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THE EFFECT OF IRRIGATION AGENTS ON THE BOND STRENGTH OF THE COMPOSITE POST WITH THE DENTIN

ЕФЕКТОТ НА СРЕДСТВАТА ЗА ИРИГАЦИЈА ВРЗ ЈАЧИНАТА НА ВРСКАТА НА КОМПОЗИТНОТО КОЛЧЕ СО ДЕНТИНОТ

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Abstract

Aim: Evaluate the effect of irrigation agents and cementation materials on the bond strength of composite post with dentin. **Material and method:** For this in vitro study, 48 single-rooted teeth were used (incisions, second premolars with one root) extracted for orthodontic and periodontal reasons. The teeth were then divided into 2 groups of 24 teeth depending on the irrigation agent used, and each group was divided into 2 subgroups of 24 teeth depending on the cementation agent. After applying the composite post to the root canal and restoration, all samples were prepared in molds to test the strength of the composite post with the dentin. For this study, a descriptive statistical analysis was used, which was implemented on the obtained results, and was made in a Excel ANOVA 2016 statistical package, where the test strength was performed with Push-out testing. **Results:** The obtained results were in favour of the group where 2.5% sodium hypochlorite and 17% EDTA were used as irrigants, where the technique of complete etching with 37% orthophosphoric acid was used, Excite adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein) and dual polymerizing cement Variolink II (Ivoclar Vivadent Inc., Schaan, Liechtenstein), the pressure, i.e. the bond strength obtained by push-out testing was the highest and was 2,185 MPa, and the weakest bond was obtained when we used only 2.5% sodium hypochlorite as an irrigant, using Excite self-etching adhesive and SpeedCEM™ dual-polymerizing cement. **Conclusion:** From the results obtained from this study we can conclude that the bond between the composite post and the dentin is strongest with the application of the irrigants: 2.5% sodium hypochlorite and 17% EDTA, and the technique of complete etching with orthophosphoric acid in combination with Excite self-etching adhesive and SpeedCEM™ dual-polymerizing cement. **Key words:** endodontic treatment, dual-polymerizing cements.

Апстракт

Цел: Да се евалуира влијанието на средствата за иригација и материјалите за цементирање врз јачината на врската на композитното колче со дентинот. **Материјал и метод:** За ова е ин витро испитување беа користени 48 еднокорени заби (инцизиви, втори премолари со еден корен) екстрахирани од ортодонтски и пародонтолошки причини. Потоа забите беа поделени во 2 групи од по 24 заби зависно од користеното средство за иригација, а секоја група беше поделена на 2 подгрупи од по 24 заби зависно од средството за цементирање. По апликацјата на композитното колче во коренскиот канал и реставрацијата сите примероци беа припремени во калапи за испитување на јачината на врската на композитното колче со дентинот. За ова испитување користена е дескриптивна статистичка анализа која е имплементирана на добиените резултати, а е изработена во статистички пакет Excel ANOVA 2016, при што јачината на тестот е работена со Пуш -аут тестирање. **Резултати:** резултатите кои се добија беа во прилог групата каде како ириганси се употребени 2.5% натриум хипохлорид и 17% EDTA, каде се примени техниката на комплетно нагризување со 37% ортофосфорна киселина, атхезивот Excite (Ivoclar Vivadent Inc., Schaan, Liechtenstein) и двојнополимеризирачкиот цемент Variolink II (Ivoclar Vivadent Inc., Schaan, Liechtenstein) притисокот односно јачиината на врската добиена со пуш аут тестирањето беше најголема и изнесуваше 2,185 MPa, а најслаба врска се доби кога како ириганс го користевме само 2.5% натриум хипохлориддот со примена на самонагризувачкиот атхезив Excite и двојнополимеризирачкиот цемент SpeedCEM™. **Заклучок:** Од добиените резултати од ова испитување можеме да зклучиме дека врската помеѓу композитното колче и дентинот е најцврста со примена на иригансите 2.5% натриум хипохлорид и 17% EDTA и техниката на комлетно нагризување со ортофосфорна киселина во комбинација со самонагризувачкиот атхезив Excite и двојнополимеризирачкиот цемент Variolink II. **Клучни зборови:** ендодонтски третман, ириганси двојно полимеризирачки цементи.

Introduction

The prognosis for endodontically treated teeth depends not only on the success of endodontic treatment but also on the type of restoration of the teeth, those teeth are weakened by the treatments themselves as well as by the loss of the tooth structure where, not infrequently, the crown of the tooth is destroyed which requires intervention with a post in the root of the tooth as a restorative process. The resin-based materials used to cement the posts may be affected by the irrigants used during the chemical-mechanical treatment of the endodontic treatment.

Dentin bond usually begins with the etching of the dentin, the removal of the smear layer, and then the placement of a layer of hydrophilic resins that diffuse into the demineralized dentin. The final application of bond resin and its polymerization complete the bond process. The diffuse surface forms a hybrid layer by penetrating around exposed collagen fibers and by penetrating open dentinal canals[1,2]. The root canal irrigation plays an important role in the endodontic therapy. Numerous studies which are conducted in this area confirm that the amount of debris is significantly higher in the root canals that are processed without the use of irrigants. The preparation of the root canals without irrigation leads to a lag of 70%, more debris and a smear layer on the walls of the root canals of the teeth[3,4]. The effectiveness of irrigation in removing the smear layer depends on the type and amount of irrigation solution, the width and morphology of the root canal and the irrigation technique[5,6]. Cleaning and disinfection of the canal system of the tooth during endodontic therapy depends on the physical and chemical effect of the irrigation, i.e. the irrigants[7].

The physical effect of irrigation is based on the flow and return jet of the irrigant through the root canal, which results in mechanical removal of the debris and the smear layer from the walls of the root canals of the teeth[8,9,10].

The chemical effect of irrigation is based on the decomposition and demineralization of debris, smear layer, remnants of pulp tissue, dentin and is also the most effective way to remove the same[11,12].

In endodontic treatment of teeth, the treatment reduces the amount of dentin in the root canal, which reