collagenolytic enzyme, i.e., has proteolytic activity for type I collagen and can adhere to the intact and denaturated collagen exposed from dentin through different mechanisms [9, 16, 17, 18].

Several other studies showed that *C. albicans* possesses additional capabilities, which may propose its significant role in dental caries pathogenesis.

Cannon RD et al. reported that *Candida* is able to adhere to saliva-coated hydroxyapatite. [19] Salivary component that contains the proline-rich proteins provides receptors for adhesion of *C. albicans* to enamel pellicles [20]. These proteins can be absorbed to streptococcal surfaces and thus enhance the adhesion of *C. Albicans* [21].

It has been shown that culture media that are rich in carbohydrates such as glucose, sucrose and particularly galactose, increase the adherence of *C. albicans* to surfaces [2]. This is clinically important because children affected with ECC are mostly fed with sucrose added milk formulas that contain lactose which degrades to galactose and glucose. This carbohydrate rich diet may lead to increased colonization of *C. albicans*. In addition, due to host defence factors, e.g. immature immune system and not completely established commensal microflora, the infants are more susceptible to opportunistic microorganism colonization in the oral cavity [2].

Taking into consideration these specificities of infant and early preschool age, and already mentioned facts that *Candida* is able to produce acids, dissolve hydroxyapatite and possesses high acid tolerance [8, 9, 10] it is reasonable to speculate that *Candida* can highly contribute to the caries disease process.

## Conclusion

The results of our study on the prevalence of *Candida* spp. in early childhood caries lesions, as well as data presented in recent literature, support the important role of *Candida albicans* in the progression of this disease. Since the role of *C. albicans* in carious process is for certain the result of contribution of the several factors, it is necessary that the association of these factors is investigated in future studies.

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# CARIES RISK IN PATIENTS UNDERGOING ORTHODONTIC TREATMENT

RIZIK KARIJESA KOD PACIJENATA PODVRGNUTIH ORTODONTSKOM TRETMANU

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## ABSTRACT

The risk of tooth decalcification around brackets in orthodontic patients can be reduced by adequate oral hygiene and use of fluoride.

The aim of the study was to evaluate the effect of the applied preventive treatment in patients undergoing orthodontic treatment as well as to detect whether healthy teeth remain intact at the end of the research period.

Clinical examinations encompassed 40 patients with diagnosed malocclusion - started before orthodontic treatment. The examinees were divided in two subgroups (20 examinees in each group). The first subgroup was preventively treated with dental cream (GC Tooth Mousse), and the second subgroup with fluor (Fluorogal - solution with a low concentration of fluoride - 0.05% F). Control group comprised 20 patients. DMFT-index was registered in all examinees (60) before and at the end of orthodontic treatment.

In this study, minimum statistically significant increase in DMFT-index was registered at the end of treatment in both examinees' groups. Statistically significant increase in the DMFT-index was registered in control group, where DMFT-index was 7.40 before initiation of treatment and at the end of orthodontic therapy its value amounted to 8.50.

Caries and decalcification continue to be a serious problem, which has also been presented by high caries rate in our study. Meticulous caries-prophylactic measures such as professional tooth cleaning and fluoridation continue to be decisive factors in prevention caries risk in patients undergoing orthodontic treatment.

**Key words:** caries, orthodontic treatment, prevention

## SAŽETAK

Rizik od demineralizacije zuba oko bravica kod ortodontskih pacijenata može se smanjiti adekvatnom oralnom higijenom i pomoću primjene fluorida.

**Cilj:** Cilj ove studije bio je da se klinički procijeni utjecaj preventivnog tretmana kod pacijenata kod kojih je primijenjen ortodontski tretman, kao i to da li zubi koji su bili zdravi ostaju netaknuti na kraju ispitivanog perioda.

Klinička ispitivanja su obuhvatila 40 pacijenata sa dijagnosticiranom ortodontskom anomalijom prije početka ortodontskog tretmana. Pacijenti su bili podijeljeni u dvije podgrupe (po 20 u svakoj grupi). Prva podgrupa je bila preventivno tretirana sa dentalnom kremom (GC Tooth Mousse), a druga podgrupa sa fluorom (Fluorogal - rastvor sa niskom koncentracijom fluora - 0,05% F). Kontrolnu grupu je sačinjavalo 20 pacijenata. DMFT-indeks bio je registriran kod svim ispitanika (60) prije i na kraju ortodontskog tretmana.

U ovoj studiji, kod ispitanika obje grupe (preventivno tretirane u toku ortodontskog tretmana) bio je registriran minimalni, statistički značajani porast DMFT-indeksa na kraju ortodontskog tretmana. Statistički značajan porast DMFT-indeksa dobili smo u kontrolnoj grupi u kojoj je prije početka tretmana DMFT-indeks bio 7,40, dok je na kraju ortodontske terapije DMFT-indeks porastao na 8,50.

Karijes i demineralizacija i dalje predstavljaju ozbiljan problem kao što smo prikazali pomoću visoke stope karijesa u našoj studiji. Karijes-profilaktičke mjere kao što su profesionalno čišćenje zuba i upotreba fluorida nastavljaju da budu odlučujući faktor u prevenciji karijes rizika kod pacijenata koji su podvrgnuti ortodontskom tretmanu.

**Ključne riječi:** karijes, ortodontski tretman, prevencija

## Introduction

Caries is a reversible multi-factorial process of tooth demineralization and re-mineralization [1]. It's also known as tooth decay or disease where bacterial processes damage hard tooth structure [2]. In orthodontics caries usually occurs on smooth surfaces, affecting 2 to 96% of all orthodontic patients [3]. Increase in caries risk during such treatment is due to several factors, lesions are difficult to locate, lowering of resting pH, increased volume of dental plaque and rapid shift in bacterial flora. Maxillary lateral incisors, maxillary canines and mandibular premolars are the most commonly affected teeth [4]. However, any tooth may be involved and often a number of anterior teeth show demineralization.

The risk of tooth decalcification around brackets in orthodontic patients can be reduced by adequate oral hygiene and use of fluoride. Artun et al. [5] in their research showed that oral hygiene during orthodontic treatment was more effective in reducing enamel decalcification. On the other hand, fluoride therapy allows reduction of enamel demineralization and prevents plaque activity by blocking the bacterial enzyme system. Geiger et al. [6] monitored the effect of fluoride on the formation of white spots in patients with fixed orthodontic appliances. After fixing the brackets to the teeth, patients were recommended a daily use of 0.05% NaF solution for rinsing mouth before sleep. Out of 101 patients, one third had formed a white stain on one or more teeth (of 1567 examined teeth, 117 or 7.5% had an early form of a white spot). The authors concluded that individual local application of fluoride immediately after fixation of the device, showed no positive effect. Patients need to use daily mouth-rinses with fluoride at all times while wearing a fixed orthodontic appliance.

Poor oral hygiene is one of the main problems routinely faced in the orthodontic treatment [7]. Orthodontic appliance creates an environment that provides potential space for bacterial flora. This condition is clinically seen as white spot lesions and cavitations in the most severe cases. It was concluded that fluoride dentifrices could indeed be considered as an efficient preventive method to enhance enamel resistance against the cariogenic challenges during orthodontic therapy [8].

Lot of research has been focused on reducing the occurrence of decalcification during orthodontic

treatment. Researchers have turned their attention toward appliance design, bonding materials, use of fluorides, sealants and improving oral hygiene [9]. Many products have been developed to prevent demineralization of enamel surface, such as phosphor-peptide-amorphous calcium phosphate (CPP-ACP). CPP-ACP can be found in multiple products. Recaldent™ is a unique complex containing amorphous calcium phosphate (ACP) and casein phosphor-peptide (CPP), obtained from milk casein. The preparation is recommended in need for hard tissue re-mineralization. The manufacturer compares the material to "liquid enamel". CPP-ACP complex make a strong binding with a bio-film on teeth and form calcium and phosphate reservoir. They are then incorporated into the surface of enamel and dentine [10]. The effect of GC Tooth Mousse, with CPP-ACP complex is part of the new and modern approach to caries prevention. The CPP-ACP complex contained in Recaldent™ is hence an ideal system for transporting free calcium and phosphate ions, and GC Tooth Mousse, containing this novel active ingredient, is the world's first product for professional use in the dental practice [11]. The proposed anti-cariogenic mechanism of CPP-ACP involves the incorporation of the nano-complexes into dental plaque and onto the tooth surface, thereby acting as a calcium and phosphate reservoir. Studies have shown that CPP-ACP incorporated into dental plaque can significantly increase the levels of plaque calcium and phosphate ions. This mechanism is ideal for the prevention of enamel demineralization as there appears to be an inverse association between plaque calcium and phosphate levels and measured caries experience [12].

The aim of the study was to evaluate the effect of the applied preventive treatment in patients undergoing orthodontic treatment as well as to detect whether healthy teeth remain intact at the end of the research period.

## Materials and methods

Clinical examinations encompassed 40 patients with diagnosed malocclusion - started before orthodontic treatment. The examinees were divided in two subgroups (20 examinees in each group). The first subgroup was preventively treated with dental cream (GC Tooth Mousse), and the second subgroup

with fluor (Fluorogal - solution with a low concentration of fluoride - 0.05% F). GC Tooth Mousse was applied for 5 minutes each day in patients undergoing orthodontic treatment. Control group comprised 20 patients. Selection criteria included ages 12-18 years, healthy and a treatment period with fixed appliance.

DMFT-index was registered in all examinees (60) before and at the end of orthodontic treatment.

Clinical oral health status was measured with a mouth mirror and a blunt probe under clinical lighting, prior to and after drying the tooth surface with compressed air according to the World Health Organization caries diagnostic criteria for epidemiological studies [13]. A tooth was marked as 'decayed' when any of the following was observed: unmistakable cavitations on the occlusal, buccal, or lingual walls of the tooth; a detectable softened floor or wall, or remaining, carious roots; and a filled tooth with signs of caries. Caries occurrence was expressed as the decayed, missing (due to caries), and filled permanent teeth (DMFT) count.

In this study GC Fuji LC was the adhesive used for bonding brackets.

During the laboratory investigation pH in saliva of the subjects was determined before orthodontic treatment (baseline assessment), in all subsequent scheduled controlled examinations (after one, three, six and twelve months) and after orthodontic treatment.

## Results

The results of our clinical examinations are presented in tables (1-10) and figures (1-2). There were no statistically significant differences according to sex between the groups (Kruskal Wallis ANOVA:  $H=0.131$ ,  $p=0.365$ ). Male and female examinees were equally represented and hence, influence of the sex on the obtained results was eliminated (**Table 1**).

Student's t - test for dependent samples in examinees treated with preventive dental cream (GC Tooth Mousse) showed a statistically significant difference between mean values of DMFT-index before and after orthodontic treatment ( $t= -4.702$ ;  $df=19$ ;  $p=0.000155$ ) (**Table 2**).

Student's t - test for dependent samples in examinees treated with preventive fluor solution (Fluoro-

Examined groups	Male	Female	n
Treatment with GC Tooth Mousse (I)	9 (45%)	11 (55%)	20 (100%)
Treatment with Fluorogal (II)	10 (50%)	10 (50%)	20 (100%)
Control group	10 (50%)	10 (50%)	20 (100%)
n	29	31	60

**Table 1.**  
Distribution of participants according to sex

DMFT-index	mean	sd	p
Before treatment	6,45	4,23	0.000155*
After treatment	7,50	4,41	

\*statistically significant differences

**Table 2.**  
Values of DMFT-index in subjects treated with GC Tooth Mousse

DMFT-index	mean	sd	p
Before treatment	7,10	4,14	0.00038*
After treatment	8,30	3,88	

\*statistically significant differences

**Table 3.**  
Values of DMFT-index in subjects treated with Fluorogal

DMFT-index	mean	sd	p
Before treatment	7,40	4,06	0.00015*
After treatment	8,50	4,08	

\*statistically significant differences

**Table 4.**  
Values of DMFT-index in control subjects

gal) showed a statistically significant difference between mean values of DMFT-index before and after orthodontic treatment ( $t= -5.338$ ;  $df=19$ ,  $p=0.000038$ ) (**Table 3**).

Student's t-test for dependent samples in control subjects (**Table 4**) showed a statistically significant difference between mean values of DMFT-index before and after orthodontic treatment ( $t= -5.772$ ;  $df=19$ ;  $p=0.000015$ ).

The analysis of variance (**Table 5 and Figure 1**) showed no statistically significant difference between the groups in relation to DMFT-index before treatment ( $F=0.274$ ;  $p=0.7609$ ). Tukey's HSD (honestly significant difference test) showed differences (not statistically significant), among mean values of DMFT-index in the examined groups before treatment (**Table 6**).

The analysis of variance (**Table 7 and Figure 2**) showed no statistically significant difference between the groups in relation to DMFT-index after treatment ( $F=0.328$ ;  $p=0.7214$ ). Tukey's HSD (honestly significant difference test) showed differences among mean values of DMFT-index in the examined groups after treatment (**Table 8**).

Analysis of variance showed statistically significant higher values of pH at different time in examinees preventively treated with GC Tooth Mousse (Friedman ANOVA:  $\chi^2=89.123$ ;  $p=0.0000001$ ) (**Table 9**).

Analysis of variance showed statistically significant higher values of pH at different time in examinees preventively treated with Fluorogal (Friedman ANOVA:  $\chi^2=82,086$ ;  $p=0,000001$ ) (**Table 10**).

## Discussion

The etiology of cariogenic process is a motive for conducting scientific researches in this field. In time, determination of caries-risk is of great importance in preventive dentistry, in which direction, different methods and procedures are applied DMFT-index, oral hygiene index, quality and quantity of saliva and its buffering capacity. A greater emphasis has been given to the dynamic characteristics of the process of demineralization and re-mineralization taking place on the enamel surface, with the apostrophe on the biological performance of the enamel, and the presence of dental plaque with its metabolites, and electrolyte composition of saliva.

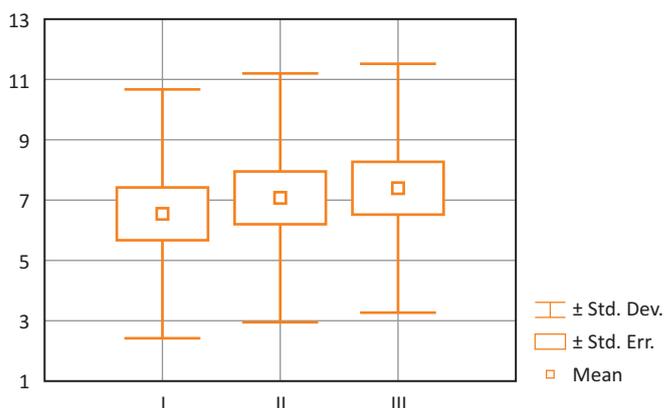
The increase in carious lesions during treatment with fixed orthodontic appliances has been confirmed by other researchers as well. Pancherz and Mulich [14] examined 108 patients for carious lesions before and after orthodontic treatment. They detected new or increased number of carious lesions in 29.4% of the teeth examined. Fluoride is one of the most effective means of preventing tooth decay. The presence of fluoride leads to inhibition of deminerali-

Groups	mean	sd	n
I	6,45	4,23	20
II	7,10	4,14	20
III	7,40	4,06	20

I - brackets bonded with Fuji Ortho™ LC and treatment with GC Tooth Mousse  
 II - brackets bonded with Fuji Ortho™ LC and treatment with Fluorogal  
 III - brackets bonded with Fuji Ortho™ LC (control group)

**Table 5.**

Values of DMFT-index in subjects of I, II and III group before treatment



**Figure 1.**

Values of DMFT-index in subjects of I, II and III group before treatment

Groups	Turkey (HSD) test
I and II	0,8736
I and III	0,7500
II and III	0,9716

\*statistically significant differences

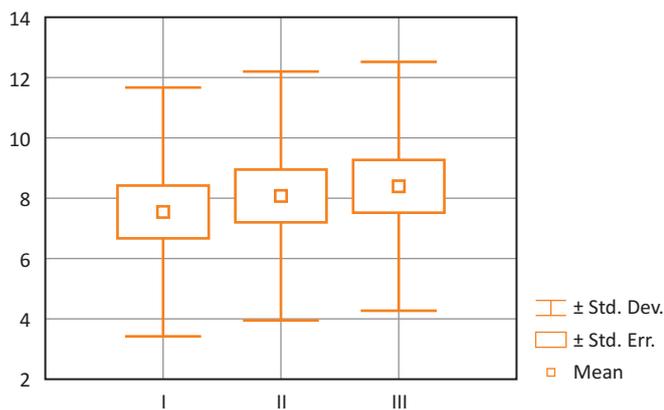
**Table 6.**

Difference between values of DMFT-index before treatment in I, II and III group

Groups	mean	sd	n
I	7,50	4,41	20
II	8,30	3,88	20
III	8,50	4,08	20

**Table 7.**

Values of DMFT-index in subjects of I, II and III group after treatment



**Figure 2.**  
Values of DMFT-index in subjects of I, II and III group after treatment

Groups	Turkey (HSD) test
I and II	0,8139
I and III	0,7254
II and III	0,9872

\*statistically significant differences

**Table 8.**  
Difference between values of DMFT-index before treatment in I, II and III group

**GC Tooth Mousse**

pH	mean	sd	n
Before treatment	6.49	0.050	20
After 1 month	6.51	0.052	20
After 3 months	6.69	0.066	20
After 6 months	6.79	0.095	20
After 12 months	6.81	0.112	20
After treatment	6.80	0.115	20

**Table 9.**  
Values of pH at different time intervals

**Fluorogal**

pH	mean	sd	n
Before treatment	6.48	0.051	20
After 1 month	6.50	0.064	20
After 3 months	6.63	0.220	20
After 6 months	6.77	0.090	20
After 12 months	6.78	0.103	20
After treatment	6.79	0.097	20

**Table 10.**  
Values of pH at different time intervals

zation process of dental hard tissues, stimulating the re-mineralization processes and giving an inhibitory effect on bacteria in dental plaque [15].

However, a more recent study by Boersma [16] found that 40% of the buccal surfaces in males had demineralization compared to 22% in females. One possible explanation for these results is that females are generally more compliant orthodontic patients [17,18]. Wisth and Nord [19] evaluated changes in the caries experience of 26 girls and 26 boys who had received orthodontic treatment and compared the results to a control group consisting of 58 girls and 53 boys who had not received orthodontic treatment in Norway. Surprisingly, the percentage distribution of DMFT counts indicated somewhat fewer caries in the treated group. They explained that regular hygiene control during orthodontic treatment was the reason for this situation. As a control group (who had not received orthodontic treatment) was not used in this study owing to ethical reasons, we could not compare our results with data of patients who had not received orthodontic treatment. The change in DMFT counts during orthodontic treatment was highest for 12-year-old children and the lowest for 18-year-old children. Respective values for 12-, 15-, and 18-year-old children were 0.46, 0.34, and 0.24. This might have been due to the increased consciousness of oral care within an older age group.

In this study, statistically significant increase in DMFT-index was registered at the end of treatment in the examinees of both groups. Statistically significant increase in the DMFT-index was registered in control group, where DMFT-index was 7.40 before initiation of treatment, and at the end of orthodontic therapy its value reached 8.50. This shows that the low level of the pH in the oral cavity persisted for longer period of time; hence, it can be accepted as an indicator of increased activity of caries in examined subjects.

It is important to reaffirm that patient compliance with regard to tooth brushing and prophylactic fluoridation are the most important factors in preventing the development of carious lesions during treatment with a fixed orthodontic appliance. The incidence of carious lesions during treatment fell in conjunction with more frequent teeth cleaning and greater intensity of fluoridation. Our results emphasize the need for good instructions, motivation, and control of patient's oral hygiene measures during treatment with fixed appliances.

Since F enhances enamel re-mineralization, its clinical use to repair early caries lesions was advocated ("fluoride therapy"). However, the effect of F in the dynamics of the caries process and its success in controlling caries should not be confused with its arrestment or reversal effect on caries lesions [20]. Furthermore, it should be emphasized that shallow de-mineralized enamel areas re-mineralized faster than deep ones. The effect of F on enamel re-mineralization is easily shown *in vitro* [21]. These study showed the effect of F on enamel with a "caries lesion" simulating a clinical situation under low caries challenge (Re > De). The enamel surface was rehardened, the lesion depth was reduced and there was an increase in F concentration in the re-mineralized enamel. However, the lesion was not totally repaired.

Most orthodontists agree that patients seeking orthodontic treatment run a high risk of developing caries [22,23]. Many publications have addressed this risk in orthodontic patients [24,25]. Multiple factors have been discussed related to the orthodontic treatment, caries development, plaque accumulation, effect of fluoride, and demineralization [26,27].

Salivary pH concentration is a significant factor for oral and dental health. The longer period of treatment with dental cream (GC Tooth Mousse) was needed for increasing the value of salivary pH. Six months were necessary to reach the desired result that is higher salivary pH (pH 6.49 at the beginning of the treatment versus 6.79 at the end of the treatment). The decrease in the production of the acid affords quicker retorted neutral salivary pH value; this, in turn, has an effect on decreasing the demineralization effect, namely to starting the process of re-mineralization. Thus, small differences in increasing the pH value (after 6 and 12 months) may also give differences in the genesis of carious lesions.

Increase of salivary pH has been noted in examinees treated with Fluorogal, in two separate time intervals. Prior to the orthodontic treatment, the pH value in this examined group was 6.48, and at 1, 3, 6 and 12 months an increase of pH was noticed, with highest values after 6 months of orthodontic treatment (6.77).

There were no changes of the concentration of hydrogen ions (salivary pH) in the control group regarding its increase at certain time intervals (before the beginning of the orthodontic treatments it was 6.47 and after treatments it was 6.50). The positive

effect of preventive treatment, especially with Fluorogal and its influence on acid and alkaline balance could be noticed. Maintenance of acid and alkaline balance have effect on oral homeostasis, regular functions of tissues and biochemical reactions which take place in the oral cavity.

## Conclusions

Caries and decalcification continue to be a serious problem as shown by high caries rate in our study. Clinicians must observe closely the new lesions and the increase of carious lesions in all the teeth evaluated. Meticulous caries-prophylactic measures such as professional tooth cleaning and fluoridation continue to be decisive factors in prevention caries risk in patients undergoing orthodontic treatment.

Salivary pH in both groups showed a gradual increase with the highest statistically significant values six months after beginning of treatment (in examined groups). There were no changes in the concentration of hydrogen ions (salivary pH) in the control group in terms of its increasing at all time intervals. The lowest increase in DMFT was noticed in the examined group treated with solution containing fluoride, and the highest increase in the control group.

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## INTERDENTAL CLEANING AT PATIENTS WITH PERIODONTAL DISEASE

ODRŽAVANJE HIGIJENE INTERDENTALNIH PROSTORA KOD PACIJENATA SA PARODONTOPATIJOM

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### ABSTRACT

The aim of this study is to determine the knowledge and motivation of periodontal patients concerning the use of supplementary items for oral hygiene and to establish the effects of these items in care for interdental space. For this purpose we conducted a questionnaire on 200 patients at the Clinic of Periodontology and oral pathology who were diagnosed with periodontal disease. They were instructed and motivated for using dental floss or interdental brush depending on the indication. It was recommended to the patients to apply the mentioned items to one region only while the counter section was used as a control parameter. Degree of dental plaque and index on gingival inflammation and bleeding were determined in patients before using these items and one month after using dental floss or interdental brush. The results were statistically analyzed and the significance of the differences was determined by Students t-distribution. Part of the patients were informed about the using supplementary items for oral hygiene, while part of them were motivated for using them. In the group of patients using interdental brush and floss significant reduction was recorded on the quantity of plaque and gingival inflammation in the section they have been applied.

**Key words:** oral hygiene, interdental brushes, dental floss.

### SAŽETAK

Cilj ove studije je da se utvrdi poznavanje i motivacija pacijenata sa parodontopatijom, koji se odnose na upotrebu dopunskih sredstava za održavanje oralne higijene i da se utvrdi učinkovitost ovih sredstava u održavanju interdentalne higijene. Za tu svrhu proveli smo upitnik kod 200 pacijenata oboljelih od parodontopatije, na Klinici za parodontologiju i oralnu patologiju. U saglasnosti sa indikacijama, pacijenti su bili obučeni i motivirani za korištenje interdentalnog konca ili interdentalne četkice. Studija je dizajnirana, tako da pacijenti upotrebljavaju navedena sredstva samo na jedan zubni segmenat, a kontralateralna strana je korištena kao kontrolni parametar. Indeks dentalnog plaka i indeksi upale desni i krvarenja određivani su prije upotrebe i jedan mjesec nakon upotrebe zubnog konca ili interdentalne četkice. Dobiveni rezultati su statistički analizirani, a značajnost razlika je određivana pomoću Student t-distribucije. Veći broj pacijenata je bio informiran o korištenje dopunskih sredstava za oralnu higijenu, a dio pacijenata je bio motiviran da ih upotrebljava. U grupi pacijenata koji su upotrebljavali interdentalne četkice i konac zabilježeno je značajno smanjenje količine plaka i upale desni u segmentu u kome su ova sredstva korištena.

**Gljučne riječi:** oralna higijena, interdentalne četkice, dentalni konac

## Introduction

Periodontal diseases are serious chronic infections that involve destruction of the tooth-supporting apparatus, including the gingiva, the periodontal ligament, and alveolar bone. These diseases are initiated by a local accumulation of bacteria adjacent to the tooth.

The disease is characterized by multiple symptoms in different stages of disease present with different intensity. They are: inflammation, recession, periodontal pocket, exudate, sub-gingival dental calculus, luxation and migration.

Inflammation of the gingiva, as one of the clinical signs of periodontal disease, is strongly associated with presence of dental plaque. In view of the fact that pathogenic reactions during periodontal development have inflammatory character, the elimination of inflammation is a required element of periodontal prophylaxis and therapy. Therefore, education and motivation of patients to maintain oral hygiene and to reduce the plaque accumulation is the first step towards successfully control of periodontal disease.

Motivation, will and training of patients, binding themselves to carry out oral hygiene and to control the level of dental plaque without causing disease are the most effective preventive measures having no better alternative. Usage of these preventive measures are equally important for people with preserve oral health so as for those having discreet or serious aberration in oral health [1,3,4,7,13].

The level of oral hygiene necessary to stop the progression of periodontal disease is individual for every patient. [12,14] Some of patients are informed and motivated for removing the plaque from interdental spaces of teeth (care for interdental spaces).

It is essential for the patients with periodontal disease to perform perfect inter-dental cleaning in order to preserve the periodontal health. Regular interdental cleaning and established habit for its continuous implementation is the main goal of educational process and instructions related to oral hygiene at the patients with periodontal disease [2, 4, 8, 10, 11, 12].

There were three types of interdental spaces:

Type 1: interdental space is fully completed with gingival,

Type 2: small recession of gingiva, making the part of interdental space empty,

Type 3: remarkable or complete loss of interdental papilla making inter-dental spaces agape.

For maintaining regular oral hygiene, especially hygiene of interdental spaces, relevant informing of patients is of specific meaning. The research, implemented at pupils in high school, showed that pupils are mostly not informed about the regular oral hygiene and care of inter-dental spaces. 80% of pupils were not informed about supplementary items for oral hygiene: interdental brush, dental floss, stimulators, and other items. Just 11% of pupils were informed about the use of supplementary items for oral hygiene. Information was given by dentist.

The aim of the study was to detect the level of information about periodontal disease, to increase motivation for using supplementary items for oral hygiene, and to record the effects of their use in the inter-dental spaces care.

## Material and methods

For this purpose, we conducted a questionnaire on 200 patients on the Clinic of periodontology and oral pathology who were diagnosed with periodontal disease. Questions were related to the knowledge for regular oral hygiene and to supplementary oral hygiene items. At the first visit, dental plaque and dental calculus with ultrasonic instrumentation at all patients were removed. We recommended the usage of dental floss or interdental brush in accordance to the indications. 70 patients were instructed to use interdental brush, and 90 patients to use dental floss only in one section. Counter section was control parameter. Control examinations were conducted once at month, and patients were followed up for 3 months. We noticed IDP (Silness-Loe) at patients and IGI (Loe-Silness). The results were statistically analyzed and the significance of the differences was determined by Students t - distribution.

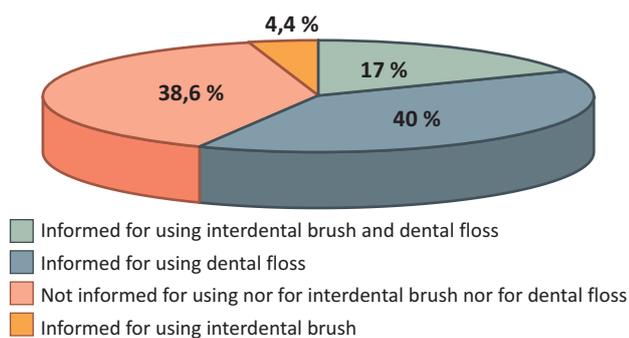


Figure 1.

Informed about the use of dental floss and inter-dental brush at 200 patients

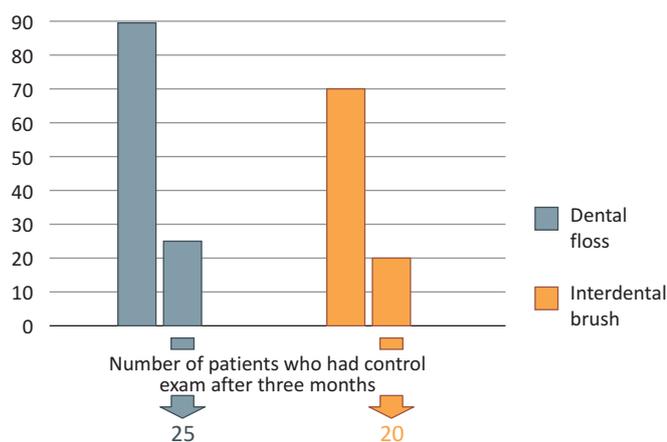


Figure 2.

Motivation of patients for using dental floss and interdental brush

	Control section* n = 25	Examine section** n = 25
X	1,20	0,56
SD	0,70	0,58
t		3,30
p		0,0016*

\* Section where dental floss isn't used

\*\* Section where dental floss is used

Table 1.

Index levels of dental plaque at patients after three months of using dental floss

	Control section* n = 25	Examine section** n = 25
X	1,12	0,68
SD	0,60	0,55
t		2,68
p		0,009*

\* Section where dental floss isn't used

\*\* Section where dental floss is used

Table 2.

Index levels of gingival inflammation at patients after three months of using dental floss

## Results

Figure 1 shows data regarding information about the usage of dental floss and interdental brush at 200 patients. 17% of patients were informed about the usage of interdental brush and dental floss. 40% of patients were informed about the usage of dental floss. 38,6% of them were not informed about the usage of interdental brush neither about the usage of dental floss. And 4,4% of patients were informed about the use of interdental brush.

Figure 2 shows data regarding the motivation of patients for using dental floss and interdental brush and a number of patients who had control exam three months after.

Table 1 shows index levels of dental plaque among control and examine section at patients three months after using dental floss. Data confirmed statistically significant reduction of dental plaque at the section where dental floss was applied ( $p < 0,01$ ).

Table 2 shows the index levels of gingival inflammation among control and examine section at patients three months after using dental floss. Data also confirmed statistically significant reduction of gingival inflammation in the examine section three months after using dental floss ( $p < 0,01$ ).

Table 3 shows index levels of dental plaque among control and examine section at patients three months after using interdental brush. Data confirmed statistically significant reduction of dental plaque at the examine section where interdental brush was used ( $p < 0,01$ ).

	Control section* n = 20	Examine section** n = 20
X	1,20	0,50
SD	0,69	0,60
t		3,39
p		0,0016*

\* Section where dental floss isn't used

\*\* Section where dental floss is used

Table 3.

Index levels of dental plaque at patients after three months of using interdental brush

	Control section* n = 20	Examine section** n = 20
X	1,05	0,50
SD	0,60	0,60
t		2,87
p		0,006*

\* Section where dental floss isn't used

\*\* Section where dental floss is used

**Table 4.**

Index levels of gingival inflammation and bleeding at patients after three months of using interdental brush

**Table 4** shows index levels of gingival inflammation among control and examine section at patients three months after using interdental brush. Data also confirmed statistically significant reduction of gingival inflammation in the examine section three months after using interdental brush ( $p < 0,01$ ).

## Discussion

Our results show low level of knowledge related to the use of supplementary items, especially the use of inter-dental brush at patients with periodontal disease (**Figure 1**). This is a result of insufficient attention paid by dentists and periodontologists to this problem. The majority of dentists are not concerned about the problem related to the care of inter-dental spaces. But, besides the dentists, more important role for better information of patients about dental care belongs to dental hygienist [17,20].

Maintaining oral hygiene of inter-dental spaces depends on anatomy of gingiva, dens and their setting in the jaw. In accordance to the type of dental space, there were varieties of supplementary items for oral hygiene. Dental floss is indicated at type 1 of inter-dental space and dental implants. The effectiveness of its use do not show any positive results in eliminating dental plaque according to the type of dental floss, but from the technique of its use [6,8,9].

Inter-dental brushes are indicated for: type 2 and type 3 of inter-dental spaces, exposed divarication of teeth, a concave parts of teeth or its radix, distal area of molars, crowns, teeth with caries, orthodontic patients and patients with implants. Brushes are applied proximal, without any pressure moving it outside-inside direction. During our investigation, we registe-

red significant reduction of dental plaque level and gingival inflammation in the section of inter-dental brushes use and dental floss application in comparison to the counter sections (**Tables 1, 2, 3, 4**). This is a result of a mechanical elimination of dental plaque from spaces inaccessible for self-cleaning even with new designed toothbrushes. Similar results were obtained in research by Graves [8] and Craft [3], Cronin [5], Rosema [18] and Tarannum [21].

We succeeded to motivate modest number of patients to use inter-dental brush and dental floss. From total 90 patients instructed to use dental floss on the third control we examined only 25. From total 70 patients instructed to use inter-dental brush on the third control we examined only 20 patients. (**Figure 2**).

During the research of the preventive program in England which included 6700 children aging from 13-14 years, Axelsson and Lindhe did not get the desired effects [1]. The program consisted from presentation of the technique of tooth brushing and experimental work (practical presentation of tooth brushing in schools).

Results showed evident reduction of the level of dental plaque and gingival inflammation, but short period of observation (5-28 weeks) was not sufficient to motivate the children for maintaining oral hygiene. We suppose that the use of supplementary items for oral hygiene and single instruction for their implementation are insufficient for patients' motivation.

## Conclusion

On the basis of the analysis of the results obtained by our investigation, we can conclude that

in the section using inter-dental supplementary we noted significant decrease in the index values of the dental plaque and gingival inflammation. Thus, we consider that:

1. Positive effects which are evident when using inter-dental supplementary items for oral hygiene impose the necessity of their use at patients with periodontal disease in accordance to the indication.

2. Insufficient informing of patients about regular oral hygiene indicate that dentists need to stop reporting only particular and inadequate information like:

"you need to brush your teeth", without proposing complete explanation.

3. Process of motivation for maintaining oral hygiene, especially for using supplementary items for oral hygiene is permanent, and is necessary to start even in childhood. Therefore, we need continuous preventive programs which will be implemented in schools.

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# THE FIVE YEAR EVALUATION OF AESTHETIC COMPOSITE RESTORATIONS ON POSTERIOR TEETH

EVALUACIJA KOMPOZITNIH ESTETSKIH ISPUNA  
NA BOČNIM ZUBIMA U PERIODU OD PET GODINA

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## ABSTRACT

Modern understanding of dentistry involves high aesthetic criteria thus placing huge demands before dentists.

**The aim** of this study is the replacement of old amalgam fillings with composite material on the molars and bicuspid teeth along with aesthetic restoration of the tooth anatomic and morphologic surfaces. All restorations were evaluated during the five year period.

54 teeth were divided in two groups of 27 teeth restored with Herculite XRV and Tetric Ceram composite materials.

Fracture of fillings, secondary caries, marginal discoloration, texture resistance, color stability, postoperative sensitivity and vitality test were checked at control examinations.

During the five year evaluation period, no statistically significant differences between used materials on the inplaced composite fillings were found.

Modern composite materials provide complete restorations on the molars and bicuspid teeth while the restauration done by modeled anatomical and morphological details provide natural relation between teeth while chewing and aesthetic look for longer period.

**Key words:** aesthetic restorations, composite materials, secondary caries

## SAŽETAK

Moderno poimanje stomatologije podrazumijeva visoke estetske kriterije, a to pred stomatologa postavlja sve veće zadatke.

**Cilj:** Cilj ovog rada je zamjena starih amalgamskih ispuna sa kompozitnim materijalom na molarima i premolarima, uz estetsku restauraciju anatomskih i morfoloških struktura zuba. Sve restauracije su evaluirane u periodu od pet godina.

Ukupno 54 zuba podijeljena su u dvije grupe, po 27 zuba, i restaurirana sa Herculite XRV i Tetric Ceram kompozitnim materijalom. Frakture ispuna, sekundarni karijes, postojanost teksture ispuna, stabilnost boje, postoperativna osjetljivost i vitalnost zuba pregledani su prilikom kontrolnih pregleda.

U evaluacijskom periodu, u trajanju pet godina, na postavljenim kompozitnim ispunima nije pronađena statistička signifikantnost između korištenih materijala.

Savremeni kompozitni materijali omogućavaju potpunu nadoknadu izgubljenih dijelova krunice zuba, a restauracijom anatomo-morfoloških detalja omogućen je prirodan odnos zuba, prilikom žvakanja, i estetski izgled zubnog niza na duži period.

**Gljučne riječi:** estetske restauracije, kompozitni materijali, sekundarni karijes

## Introduction

Modern understanding of dentistry involves high aesthetic criteria thus placing higher demands before dentist. Aesthetic component has become an important factor in the psychology of good appearance and thus one of the main tasks of restorative dentistry. The importance of beautiful teeth and mouth lies in the fact that they are an integral part of the face being the most striking aesthetic fact characterized by each person [1]. A clinical study has shown that painful vital teeth with incomplete fractures can be treated successfully by replacing the amalgam fillings with bonded composite restorations [2]. On the other hand, posterior composite restorations have been shown to produce higher failure rates due to secondary caries [3,4]. However, although used in many practices around the world, amalgam is facing its demise, leaving a resin composite as the most likely material for posterior restorations for widespread use in the near future.

Contemporary dental practices have embraced the process of bonding to natural tooth structure to combine function and esthetics. Direct composite resin restorations have replaced amalgam and gold in many clinical situations where esthetics is of primary concern and an adequate amount of natural tooth structure remains.

Modern composite materials allow full compensation for the lost parts of the crowns of teeth, and restoration of anatomical and morphological details provide natural relationship between the teeth while chewing and aesthetic look of the dental arch.

Bonded composite resin materials can deliver desired results while providing longevity that is acceptable to most patients. Still, it is very likely that the restoration which a patient receives today will need replacement in the future.

After years of in vitro and in vivo investigations, it is currently possible for the clinician to develop a durable, long-lasting restoration that is esthetically indistinguishable from natural tooth structure. Exact shade matching and localized characterization are entirely possible. However, achieving the ultimate in esthetics can take a considerable amount of time and experience. An alternative approach that is

simpler yet based on sound scientific principles can be used to achieve predictable long-term success with direct placement of composite resin restorations for anterior and posterior teeth in more time-efficient manner. In order to estimate duration of posterior composite restorations, long-term studies are needed to identify modes of failure and possible reasons for these failures.

The aim of this study is the replacement of amalgam fillings with the composite material on the molars and bicuspid teeth with esthetic restoration of the tooth surface producing anatomical and morphological details of the natural tooth.

## Material and Methods

Patients for this study were middle aged male and female selected randomly. All patients selected for the research are of similar personal habits, proper oral hygiene and non-smokers. Chosen patients had amalgam fillings needing replacement. The fillings were sized class II; mesio-occlusal, disto-occlusal and mesio-occlusal-distal surface restorations. All research restorations were done on vital teeth. Teeth with root canal treatments are not included in the research. The total number of teeth included in research was 54.

After removing the old amalgam fillings the secondary caries of dentine and enamel was removed. After determining the color with Vita-pan shade guide (Vita Zahnfabric, Bad Sackingen, Germany), the calcium hydroxide based liner was applied on pulpal cavity walls (Kerr Life, Keer Italia Srl, Salerno Italia) and glass ionomer cement (Ketac Cem, 3M ESPE, Dental-Medizin GmbH + Co., KG, Seefeld, Germany). The cavity is treated with 37% orthophosphoric acid (Gel Etchant, Keer Italia Srl, Salerno Italia) by total etch technique with applied adhesive system (Optobond Solo Plus, Keer Italia Srl, Salerno Italia). 27 teeth were restored using Herculite XRV with dentine and enamel composite material.

After polymerization of dentin composite, modeling with enamel composite was achieved in producing cusps and fissure morphology (Herculite XRV, Keer Italia Srl, Salerno Italia). Other 27 teeth were restored in the same way with Tetric Ceram (Ivoclar

Vivadent AG, Schaan, Liechtenstein). After checking the articulation and occlusion of the restorations, polishing was done with silicone rubbers in the presence of water, and high-gloss polishing was performed with paste Dura-Polish Dia (SHOFU DENTAL GmbH, Germany) and brush of goat hair at a low level rotation up to 900 RPM. After polishing, the surface was applied by OptiGuard (Herculite XRV, Keer Italia Srl, Salerno Italia) composite surface sealant, thus preventing premature wear and staining of composite material.

Recalls were done six months and twelve months after treatment in the first year and later one time of year for a four year period. Recalls checked: fracture of filling, secondary caries, marginal discoloration, texture resistance, color stability, postoperative sensitivity and vitality test of teeth. Vitality test was performed with electric tester. (Parkell, USA) Checking of patients was performed by six practitioners. The restorations were evaluated using the modified USPHS parameters to check their stability, and the scores were A (good), B (acceptable), and C (unacceptable).

## Results

During the five years of evaluation of placed composite restoration, no it statistical differences between composite materials were found. Also, there were no differences in behavior of used materials regarding the size of the restoration. With both materials, postoperative sensitivity was recorded in four patients with Herculite XRV and six patients with Tetic Ceram during one day after treatment.

Vitality test was positive and without change during evaluation period. The fracture of materials was not recorded. Marginal discoloration after evaluation period was shown at 21% cases with Herculite XRV and 30% restorations with Tetric Ceram. This marginal discoloration was described like acceptable because it was found only on certain parts of occlusal surface and did not jeopardize overall aesthetic and functionality of restorations (**Figure 1 and 2**).

Secondary caries were found at 9% in Herculite XRV group and 14% an Tetric Ceram group during the



**Figure 1.**  
Herculite XRV restoration after five years of tooth 26



**Figure 2.**  
Tetric Ceram restoration after five years of tooth 18  
and Herculite XRV immediately after placing on tooth 17

Clinical Results Based on USPHS Criteria for Herculite XRV restoration

	6 month			12 month			2 year			3 year			4 year			5 year			%					
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C			
<b>Restoration (n=27)</b>																								
Vitality test	27			27			27			27			27			27			27			100		
Marginal discoloration	27			27			22	5		22	5		21	6		21	6		79	21				
Secondary caries	27			27			27			27			27			25	2		91	9				
Color stability	27			27			24	3		21	6		16	11		12	15		45	55				
Postoperative sensitivity	27			27			27			27			27			27			100					
Wear resistance	27			27			25	2		25	2		23	4		23	4		85	15				

A - good; B - acceptable; C - non acceptable

**Table 1.**  
USPHS Criteria for Herculite XRV

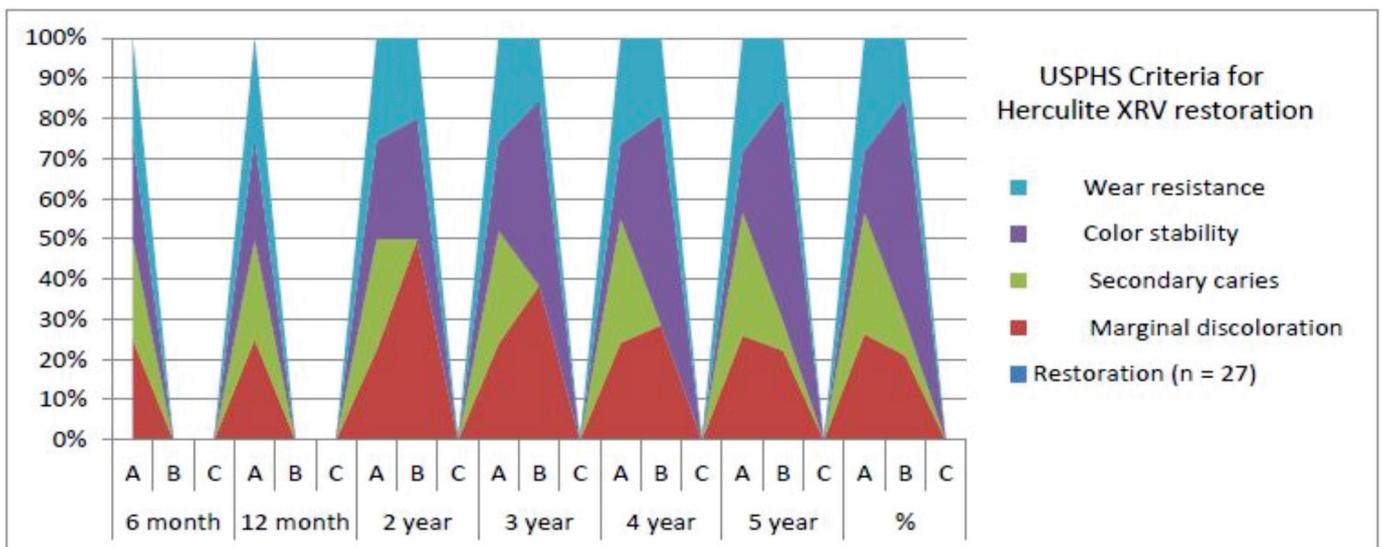
fifth year checkup. Surface texture was not changed to be described like non acceptable, during the evaluation period for both used materials, and occlusal anatomy of teeth was preserved.

Wear resistance change in luster appeared in 15% Herculite restorations and 31% Tetric Ceram restorations being registered like acceptable.

Color stability of both materials was described like clinically acceptable. No non acceptable color change for all restoration was found regarding this investigation circumstances. (Table 1, Figure 3, Table 2, Figure 4)

Discussion

Due to their aesthetic properties and good clinical service, composites have become the preferred material for direct posterior restorations. The main reasons for the failure of posterior composite restorations are secondary caries, fracture and color change. The failure of restorations related to the wear of these materials in the posterior region seems, nowadays, almost absent and may be restricted to bruxing and clenching patients. A review of the literature on long-term clinical trials of posterior composite restora-



**Figure 3.**  
USPHS Criteria for Herculite XRV

## Clinical Results Based on USPHS Criteria for Tetric Ceram restoration

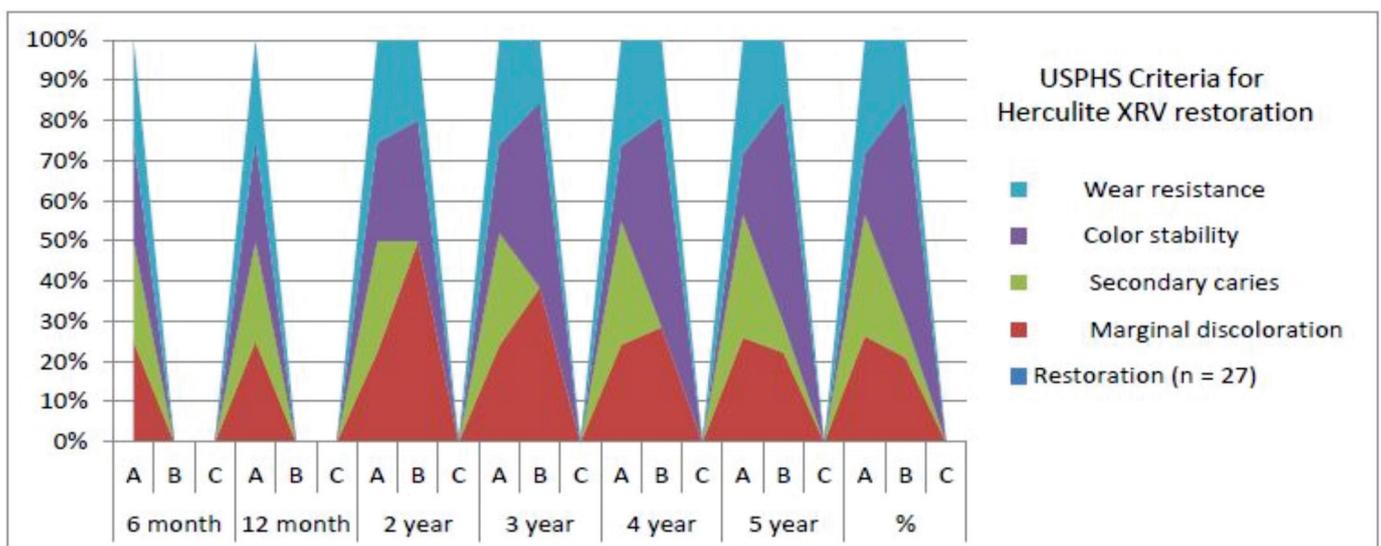
	6 month			12 month			2 year			3 year			4 year			5 year			%					
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C			
<b>Restoration (n=27)</b>																								
Vitality test	27			27			27			27			27			27			27			100		
Marginal discoloration	27			27			20	7		20	7		19	8		19	8		70	30				
Secondary caries	27			27			27			27			27			23	4		86	14				
Color stability	27			27			22	5		18	9		17	10		15	12		55	45				
Postoperative sensitivity	27			27			27			27			27			27			100					
Wear resistance	27			27			23	4		21	6		20	7		18	9		69	31				

A - good; B - acceptable; C - non acceptable

**Table 2.**  
USPHS Criteria for Tetric Ceram

tions showed that the duration of these restorations is influenced mainly by clinical variables (type, size, and location of the restoration), the quality and technique of the operator, socioeconomic factors such as income and type of dental service, demographic factors (age of patients) and behavioral aspects (caries prevalence) [5]. At the research done 12 years later, large composite restoration showed a higher survival in the combined population and in the low-risk group. For three-surface restorations in high-risk patients, amalgam showed better survival [6]. There is no much evidence that the material properties of the used composite are a relevant factor in restora-

tion longevity. Da Rosa et al reported that there is superior longevity for the higher filler loaded composite [7]. Choosing the right material can also be the reason for success of aesthetic composite restoration. Today, dental market offers a wide range of composite materials with different prices and properties. One of the characteristic of composite materials is polymerization shrinkage and choosing the material with lowest polymerization shrinkage rate can improve longevity of the restoration. For this research, two types of material were chosen. Herculite XRV, microhybride composite is one of the first products which offers dentin and enamel material for producing high



**Figure 4.**  
USPHS Criteria for Tetric Ceram

aesthetic direct restorations. Tetric Ceram is also microhybride composite which has been used for long time in dentistry. The both products showed acceptable physical properties, good handling characteristic and longevity aesthetic [8, 9, 10].

Under the circumstances of this research, used restoration materials did not show statistical differences in five year evaluation period. All patients selected for this research were low risk patients being the possible reason for good fractural resistance and low rate of secondary caries which is mostly found in the gingival region of restoration. All those secondary caries were found in the last year of research. Risk for secondary caries can be reduced firstly by removing all pathologically changed dentin and enamel by the initial preparation with disinfection of prepared cavities. Use of the proven quality of adhesive materials, and adequate technique of placing and polymerizing composite material for reducing polymerization shrinkage can also be the fact for reducing secondary caries risk. The patients may have benefit by proper information and education about oral hygiene in order to reduce secondary caries reducing.

The materials used in this research showed acceptable aesthetic after five years. Best esthetic is shown one year after placing restoration. Ageing of material is the reason for the changing of color and marginal discoloration. Using the OptiGuard or similar material for final coating after polishing of restoration can slow down aging process of material and prevent pigment accumulation from food or drinks [11].

Fillings that last for five years with acceptable esthetics, even with small surface secondary caries, can be repaired with refurbishing treatments consisting of repolishing and applying the OptiGuard. This can improve the clinical properties of defective or slight color changed resinbased composite restorations by increasing the longevity of the restorations with minimal intervention [12].

This research shows that fillings lasting five years can assume clinically acceptable success. This is proved by the results of Lundin and Koch showing that out of 137 restorations, after the 5 years of evaluation, 114 of the examined restorations were in clinical function and after 10 years 92, meaning 90% and 79 % respectively [13].

Composite restoration achieved a morphological form of teeth with satisfactory aesthetic appearance. Composite restoration allows the correction of the anatomical and morphological shape of teeth to achieve the desired aesthetic solutions. Correct articulation of restoration is achieved through absolute functionality of the restored teeth in the articulatory system.

## Conclusion

Composite restorations on the molars and bicuspid teeth with modeled anatomical and morphological details of the natural teeth allow the achievement of proper articulation and occlusal relationships and meet long-term aesthetic effects.

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# THE DIMENSIONAL STABILITY OF FOUR ELASTOMERIC IMPRESSION MATERIALS

DIMENZIONALNA STABILNOST ČETIRI ELASTOMERNA OTISNA MATERIJALA

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## ABSTRACT

**Objective:** The aim of this study was to determine and compare the linear dimensional change of four frequently used elastomeric impression materials: two vinyl polysiloxane, one polyether, and one condensation silicone.

**Material and Methods:** Test of linear dimensional change was conducted according to the standardized method that has been described in ISO 4823. A stainless steel test block with engraved reference lines was used for impressions making. A total of 12 specimens (three specimens of each material) were made. The linear dimensional change of specimens was evaluated under the microscope after 24h have been elapsed since their preparation. The distance between the cross-lines, along the horizontal 75µm-wideline, was measured on the test block and on each sample three times. The percentage of linear dimensional change was calculated for each sample. The data was subjected to analysis of variance (ANOVA) and Scheffe's post hoc test.

**Results:** The lowest value of dimensional change was determined in addition silicone Virtual ( $0.03 \pm 0.11\%$ ), followed by polyether Impregum ( $0.10 \pm 0.07\%$ ), addition silicone Elite H-D+ ( $0.18 \pm 0.03\%$ ), and condensation silicone Oranwash L ( $0.36 \pm 0.39\%$ ). Statistical analysis showed that the detected differences between the impression materials are not significant ( $p > 0.05$ ).

**Conclusion:** Addition silicones and polyether displayed superior dimensional stability in relation to condensation silicone also showing a low change in dimension, but was less stable compared to the other tested elastomers. The dimensional stability of all examined impression materials was in compliance with ISO 4823.

**Key words:** elastomeric impression material, dimensional stability, linear dimensional change, vinyl polysiloxane, polyether, condensation silicone

## SAŽETAK

**Cilj:** Cilj ove studije bio je da odredi i uspoređi linearnu dimenzionalnu promjenu četiri često korištena elastomerna otisna materijala: dva vinil polisiloksana, jednog polietera i jednog kondenzacionog silikona.

**Materijal i metode:** Test linearne dimenzionalne promjene izveden je u saglasnosti sa standardiziranom metodom koja je opisana u ISO 4823. Za izradu otisaka korišten je testni blok od nehrđajućeg čelika sa referentnim linijama. Napravljeno je ukupno 12 uzoraka (tri uzorka od svakog materijala). Linearna dimenzionalna promjena evaluirana je pod mikroskopom nakon 24 sata od pripreme uzoraka. Rastojanje između poprečnih linija, duž horizontalne linije širine 75 µm, izmjereno je na ispitnom bloku i na svakom uzorku tri puta. Za svaki uzorak izračunat je procenat linearne dimenzionalne promjene. Podaci su podvrgnuti analizi varijance (ANOVA) i Scheffe post hoc testu.

**Rezultati:** Najniža vrijednost dimenzionalne promjene utvrđena je kod adicisionog silikona Virtual ( $0,03 \pm 0,11\%$ ), a slijede ga polieter Impregum ( $0,10 \pm 0,07\%$ ), adicioni silikon Elite H-D+ ( $0,18 \pm 0,03\%$ ) i kondenzacioni silikon Oranwash L ( $0,36 \pm 0,39\%$ ).

Statistička analiza je pokazala da otkrivene razlike između elastomernih otisnih materijala nisu značajne ( $p > 0,05$ ).

**Zaključak:** Adicioni silikoni i polieter su pokazali superiorniju stabilnost dimenzija u odnosu na kondenzacioni silikon, koji je također imao malu promjenu u dimenziji ali je bio manje stabilan u odnosu na druge testirane elastomere. Dimenzionalna stabilnost svih ispitivanih otisnih materijala bila je u skladu sa ISO 4823.

**Ključne riječi:** elastomerni otisni materijali, dimenzionalna stabilnost, linearna dimenzionalna promjena, vinil polisiloksan, polieter, kondenzacioni silikon

## Introduction

The first impression technique was presented by Philip Phaffin in 1755. Since that time, when the impressions were made with softened wax, until today, the properties of impression materials have been significantly enhanced [1]. The contemporary prosthodontics commonly use the elastic impression materials (hydrocolloids and elastomers) [2]. Elastomeric impression materials are superior than hydrocolloids because of their accuracy and reliability [2-6]. The rubber impression materials are used worldwide, and consider to be the gold standard for impression materials in the fixed prosthodontics [7]. Furthermore, they are the materials of choice in the removable prosthodontics, [8] and in the implant dentistry [9]. Chemically, the four kinds of elastomers are used as the impression materials: polysulfide, polyether, condensation and addition silicones [10]. Although these are the best materials on the market, each possesses specific advantages and disadvantages [11]. Knowledge of the strengths and weaknesses, as well the physical and biological properties of different materials, can provide their successful use [12]. One of the crucial physical properties of the impression materials is the dimensional stability because it affects the quality of prosthetic restoration [13,14]. The error made at making impression stage cannot be fixed in the further process. Moreover, it becomes a source of new inaccuracies [7]. Thus, the accurate impression is the key to restorative success [15]. Accuracy of the impression material depends on dimensional stability [16]. Main causes of the dimensional changes of impression materials are thermal contraction, polymerization shrinkage, and contraction due to loss of volatile by-products [17]. Furthermore, several clinical parameters, such as periodontal status, oral hygiene, location of the preparation finish lines [18,19], tooth mobility [20], and mandibular deformation during the opening [21], can affect the accuracy of an impression. The impression technique, impression tray and properties of the impression material as well contribute to the accuracy of impressions, [9,18,19,22,23] including factors related to laboratory processes, should also be considered when producing prosthetic restorations [24].

Several studies investigated the dimensional changes of impression materials, and the results are

not consistent. Literature has not yet achieved consensus about the most accurate elastomeric impression material. Considering the great varieties of impression materials, a testing of their dimensional accuracy can be helpful for professionals who wish to select the best material and achieve the most successfully clinical results [8].

Therefore, the aim of this study was to determine and compare the linear dimensional change of four frequently used elastomeric impression materials: two vinyl polysiloxane, one polyether, and one condensation silicone.

## Material and Methods

In the present in-vitro study following elastomeric impression materials were tested: 2 addition silicones (Virtual; type 2, Ivoclar Vivadent AG, Schaan, Liechtenstein, and Elite H-D+; type 3, Zhermack, Badia Polesine (RO), Italy), polyether (Impregum F; type 2, 3M Espe, St. Paul, Minnesota), and condensation silicone (Oranwash L; type 3, Zhermack, Badia Polesine (RO), Italy).

The test of linear dimensional change was performed in accordance with ISO 4823.[25] The recommended stainless steel test block with five reference V-shaped grooves on its top surface, and the acrylic ring molds were used to produce the sample. The test block was cleaned (with ethanol and ultrasonically), air-dried, and together with the ring mold heated in an incubator (15 minutes at  $35^{\circ}\text{C}\pm 1^{\circ}\text{C}$ ). Impression materials were prepared according to the manufacturer's recommendations. The ring mold was connected to the test block, and the mixed material was injected into existing cavity, covered by a polyethylene foil, pressed with a glass plate, and placed in the C-clamp. The specimen was polymerized in water bath at  $35^{\circ}\text{C}\pm 1^{\circ}\text{C}$ , and removed one minute after the manufacturer's recommended setting time. The specimen with the ring mold was then separated from the test block, rinsed under a stream of distilled water, and dried with compressed air. A total of 12 specimens (three specimens of each material) was made, covered with talc from the bottom side, placed on a glass plate, and left in the air in a lab during the next 24 hours. After the mentioned period, the specimens were evaluated under the microscope with

measurement accuracy of 0.1  $\mu\text{m}$  (ZKM 01-250C, 2-coordinate measuring microscope, Carl Zeiss, Jena, Freiberg, Germany). The distance between the cross lines, along the horizontal 75 $\mu\text{m}$ -wideline, was measured on the test block and on each sample three times. For each sample, the percentage of linear dimensional change was calculated ( $\Delta L$ ) by the formula  $\Delta L = ((L_1 - L_2) / L_1) \times 100$ , where  $L_1$  represents the mean of three readings of the test block, and  $L_2$  represents the average of three measurements of the specimen.

The data was subjected to One-Way analysis of variance (ANOVA) and Scheffe's post hoc test. Each test was conducted at the .05 alpha level.

## Results

Mean and standard deviation values of dimensional changes in the tested elastomeric impression materials are presented in **Table 1**. The lowest mean of linear dimensional change was observed in addition silicone Virtual ( $0.03 \pm 0.11\%$ ), followed by polyether Impregum ( $0.10 \pm 0.07\%$ ), and addition silicone Elite H-D+ ( $0.18 \pm 0.03\%$ ). In comparison with other tested impression materials, the largest mean and standard deviations of dimensional change were found in condensation silicone Oranwash L ( $0.36 \pm 0.39\%$ ).

The statistical significance of determined differences in dimensional stability between the four impression materials was tested with One-Way Analysis of Variance (ANOVA), and the results from the test are shown in **Table 2**. It is obvious that the F-value of 1.44 with degree of freedom of 3 resulted in a statistically insignificant p-value ( $p=0.30$ ).

Furthermore, Scheffe's post hoc test was performed for the comparison of each pair of impression materials (**Table 3**). Between addition silicone Virtual and condensation silicone Oranwash L the lowest p-value to Scheffe's post hoc test was achieved ( $p=0.34$ ). However, the individual comparisons of dimensional changes resulted in statistically insignificant value of p-parameter ( $p>0.05$ ) for all possible combinations of pairs of the tested impression materials.

		Elastomeric impression materials			
		Virtual	Elite H-D+	Oranwash L	Impregum F
$\Delta L$	x	0.03%	0.18%	0.36%	0.10%
	SD	0.11	0.03	0.39	0.07
N		3	3	3	3

**Table 1.**

Mean and standard deviations of linear dimensional change ( $\Delta L$ ) for evaluated impression materials

Analysis of Variance (ANOVA)				
	Sum of Squares	Degree of freedom	F- value	p- value
Between groups	0.18	3.00	1.44	0.30
Within groups	0.34	8.00		
Total	0.52	11.00		

**Table 2.**

The comparison of the linear dimensional change ( $\Delta L$ ) for four impression materials using ANOVA

Scheffe			
Dependent variable: The percentage of linear dimensional change			
	(J) Material	Mean Difference (I-J)	p
Virtual	Elite H-D+	-0.2	0.84
	Oranwash L	-0.3	0.34
	Impregum F	-0.1	0.98
Elite H-D+	Virtual	0.2	0.84
	Oranwash L	-0.2	0.78
	Impregum F	0.1	0.97
Oranwash L	Virtual	0.3	0.34
	Elite H-D+	0.2	0.78
	Impregum F	0.3	0.54
Impregum F	Virtual	0.1	0.98
	Elite H-D+	-0.1	0.97
	Oranwash L	-0.3	0.54

**Table 3.**

The comparison of dimensional stability between four elastomeric impression materials by using Scheffe's post hoc test (Comparison of individual pairs of groups)

## Discussion

The methodology for evaluating the dimensional stability of elastomeric impression materials is not uniform in the literature. The present study applied the test method that has been recommended by ISO 4823 [25]. This approach provides the standardized conditions to test and compare the materials, although some have criticized the testing conditions that vary from those met in clinical practice.

Therefore, the master models used in some previous studies were designed as an edentulous ridge, half or full dental arch, the teeth prepared for a crown, etc. Furthermore, Quicket al.[26] have presented 3D testing for dimensional accuracy of impression materials. However, the ISO 4823 approved test method was also been used before, and its benefit is widely accepted in the dentistry. Moreover, it could be considered that the studies of dental materials have not been serious if not based on the relevant standards [12].

In this study, the dimensional change of each sample was lower than 1.5%, and therefore, all evaluated materials satisfy the requirement of ISO 4823, regarding of dimensional stability. The tested materials showed a certain degree of the contraction, in line with the manufacturer's specifications. The established differences between the various materials were not statistically significant, although there was a tendency of the greater stability of addition silicone Virtual, and the tendency for the least stability of condensation silicone Oranwash L. McCabe and Storer [17] inform that addition silicones have less polymerization shrinkage than condensation silicones.

During the polymerization of the condensation silicones a volatile byproduct is released. Therefore, their mode of polymerization leads to the dimensional instability [27]. Evaporation of ethanol continues even up to seven days after the setting of condensation silicones was completed [28]. Anyhow, Baldissara et al.[29] have found the greatest change in condensation silicone Oranwash L in the first 24 hours (0.68%), while the stability was insignificantly altered during the following seven-day period (0,71%).

Šimunović-Šoškić et al.[30], have shown similar contractions of condensation silicones (Xantopren; Bayer, Germany and RTV; Bosnalijek, Sarajevo, Bosnia and Herzegovina) after 24 hours (0.665% and 0.664%), but also recommended that the impressions of these materials should be poured as soon as possible because of evident loss of stability over time. Condensation silicones were less dimensionally stable compared to the addition silicones and polyethers in some previous studies [31, 32]. However, it is difficult to correlate the results because these studies used different master models and/or brands of impression materials that may influence the disagreements between the results. In addition, there is also a possibility that the established differences between condensation silicone and the other materials in the present study could be of the statistical significance if the testing was performed on a larger sample. Previously mentioned should be considered as a limitation of this study.

The vinyl polysiloxanes show a superior dimensional stability, primarily because they do not release any byproducts during the polymerization [10, 33, 34]. High dimensional stability of the addition silicones [35, 36] allowed to pour the impressions and to fabricate accurate models even seven days after [37]. Thus, if delayed pouring of impressions is anticipated, the addition silicones are better choice than the other elastomers [38]. According to the results of this study, the addition silicones did not differ importantly among themselves, with regard to dimensional stability. Vitti et al. [39] have obtained similar results. Katyayan et al. [40] have compared the linear dimensional changes of two hydrophilic vinyl polysiloxane (type 2) under dry, moist, and wet conditions. Statistical analyses revealed no significant difference between materials for the moist and wet conditions, and a significant difference between materials under the dry condition ( $p=0.043$ ), indicating that only in a dry atmosphere, the mono phase consistency shows the lesser dimensional change than the regular body consistency. However, in their study, the dimensional changes of vinyl polysiloxanes were also negligible, confirming the exceptional accuracy of these materials.

In the literature, most of the conflicting attitudes have been related to the mutual comparison of di-

dimensional stability of addition silicones and polyethers. So, some consider that the addition silicones are superior in relation to polyether [6, 32, 41], but the contrary results have also been presented [42-44]. In this study, the significant differences have not been found between these two groups of materials. Faria et al. [31] have obtained similar results, but with a different methodological approach. Master model that simulated a partially edentulous mandibular hemi-arch segment with teeth prepared to receive full crowns was used. Polyether (Impregum) and addition silicone (Aquasil LV) were tested, and stone casts were fabricated from the impressions. Photographs of the master model or stone casts and a caliper, set at 1 mm, were taken using a digital camera. The software Image Tool was used to measure the distance between the teeth. Statistical analysis showed no significant difference between the polyether and addition silicone impression materials (single-phase mix technique). When a double-mix technique was used with the addition silicone, the polyether was statistically more accurate. In the literature, the opinions are also divided with regards to the long-term dimensional stability of polyethers. Luebke et al. [45] have found that this material does not change considerably, even after seven days. To the contrary, other studies confirmed that the accuracy of the polyether change importantly depending on the time the impression was made and the humidity of the environment [46, 47]. Anyway, both polyethers and addition silicones, have become very popular and are the most-used impression materials today [48].

## Conclusion:

Addition silicones and polyether displayed superior qualities in terms of dimensional stability in relation to condensation silicone, which also showed a low change in dimension, but was less stable compared to the other tested elastomers. The dimensional stability of all examined impression materials was in compliance with ISO 4823.

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# UPDATE OF ORAL SURGERY MANAGEMENT IN ORALLY ANTICOAGULATED PATIENTS

AŽURIRANI ORALNOHIRURŠKI MENADŽMENT BOLESNIKA SA ORALNIM ANTIKOAGULANSIMA

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## ABSTRACT

Aim of this study is to review the evidence of different therapy approach, to highlight the areas of major concern and to suggest specific oral surgery treatment for patients on oral anti-coagulants. The aim of operative treatment is to minimize the risk of hemorrhage while continuing to protect the patient against thrombus-embolism formation. The ordinary treatment includes the interruption of anticoagulant therapy for oral surgery interventions to prevent hemorrhage. However, this practice may logically increase the risk of a potentially life-threatening thrombus embolism. Thus, this issue is still controversial.

The update management of oral surgery procedures on patients treated with oral anticoagulants should be influenced by several factors: laboratory values, extent and urgency of the intervention, treating physician's recommendation, available facilities, dentist expertise, and patient's oral, medical, and general condition.

**Key words:** oral surgery, oral anticoagulant therapy

## SAŽETAK

Cilj ovog rada je dati pregled dokaza drugačijeg terapijskog pristupa, da se istaknu područja koja su od velike važnosti, i predložiti određeni oralnohirurški tretman za pacijente na oralnim antikoagulansima. Cilj operativnog liječenja je smanjiti rizik od krvarenja, dok je pacijent sa kontinuiranom zaštitom od tromboembolijske formacije. Obični tretman uključuje prekid antikoagulantne terapije prije oralnohirurških intervencija kako bi se spriječilo krvarenje. Međutim, logično ova praksa može povećati rizik od potencijalno opasne po život tromboembolije. Dakle, ovo pitanje još uvijek je kontroverzno.

Ažurirani menadžment oralnohirurških procedura kod bolesnika liječenih oralnim antikoagulansima trebao bi biti pod utjecajem nekoliko faktora: laboratorijske vrijednosti, opsega i hitnosti intervencije, liječničke preporuke, dostupnih sadržaja, stručnosti stomatologa i oralnog, medicinskog i općeg stanja pacijenta.

**Ključne riječi:** oralna hirurgija, oralni antikoagulantsna terapija

## Introduction

The race for time and money in everyday and ordinary life has implications on human health, which has resulted with increased number of cardiovascular diseases in the young population and with consequences creating socio-economic problem. The scientific literature, the rapid development and the use of new scientific clinical methods of laboratory investigations changed the oral surgery treatment for the patients on oral anticoagulants [1].

Thrombosis is the formation, from the components of blood, of an abnormal mass within the vascular system. It involves the interaction of vascular, cellular, and humoral factors within a flowing stream of blood. Thrombosis and the emboli as the complication that can result are among the most important causes of sickness and death in developed countries. Thrombosis is of greater overall clinical importance in terms of morbidity and mortality than all others hemorrhagic disorders combined [1].

## Antithrombotic agents

The anti-thrombosis medicaments are antiplatelet, anticoagulant and thrombolytic agents. Antiplatelet drugs are used to prevent and / or treat thrombo-embolic disorders, which play a key role in cardiovascular diseases. Given the fact that the anti-aggregate mechanism of action consists in inhibiting the platelet function by preventing aggregation, in the initial phase of hemostasis, usage of these drugs can make patients more susceptible to hemorrhages [2].

The term oral anticoagulant (OAC) refers to oral vitamin K antagonists, including mainly sodium warfarin (the most widely used agent in Anglo-Saxon countries) and acenocoumarol (widely used in some European countries). These drugs are widely prescribed for preventing arterial thrombo-embolism in patients with atrial fibrillation and/or heart valve prostheses, so as for the treatment and prevention of deep venous thrombosis and pulmonary embolism. Oral anticoagulants (OA) inhibit the enzyme vitamin K epoxide reductase, which converts vitamin K into vitamin K hydroquinone. The vitamin K hydroquinone is needed to gamma carboxylate the glutamic acids at the N-terminal portion of the clotting factors II, VII, IX, and X and endogenous proteins C and S. If the

clotting factors are not carboxylated, they are not biologically active. Return of normal clotting after stopping OA requires the elimination of OA followed by the synthesis of new clotting factors. As the elimination half-life of OA is 40 hours and the clotting factors have different and sometimes long half-lives, it takes days to reverse the effects of OA [2].

Oral anticoagulants act by blocking the ability of Vitamin K to carboxylate the Vitamin K dependent clotting factors, thereby reducing their coagulant activity. OA works by interfering with internal recycling of oxidized Vitamin K to reduced form. When OA are given, the oxidized form of Vitamin K builds up in the blood leading to a deficiency of reduced Vitamin K and a decrease in carboxylation of prothrombin. OA interferes with  $\gamma$ -carboxylation of terminal glutamic acids on the procoagulant proteins, Factors II, VII, IX, and X [3].

The antiplatelet and anticoagulant agents have been extensively researched and developed as potential therapies for prevention and management of arterial and venous thrombosis. Also, these drugs have been associated with prolongation of bleeding after oral surgery interventions. Thus, some of the oral surgeons still recommend stopping of antiplatelet and oral anticoagulants at least 3 days before any kind of oral surgery procedure. However, the stopping of these drugs before the interventions expose the patient to vascular problems, and to potential morbidity [3].

The handling of these drugs requires correct monitoring and dose adjustment to obtain the desired therapeutic effect while minimizing the adverse effects associated both with excessive anticoagulation (which leads to bleeding) and with insufficient anti-thrombotic action (which can produce thrombosis).

The aim of this study is to review the evidence of different therapy approach, to highlight the areas of major concern, and to suggest specific oral surgery treatment for patients on oral anticoagulants.

## Oral anticoagulants – withdraw or continuation

The oral and maxillofacial surgeons are frequently asked to manage patients who are receiving oral anticoagulants. The goal of treatment is to minimize

the risk of hemorrhage while continuing to protect the patient against thrombus-embolism formation. The ordinary treatment includes the interruption of anticoagulant therapy for oral surgery interventions to prevent hemorrhage. However, this practice may logically increase the risk of a potentially life-threatening thrombo-embolism. Thus, this issue is still controversial [4].

Assael said that the hemostasis care of the oral anticoagulated patients is a shared responsibility of oral and maxillofacial surgeons, and the hematology/coagulation team huddle to determine the steps.

The surgeon is faced with the choice of altering or stopping oral anticoagulants thus risking thrombo-embolism or leaving the patient on the oral anticoagulants therapy with risk of uncontrolled bleeding. A common approach to managing patients with a low risk of thrombo-embolism needing surgery is to interrupt oral anticoagulants therapy for several days before and after surgery. Patients with a high risk of thrombo-embolism commonly stop with OA and bridge anticoagulation with infractional heparin (UHF) or low-molecular-weight heparin (LMWH) [4, 5].

The anticoagulant effect in turn depends on the half-life of the inhibited factors. In this sense, the half-lives of factors VII, IX, X and II are 6, 24, 40 and 60 hours, respectively. Blood coagulation factor VII is the first to be affected, prolonging prothrombin time (PT). Factors IX, X and II are posterior affected: factor IX prolongs activated partial thromboplastin time (aPTT), while factors X and II prolong both PT and a PTT. These are well tolerated drugs, with rapid absorption via the oral route. The peak plasma concentrations are reached one hour after administration, though the reduction in coagulation factors takes place 48-72 hours after dosing. The half-life of warfarin is 48-72 hours, versus 8-10 hours in the case of acenocoumarol. Thus, the effects of warfarin are longer lasting in terms of both the induction and disappearance of therapeutic action [6, 7].

However, patients who interrupt oral anticoagulants therapy are at risk of developing a thrombo-embolism with or without bridging therapy. On the other hand, oral anticoagulants therapy can be continued without interruption for procedures such as dento-alveolar surgeries that rarely cause significant or life-threatening bleeding. Stopping oral anticoagulants is problem creating because of its slow unpredictable reversal effect [8].

## Interruption of Oral Anticoagulant Therapy and Risk of Thrombotic Episode

The risk for thrombo-embolism depends on several factors, including the clinical indications for anticoagulation. Anticoagulation is required in the management of patients with prosthetic heart valves, chronic atrial fibrillation, hypercoagulable states (ie, protein C deficiency, protein S deficiency, factor V Leiden mutation, antithrombin III deficiency, antiphospholipid-antibody syndrome), venous or arterial thromboembolism, and cerebrovascular disease with strokes. However, patients who require anticoagulation do not have equal risk of developing thrombo-embolism [9].

The goal of managing anticoagulated patients who need surgery is to prevent major or life-threatening bleeding while protecting them against thrombo-embolism. Some procedures such as intra-abdominal, intrathoracic, major cancer surgery, removal of head and neck of tumors, and extra oral open reduction of facial fractures are associated with considerable bleeding [9].

Some patients are particularly sensitive to OACs, and the activity of these drugs moreover can be affected by a range of factors including individual patient response, diet, or the simultaneous administration of other commonly used drugs such as antibiotics, analgesics, or even herbal remedies. As a result, regular monitoring is required, and such control must be more frequent when changes occur in any of the aforementioned aspects. OAC action is monitored on the basis of the effect of such drugs on prothrombin time (PT), i.e., the time required for the clotting of citrate-treated plasma, after adding calcium and thromboplastin. Thromboplastin is extracted from different tissues with different levels of sensitivity - a fact that complicates the comparison of PT test results. The PT results are usually reported as the ratio patient time / control time. The simple ratio is extremely variable, depending on the sensitivity of the reagent used - thus making it impossible to establish universally applicable therapeutic margins [10].

For this reason, in 1978 the World Health Organization (WHO) recommended PT standardization, and in 1983 it introduced the INR (international

normalized ratio), which is calculated by raising the simple ratio to the international sensitivity index (ISI) of the thromboplastin used [11].

Thus,  $INR = (\text{patient time} / \text{control time})^{ISI}$ .

This is the formula used to standardize PT, allowing comparison regardless of the thromboplastin used by the different laboratories, and ensuring increased reliability in monitoring OAC treatment. At the same time, the different international societies established recommendations regarding the therapeutic anticoagulation levels to be maintained according to the existing patient pathology - the corresponding INR value ranging from 2 to 3.5. Because of that there is a strong correlation between INR and bleeding risk - the latter increasing when  $INR > 4$  (Table 1)[11].

The recommendations vary according to the bleeding risk of the surgical intervention and the indication of anticoagulation therapy (i.e., the thromboembolic risk of the patient). Thus, for example, treatment to prevent venous thromboembolism is not the same as treatment for dealing with an acute thrombotic episode [12].

Although consensus is lacking, the expert groups do establish a series of recommendations:

1. For patients at low risk of bleeding after the operation, anticoagulation can be maintained at the lower limit of the therapeutic range (INR = 2.0).
2. For patients at high bleeding risk, anticoagulation should be maintained at sub-therapeutic levels (INR = 1.5). Accordingly, acenocoumarol should

be suspended 3-4 days before surgery (4-5 days in the case of warfarin). On day -3, low molecular weight heparin (LMWH) should be provided at therapeutic, medium or prophylactic doses, depending on whether the thrombotic risk of the patient is high, moderate or low, respectively. This is to be maintained 12 hours before surgery, followed by 12 hours after surgery to be reintroduced to the original treatment, provided there is no bleeding [13].

### Bridging Therapy

Life threatening or major bleeding in patients who need high-risk surgery may be avoided by stopping oral anticoagulants with or without bridging therapy. The Food and Drug Administration has not approved bridging therapy with LMWH in patients with prosthetic heart valves, and UFH is frequently recommended as bridging therapy in these high-risk patients who develop arterial thrombo-embolism [13].

Bridging with UFH or LMWH is done to shorten the interval of sub therapeutic anticoagulation while waiting for the reversal of oral anticoagulation. For patients with a low risk of thrombo-embolism, bridging is not recommended because the efficacy of bridging with UFH and LMWH does not outweigh the risk of postoperative bleeding [14].

Patients with a low risk of thrombo-embolism can stop the oral anticoagulant and restart it after the surgery. Stopping oral anticoagulant and bridging is

Clinical pathology INR	INR
Prophylaxis – venous thrombo-embolism (high risk surgery)	2.0-3.0
Prophylaxis – venous thrombo-embolism (hip surgery)	2.0-3.0
Treatment of deep venous thrombosis or pulmonary embolism	2.0-3.0
Prevention of systemic embolism in patients with atrial fibrillation, heart valve disease, bio prostheses, or acute myocardial infarction	2.0-3.0
Valve prostheses, recurrent systemic embolism, recurrent myocardial infarction	2.5-3.5

INR = International Normalized Ratio

Table 1. Therapeutic anticoagulation levels [11]

not recommended for procedures for which major bleeding is not likely to develop.

Depending on the existing thrombo-embolic risk, the American Heart Association /American College of Cardiology Foundation Guide to Warfarin Therapy recommends different heparin management regimens for the patients with moderate, high and low thrombo-embolic risk. In general, heparins are reintroduced only 12 hours post-surgery, and dosing is postponed for longer periods in the case of evidence of bleeding [15, 16].

## Oral Surgery Procedures and management of bleeding

The management of oral surgery procedures on patients treated with anticoagulants is very much influenced by several factors: laboratory values, extent and urgency of the intervention, treating physician's recommendation, available facilities, dentist expertise, and patient's oral, medical, and general condition and antibiotic prophylaxis [17].

Procedures including single and multiple dental extractions, full mouth extractions, and alveolotomies are associated with very few bleeding episodes in patients who continue oral anticoagulants therapy [18].

In Sindet-Pedersen's original article [19], anticoagulant-treated patients undergoing oral surgery were prescribed a 4.8% aqueous solution of tranexamic acid for seven days post-surgery to prevent re-bleeding secondary to fibrinolysis of the wound clot.

The results of the most scientific studies confirm that anticoagulation treatment with warfarin need not be withdrawn prior to dental extractions, provided that the patients do not have a preoperative INR value exceeding 4.0, and local measures including antifibrinolytic therapy were instituted [20, 21, 22].

Wahl [23] published a review of peri-operative management of patients receiving oral anticoagulants in 1998. He summarized the outcome of 2,014 dental surgical procedures in patients who continued oral anticoagulation. Serious bleeding occurred in only 12 of the procedures, and 5 of the 12 bleeds were associated with INRs above therapeutic levels. Wahl also examined reports including 493 patients who

discontinued warfarin; 5 of these patients developed serious thrombo-embolic complication, resulting in 4 deaths. He concluded that as long as the surgery was done with INR introduced into therapeutic range, 2.0 to 4.0, the chance of serious bleeding following dentoalveolar surgery was low in patients who continue their oral anticoagulation therapy [24, 25].

Martinowitz et al. [26] followed 40 patients having 63 teeth removed without altering the oral anticoagulation. Local hemostasis was obtained using a biological adhesive after placing thrombin soaked gauze into the socket for 3 minutes. The INRs on the day of surgery ranged from 2.5 to 4.0. There were no incidences of prolonged or excessive bleeding. One patient had hemorrhage on the third postoperative day that was controlled by biting on gauze.

Recently, some authors have recommended that the most anticoagulated patients are capable of withstanding routine, limited, oral surgery procedures without additional medical intervention such as an antifibrinolytic mouthwash, provided a good surgical technique is employed. However, they limit acceptable INR values for this proposal to 3.0 or less for the patients with therapeutic levels higher than 3.0 and this group comprises the highest risk of serious thrombo-embolic events if their anticoagulation is temporarily discontinued or decreased such as in the case of prosthetic mitral valve replacement. A 4.8% tranexamic acid mouthwash is effective in controlling local hemostasis in anti-coagulated patients undergoing dental extractions. Statistically, there appears to be no difference between prescribed two-days vs. a five-day course [27, 28].

The usage of Surgicel, according to the scientific studies, is very common, because it is widely available, easy to handle, inexpensive and acts as a good delivery vehicle for the tranexamic acid deep into the base of the tooth sockets and subsequent blood clot after surgery. Surgicel is an oxidized regenerated cellulose preparation whose local hemostatic action depends on the binding of hemoglobin to oxycellulose, allowing the dressing to expand into a gelatinous mass, which in turn acts both as scaffolding for clot formation and a clot stabilizer. The material is completely absorbable and does not interfere with healing or bone regeneration [29].

In 2003, Carter et al. [30] conducted a randomized study in patients under oral anticoagulation and

subject to extractions without modifying the OAC regimen, and applying two types of hemostatic agents (4.8% tranexamic acid and autologous fibrin adhesive). The authors concluded that both approaches are effective and safe in controlling post-extraction bleeding.

Autologous fibrin adhesive applied to the socket walls was in turn recommended for the patients having difficulties to perform rinses correctly. Posterior studies reported the same efficacy in controlling hemostasis by applying rinses for two days only. Tranexamic acid has no marketing licenses in some countries, and fibrin adhesives are not recommended by all authors, due to the risk of disease transmission - though such systems are subjected to viral inactivation processes - and their high cost [30].

Post-extraction bleeding is generally controlled by local measures such as socket curettage, suturing, and local compression, thanks to an easy access to the bleeding zone [31, 32].

Given such measures proved insufficient, and the anticoagulation effect must be suppressed, the solution is in administering vitamin K. In this sense, intravenous administration elicits faster effects than the oral route - the recommended dose being 5-10mg. The use of concentrates of prothrombin complex or fresh frozen plasma is reserved for significant bleeding cases [33, 34, 35].

Based on the evidence that the benefit of preventing thromboembolism outweighs the risk of bleeding, the recommendations of the published clinical studies and the experts' opinions are to keep the OAC dose unchanged, working with therapeutic INR levels, and adopting local hemostatic measures - using antifibrinolytic agents such as tranexamic acid, in dental extractions. More invasive oral surgery with an increased bleeding risk may constitute an exception to these guidelines, requiring due evaluation in coordination with the hematologist [36, 37, 38].

## Conclusions

The evidence from clinical trials and focused reviews support the continuation of oral anticoagulation for patients needing dentoalveolar surgery. As long as the INR is within the therapeutic range and local hemostatic measures are taken following the

surgery, these patients will have little chance of developing uncontrolled bleeding following the surgery.

Stopping warfarin with or without bridging for dento-alveolar surgery is not supported by clinical evidence. The risk of developing life-threatening bleeding or uncontrolled bleeding using local measures following dental extractions, alveoloplasties, or dental implants is so low not needing stopping of warfarin.

Local hemostasis will control the bleeding in the few patients who develop post-surgical bleeding. The risk of uncontrolled life threatening bleeding following dento-alveolar surgery is so low not necessarily leading towards the stopping of anticoagulation even for a short interval and risk thrombo-embolism in patients being on oral anticoagulants.

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# FREQUENCY AND LOCALIZATION OF ALVEOLITIS IN ADULT PERSONS IN THE REGION OF THE CITY OF BANJA LUKA, BOSNIA AND HERZEGOVINA

UČESTALOST I LOKALIZACIJA ALVEOLITISA U ODRASLIH OSOBA NA PODRUČJU GRADA BANJA LUKE, BOSNA I HERCEGOVINA

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## ABSTRACT

**Aim:** The aim of this study is to determine frequency and localization of alveolitis after extraction of permanent teeth in adult patients (older than 18) in the region of the City of Banja Luka during the year 2012.

**Materials and methods:** The research included 191 adult patients out of the total number of patients that came to the Clinic for extraction of the Service for Dental Health Protection of the Health Centre Banja Luka during 2012. Data on gender, age, localization, number and type of teeth after the extraction which was followed by alveolitis, and other data related to this study were taken from dental carnets (with the written consent of the Institution director).

**Results:** 50,26% patients were of male gender and 49,74% of female. We divided the patients into 6 age groups.

Alveolitis mostly occurred in the patients' group aging from 45 to 54 (23.56%), then in the group aging 65 and more (23.04%) and the one ranging from 55 to 64 years (22.51%). Alveolitis mostly occurs in the lower jaw (86.39%), while in the upper jaw is represented with 13.61% of all alveolitis recorded cases. Alveolitis usually occurs after the extraction of the first molar (30.89%), then the second molar (23.56%) and the second pre-molar (20.42%).

**Conclusion:** The total percentage of alveolitis in this study is 6,32%. Alveolitis mostly occurs in the middle and older age, far more often in the lower than in the upper jaw and then on multi-rooted teeth. The separation of multi-rooted teeth and minimal traumatic work is recommended in order to reduce emerging of alveolitis.

**Key words:** dolor post extractionem, frequency of alveolitis, localization of alveolitis.

## SAŽETAK

**Cilj:** Cilj istraživanja ove studije jeste odrediti učestalost i lokalizaciju alveolitisa poslije ekstrakcije stalnih zuba u odraslih pacijenata (starijih od 18 godina) na području grada Banje Luke tokom 2012. godine.

**Materijali i metode:** U istraživanje je uključen 191 odrasli pacijent, od ukupnog broja pacijenata koji su posjećivali ambulantu za ekstrakciju zuba tokom 2012. godine Službe za stomatološku zdravstvenu zaštitu, Doma zdravlja Banja Luka. Podaci o spolu, godinama, lokalizaciji, broju i vrsti zuba, poslije čije ekstrakcije se javio alveolitis, i drugi podaci vezani za ovu studiju su uzeti iz stomatoloških kartona (uz pismenu saglasnost direktora ustanove).

**Rezultati:** 50,26% pacijenata je bilo muškog spola, a 49,74% ženskog pola. Pacijente smo podijelili u šest starosnih skupina.

Alveolitisi se najčešće javljaju kod ispitanika od 45 do 54 godine starosti (23,56%), zatim kod ispitanika sa 65 i više godina (23,04%) i kod ispitanika od 55 do 64 godine starosti (22,51%). Alveolitisi se uglavnom javljaju u donjoj vilici (86,39%), dok je u gornjoj vilici uočeno 13,61% od svih alveolitisa. Alveolitisi se najviše javljaju poslije ekstrakcije prvog molara (30,89%), zatim drugog molara (23,56%) i drugog premolara (20,42%).

**Zaključak:** Ukupan procent alveolitisa u ovoj studiji je 6,32%. Alveolitisi se najčešće javljaju u srednjem i starijem životnom dobu, daleko češće u donjoj vilici nego u gornjoj, i to poslije ekstrakcije višekorjenih zuba pri čemu dolazi do traume alveole. Treba ukazati na značaj prezervacije alveole i očuvanja njenih zidova.

**Ključne riječi:** dolor post extractionem, učestalost alveolitisa, lokalizacija alveolitisa

## Introduction

Alveolitis is a disorder of wound healing which is also known in literature as "dry socket" (dry alveolus). The term alveolitis was described for the first time by Crawford in 1896 [1]. Other synonyms are: alveolalgia and alveolar osteitis, localized osteitis [2, 3, 4].

It represents post-extraction pain which can be caused by different factors.

Etiologic factors can be:

General: hypo-vitaminosis D and E, hypo-proteinemia, diabetes, oral contraceptives [5].

Local: trauma of alveolus with rough manipulation and damage of mycosis and sub-mycosis, as well as by remains of bone sequestra, tooth parts or parts of filling [6].

It occurs after extraction of gangrenous and pulpitic teeth. Two main symptoms are absence of healthy, vital coagulum and intensive pain. Alveolus is filled by mealy and disintegrated coagulum, which is of dirty grey colour, has an unpleasant smell and can be easily torn by tweezers (alveolitis exudativa), though alveolus can also be completely empty (alveolitis sicca). Pain and empty alveolus are also present in almost all patients with alveolitis [7, 8]. In some patients pain spreads towards the ear and temporal region [9, 10], then there are halitosis [9,11], gingivitis and naked bone [12].

Pain appears immediately after the cease of anaesthesia effects and very often any pain after 24 hours can be placed in this category of post-extraction complications. It most often appears on the third and fourth days after extraction, though possibly somewhat later as well.

## Materials and Methods

Research was conducted by observing patients who went through the Service for Dental Protection of the Health Centre Banja Luka and, in particular, through the Clinic intended only for tooth extraction.

The total number of patients in the given Clinic for 2012 was 3024 by which we were guided in doing this study finding it interesting for our topic; out of all

patients with extracted teeth, 191 patients were registered with alveolitis diagnosis.

All data related to extraction of certain teeth were taken from dental carnets provided the Chief of Service and Institute Director consents. Personal data are protected and patients' privacy was not jeopardized in any case.

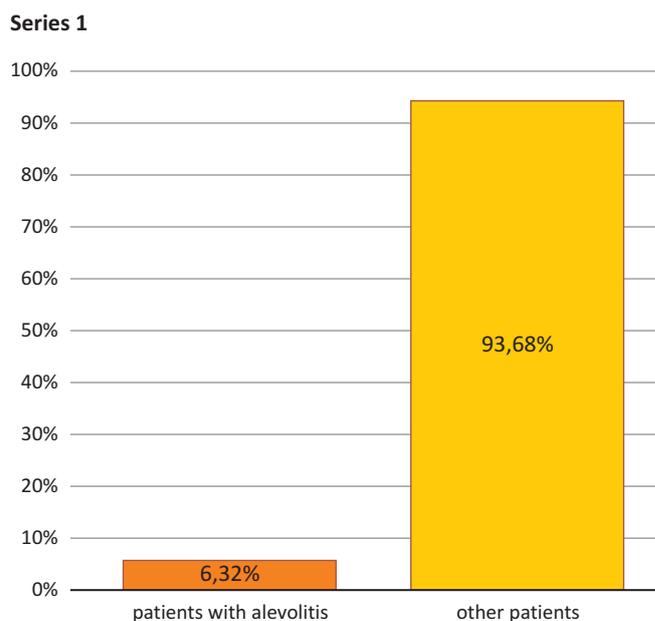
In this study we kept a record for every patient who came to the Clinic after extraction with the symptoms and signs of the clinical appearance of alveolitis, paying attention to the data on patient's age, gender (male/female), localization of alveolitis (upper or lower jaw) as well as the group they belong to with the exact localization (for example, the first upper molar, the second lower pre-molar etc.).

Qualitative data are shown through the number of occurrences and incidence in terms of percentages.

## Results

Total percentage of patients with alveolitis is 6,32%. (**Figure 1.**)

Alveolitis occurs mainly in the lower jaw (86.39%), while in the upper jaw it was represented by 13.61% out of all alveolitis observed (**Figure 2.**). This difference is statistically significant.



**Figure 1.**  
The incidence rate of alveolitis in relation to all patients in 2012

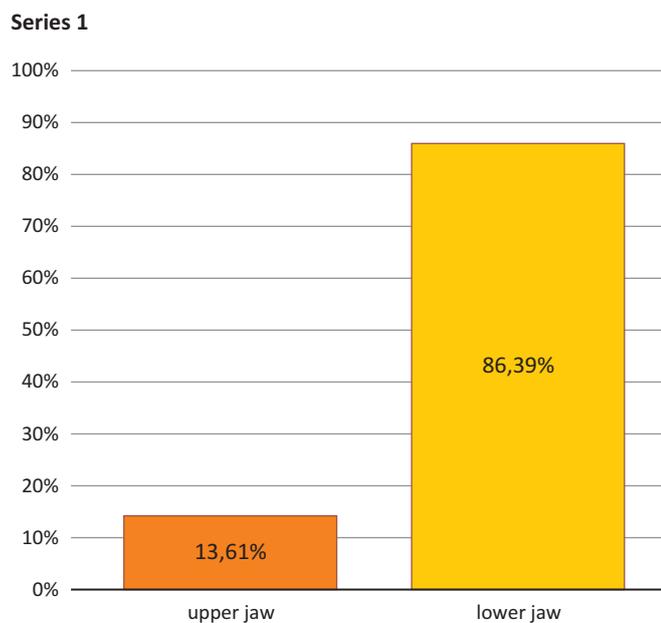


Figure 2.

The incidence rate of examinees according to the jaw in which alveolitis is located

This research involved 191 examinees with alveolitis. 50.26% of all examinees were of male gender and 49.74% of female gender. Alveolitis mostly occurs in examinees aging from 45 to 54 years (23.56%), then in examinees of 65 and more (23.04%) and in examinees from 55 to 64 years of age (22.51%). In relation to the total number of alveolitis cases, the youngest examinees were those least suffering from alveolitis (from 18 to 24 years of age), reaching 8.38% of all alveolitis cases (Figure 3.).

Greater incidence of examinees with alveolitis in "older" age groups is statistically significant.

Greater incidence of alveolitis in the lower jaw was observed both in men (86.46%) and women (86.32%).

The difference in the incidence of alveolitis in the upper or lower jaw according to the gender of the examinees is not statistically significant.

Alveolitis most often occurs after the extraction of the first molar (30.89%), then the second molar (23.56%) and the second pre-molar (20.42%) while it occurs rarely after extraction of other teeth (Figure 4.). Difference in the occurrence of alveolitis on certain teeth is statistically significant.

Incidence of alveolitis in the upper or lower jaw does not diverge in a statistically significant way in

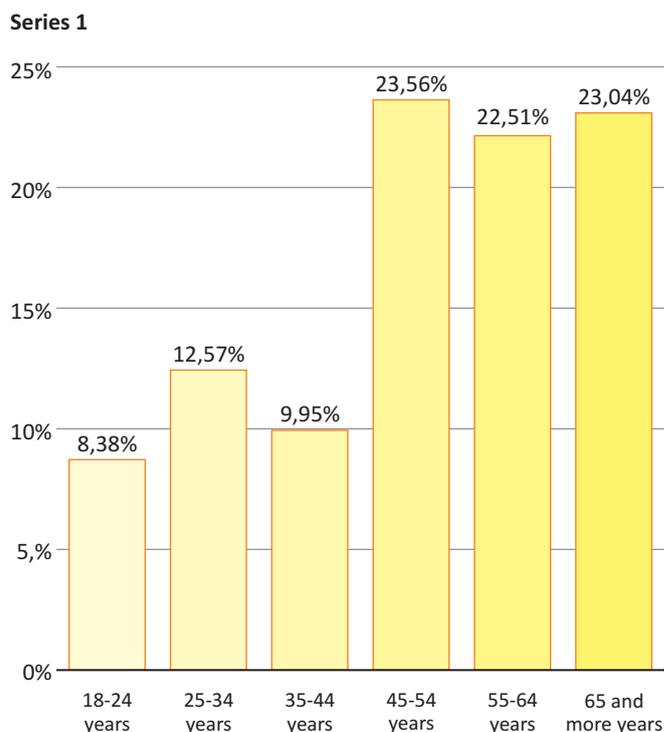


Figure 3.

The incidence rate of examinees according to age groups

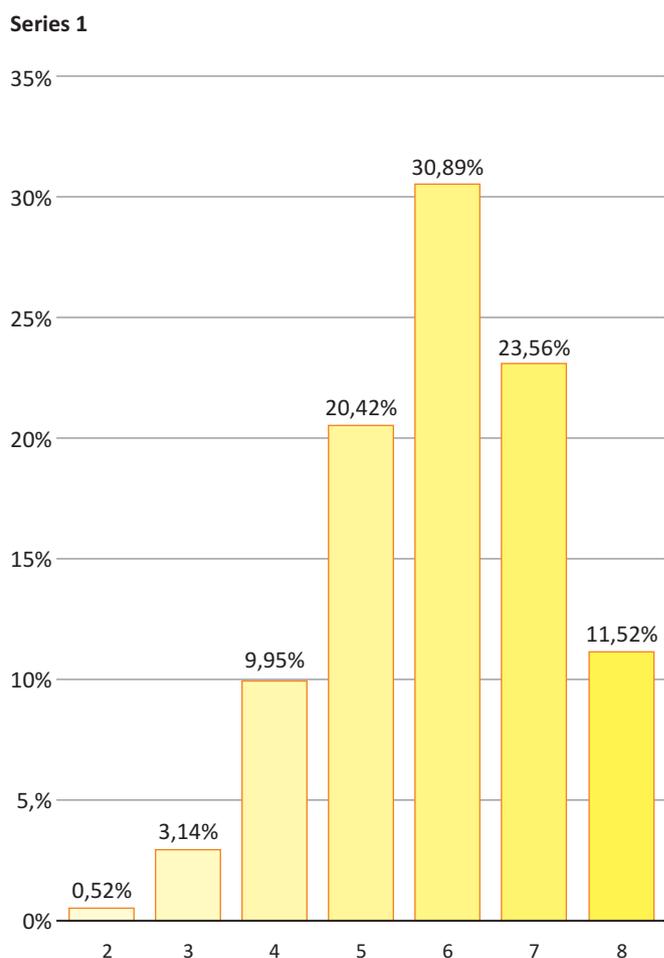


Figure 4.

The incidence rate of examinees according to the tooth in which alveolitis occurs

Jaw	Age group											
	15-24 years		25-34 years		35-44 years		45-54 years		55-64 years		65 and more years	
	n	%	n	%	n	%	n	%	n	%	n	%
Upper	3	18,75	7	29,17	0	0,00	5	11,11	6	13,95	5	11,36
Lower	13	81,25	17	70,83	19	100,00	40	88,89	37	86,05	39	88,64
<b>Total</b>	<b>16</b>	<b>100,00</b>	<b>24</b>	<b>100,00</b>	<b>19</b>	<b>100,00</b>	<b>45</b>	<b>100,00</b>	<b>43</b>	<b>100,00</b>	<b>44</b>	<b>100,00</b>
$\chi^2$	<i>df</i>		<i>P</i>									
8.724	5		0,121									

**Table 1.**  
The frequency and incidence rate of alveolitis in the upper and lower jaw according to age groups

any observed age group from the structure on the total level (**Table 1**).

In **Table 2**, the frequency of alveolitis on certain teeth in the upper and lower jaw according to the examinees gender, as well as age group, is shown.

Statistically significant differences in the incidence of alveolitis were not observed either in the first or in the second case. Not a single occurrence of

alveolitis after the extraction of lateral incisor tooth and eye tooth was observed in the upper jaw. Alveolitis rarely occurs in the upper jaw and mostly after extraction of the first pre-molar and the first molar. In the lower jaw, alveolitis most often occurs after extraction of the first molar (31.52%), the second molar (24.85%) and the second pre-molar (22.42%)

Jaw	Tooth	Age group											
		15-24 years		25-34 years		35-44 years		45-54 years		55-64 years		65 and more years	
		n	%	n	%	n	%	n	%	n	%	n	%
Upper	4	2	66,67	0	0,00	0	0,00	2	40,00	2	33,33	2	40,00
	5	0	0,00	1	14,29	0	0,00	0	0,00	1	16,67	0	0,00
	6	1	33,33	4	57,14	0	0,00	0	0,00	1	16,67	1	20,00
	7	0	0,00	1	14,29	0	0,00	2	40,00	1	16,67	0	0,00
	8	0	0,00	1	14,29	0	0,00	1	20,00	1	16,67	2	40,00
	<b>Total</b>	<b>3</b>	<b>100,00</b>	<b>7</b>	<b>100,00</b>	<b>0</b>	<b>0,00</b>	<b>5</b>	<b>100,00</b>	<b>6</b>	<b>100,00</b>	<b>5</b>	<b>100,00</b>
Lower	2	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	1	2,56
	3	0	0,00	0	0,00	1	5,26	1	2,50	2	5,41	2	5,13
	4	0	0,00	0	0,00	1	5,26	1	2,50	4	10,81	5	12,82
	5	1	7,69	4	23,53	3	15,79	12	30,00	8	21,62	9	23,08
	6	8	61,54	5	29,41	10	52,63	15	37,50	6	16,22	8	20,51
	7	2	15,38	6	35,29	4	21,05	8	20,00	11	29,73	10	25,64
	8	2	15,38	2	11,76	0	0,00	3	7,50	6	16,22	4	10,26
	<b>Total</b>	<b>13</b>	<b>100,00</b>	<b>17</b>	<b>100,00</b>	<b>19</b>	<b>100,00</b>	<b>40</b>	<b>100,00</b>	<b>37</b>	<b>100,00</b>	<b>39</b>	<b>100,00</b>
Upper jaw						Lower jaw							
$\chi^2$		<i>df</i>		<i>P</i>		$\chi^2$		<i>df</i>		<i>P</i>			
14.835		16		0,537		31.186		30		0,406			

**Table 2.**  
The frequency and incidence rate of alveolitis on teeth in the upper and lower jaw according to age groups

## Discussion

In this research we met with various cases which could explain this percentage of alveolitis for the given year (6,32%). For routine dental interventions, the incidence of alveolitis after tooth extraction is variable, and moves in the range of up to 5% [13], being much bigger in the chirurgic tooth extraction and amounting even to 37% [14]. In over 95% of cases alveolitis occurs in the first week [13].

Statistically significant is the fact that the greatest number of cases of alveolitis occurs in the lower jaw because of its compact structure, lower blood supply and higher bone density, as well as reduced capacity for the process of tissue granulation [15]. There is a high incidence of alveolitis in the lower jaw (86,39%), both in male population (86,46%) and female population (86,32%).

The results show that both in the upper and lower jaw alveolitis more often occurred on multi-rooted teeth. In this research we obtained data showing that the incidence of alveolitis after the extraction of lower molars has the stated order: the first lower molar (31, 52%), the second lower molar (24,85%), the third lower molar (10,30%). In the upper jaw the incidence of alveolitis is 13,61% only after the extraction of the first upper molar (30,77%) because of the fact that this tooth most often has two roots (often fused) and gracile structure sensitive to fracture, which can additionally traumatize alveolus. We obtained the following data in relation to the occurrence of alveolitis after the extraction of molars: the first upper molar (26,92%), the second upper molar (15,38%), the third upper molar (19,23%). During the extraction of molars alveolus is traumatized and damaged, which, together with root fracture and damage of adjacent soft tissue, causes a higher percentage of the alveolitis appearance.

There is higher possibility of the alveolitis appearance in older patients (older than 65) being explained by lower biological and biochemical processes in their organisms as well as harder wound healing [4]. Even this study showed that the incidence of alveolitis is increased in the last three age groups, namely from 45-54, where it amounts to 23, 56%, then from 55-64, amounting to 22, 51%, and finally in the age group of over 65 with the incidence percentage of 23, 04%.

## Conclusion

This epidemiological study for the given year and the city showed higher percentage (6, 32 %) of the occurrence of alveolitis than the standard percentage is (up to 5%). This higher incidence of alveolitis occurs after the extraction of multi-rooted teeth. By means of the techniques of luxation during extraction, and due to morphological characteristics of teeth, the greater trauma and damage of the alveolus tissue happen, particularly in the lower jaw. It is necessary to pay attention to the significance of the preservation of alveolus after the extraction of multi-rooted teeth, as well as of the preservation of the walls of alveolus in all extractions. The separation of multi-rooted teeth and minimal traumatic work is recommended in order to reduce the emergence of alveolitis.

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# PERIODONTAL REGENERATIVE EFFECT OF HYDROXYAPATITE IN THE TREATMENT OF INTRABONY DEFECT

PARODONTNI REGENERATIVNI UČINAK HIDROKSIAPATITA U LIJEČENJU INFRAKOŠTANOG DEFEKTA

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### ABSTRACT

Periodontal regeneration in patients with advanced periodontitis and loss of a connector is a big challenge for the periodontist.

**Objective:** To describe a case of application of hydroxyapatite in the treatment of intra-bony deep pocket.

**Methods:** At the beginning of therapy, the plaque index was verified and gingival bleeding index and pocket depth were measured. After the initial therapy was performed, an open flap surgery was done filling the intra-bony pocket with bone substitute. Radiograph analysis was performed before and after surgical treatment.

**Conclusion:** After a year, clinical parameters and radiographic analysis showed a reduction of pocket depth and tooth scheduled for extraction was preserved.

**Key words:** Periodontal regeneration, Intra-bony defect, Bone Substitute

### SAŽETAK

Parodontna regeneracija kod pacijenata sa uznapredovalim parodontitisom i velikim gubitkom pripoja predstavlja veliki izazov za parodontologa.

**Cilj:** Opisati slučaj primjene hidroxyapatita u liječenju infrakošanog dubokog džepa.

**Metode:** Na početku terapije verificiran je plak indeks, index krvarenja gingive i izmjerena dubina džepova. Nakon provedene inicijalne terapije pristupa se otvorenoj flep operaciji, tokom koje je infrakoštani džep ispunjen koštanim nadomjestkom. Rengenološka analiza rađena je prije i nakon hirurškog tretmana.

**Zaključak:** Godinu dana kasnije klinički parametri i RTG analiza pokazali su redukciju dubine džepa, a zub predviđen za ekstrakciju sačuvan je.

**Gljučne riječi:** parodontalna regeneracija, infrakoštani defekt, koštani nadomjestak

## Introduction

Periodontal regeneration of patients with aggressive periodontitis and high level of a connector loss presents great challenge for periodontist [1]. Implementation/Application of guided tissue regeneration (guided tissue regeneration-GTR) and guided bone regeneration (guided bone regeneration-GBR) became healing/treatment standard in Periodontology. Principals of guided regeneration application combined with endodontics - periodontal treatment of pulp-periodontal lesion is very challenging task [2]. Interdisciplinary approach, that includes combination of endodontic and periodontal (chirurgical) treatment can save the tooth intend for extraction. Guided tissue regeneration was introduced as a term by Melcher [3]. Epithelial cells migrate 10 times faster than other types of periodontal cells [4]. If migration of epithelial cells to wound is disabled long enough, other types of cells with regenerative potential will have a chance. That can be performed with usage of various kinds of barriers, membranes, with or without bone substitute.

Contrary to non-absorbing membranes, absorbing membranes have relatively good features and can be reabsorbed in optimal period, denying a need for chirurgical interventions [5]. However, these

membranes are very sensitive and it is recommended to reinforce them by combining them with bone substitute (bone graft) [6]. Since usage of membranes increases costs and work duration, several authors tried to apply bone substitute without membrane as an alternative way of treatment. In order to achieve the simplicity of handling without need to apply membrane, bovine hydroxyapatite (BH) is developed. BH is used for correction of periodontal bone defects and reabsorbed alveolar bone around the implants [5,7,8-13]. Resemblance that it has with human bone (porosity and microstructure) induces/creates great osteo-conductive environment within bone defects. Several pre-clinic and clinic studies are showing that combination of BH and GTR improves periodontal regeneration especially for infra-bony pockets [13-16]. Endodontic infection influences development of bone loss [17]. Teeth with periapical pathological process have approximately 2 mm lower radiological loss of connection in comparison to teeth without it [18]. Thomas Von ARX et al. 2001 suggested classification of membrane application in endodontic chirurgical treatment that is based on type of peri-radicular lesion [19]. According to Thomas Von ARX et al. Class II of lesions presents combination of endodontic and periodontal lesion. According to the same author Class II b of lesion (pulpy-periodontal communication) is the most difficult to treat and



**Figure 1.**

X-ray image before periodontal chirurgical therapy



**Figure 2.**

3 months after chirurgical therapy

imply usage of GTR and GBR principles in order to improve conditions for tissue renewal, providing optimal environment for creation of needed connective tissue.

## Case report

35-year old patient D.A. was admitted at the Department for Oral surgery according the recommendation of her dentist for tooth extraction 21 that was under pain and mobility.

Through clinical examination and with an x-ray analysis, it was diagnosed pulp-periodontal communication, infra-bony pocket 11 mm deep on mezzoproximal side, and II degree of tooth mobility giving that tooth extremely bad prognosis.

Since it was central incisors in complete dental arch, combined endodontic periodontal treatment was suggested to the patient D.A. trying to preserve the tooth. After patient agreed on treatment, endodontic treatment was performed first followed by periodontal therapy. At the beginning of periodontal therapy, plaque index, bleeding on probe index (BOP), depth on probe measured and occlusion analysis were verified. After initial therapy was done, flap operation followed. After local anesthesia, cut with vertical relaxation distally was made with muco-

periost lifted on the part of partial loss of buccal bone lamella. Using the Greycy and universal curette, complete scaling and root plane (de-bridman) was performed. All granulated tissue was removed from the bone defect and root surface was treated. Bone defect was filled with graft of hydroxyapatite type (Geistlich Bio Oss) and stabilized by covering with tensionless lobe and sewn with non-absorbing silk (4-0 Silkam, Brown).

Patient received guidelines on the post-operational treatment including the rinsing of mouth with Curasept ADS 220 liquid (Curadent, Swiss) during the first 2 weeks. Antibiotics were recommended (Amoxicillin 500mg with clavulanic acid 125 mg) for 14 days. Stitches were removed 10 days after and wound treated with 3% hydrogen peroxide and cotton balls. Directives about oral hygiene were given again and control examinations were scheduled at 3, 6 and 12 months after the operation.

At clinical control examination after 12 months 2 mm recessions were noticed, and even with present esthetic, the patient was satisfied with achieved results.

Analysis of x-rays made before chirurgical intervention (**Figure 1**) and the other made at control examinations after 3, 6, and 12 months (**Figure 2, 3, and 4**) were used for the evaluation of this therapy's success.



**Figure 3.**  
6 months after chirurgical therapy



**Figure 4.**  
12 months after chirurgical therapy

## Discussion

It was proved that the Class II b lesion is the biggest challenge for treatment. In clinical research including periapical surgery, according to Hirsch et al., only at 27, 3% teeth out of the total number of teeth with buccal bone loss, satisfying treatment outcome is achieved [20]. According to Skoglund and Persson, retrospective evaluation of periodontal therapy of teeth with total loss of buccal bone lamella showed that only 37 % was successful three years after [21]. Sculean et al. concluded that treatment of infra-bony defects with flap-operation resulted with better clinical connection level staying during 5 years [22].

We decided in our case to apply bone graft without absorbing membrane based on the experience of numerous authors [22, 23, 24, 25, and 26], as well as due to size of defect itself and good conditions of its total coverage with tensionless lobe. Based on clinical surveillance and x-ray control examinations we came to the conclusion that significant probing depth reduction was achieved and degree of tottering was reduced even after 12 months. Our result is correlating with results of quoted authors by whom this therapy is evaluated as exceptionally complicated, so more cases that would be long-term monitored should get better clinical results.

## Conclusion

Successful therapy (open flap operation with principal GTR and GBR) represents imperative in treating infra-bony defects with buccal bone lamella loss. Interdisciplinary approach of endodontic and periodontal therapists' in treatment of pulp-periodontal complications can prevent teeth loss being indicated for extraction.

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This book presents the latest modern concept of original and innovated doctrine in surgical disciplines. Presented problems are well covered in all areas. Special emphasis is given to the chronological segments designed and developed by chapters: A. BASICS, B. TECHNIQUES and C. COMPLICATIONS.

The Basics section presents the anatomical, structural and biological basis of periodontal structures handled schematically, histological and electron methods that indicate, along with the latest scientific data and information, the importance of periodontal structures. Innovation that this book brings concerning micro-surgical procedure is here presented method of fluorescent angiography with significantly less anemia of operated area. In the aesthetic, periodontal, plastic and implant surgery there are clinically imperatives to use atraumatic needles and fine gracile surgical instruments, sewing kits, as well as numerous new techniques of sewing. Microsurgical concept is the concept of the future and has the advantage over conventional surgery, and all that is very well documented with original photographs in this book.

Principles and stages of wound healing in this chapter are vividly presented. Specially evaluated are systemic factors, diabetes mellitus, smoking, immunosuppressive medications and AIDS as their influence on the course of healing and quality of primary healing.

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necessary preoperative and postoperative medication, after which they described clinical procedures with the administration of antibiotic prophylaxis.

Through Chapter techniques the authors have treated reconstructive procedures that are carried out through the use of grafts. It is also presented, by RASTER electron microscopy footage, xenogenic bone replacement material in the case of BIO - OSS particles in the form of granules of size between 0.25 mm and 1 mm. This problem, the authors give a great importance and attention in the context of the gingival index, the potential of the different surgical techniques, in order to fully meet the requirements of aesthetics, as important parameter of successful treatment outcomes. Implant surgery today holds a special place in the rehabilitation of edentulous region. Indications, technical and technological parameters are crucial in selecting patients for this surgical discipline. This chapter gives a detailed description, numerous clinical examples with the original photo-documentation of various surgical and combined periodontal-surgical and aesthetic prosthetic procedures to the final functional and aesthetic outcomes. It points to the importance of the

technical process of making X-ray or surgical jig with the final radiographs after implant placement.

In chapter Complications authors presented methods to overcome possible complications, then continue therapy in order to establish normal reparative mechanisms.

All this original, innovated and modern material, we only hinted at in this brief overview is presented in the book in logical and systematic sequence, enriched schematically, histological and electron images of clinical examples. The book gives a contemporary concept of surgical doctrinal principles, documenting stages of surgical intervention from initiation to final prosthetics. Principles of clinical practice in surgical disciplines are incorporated both in content and photo-documentation. The book conveys diagnostic and therapeutic skills for all surgeons in clinical practice dentistry. Latest surgical procedures and doctrines that are now used in the surgical treatment protocols represent a new dimension of aesthetic, periodontal, cosmetic and implant surgery in the 21st century.

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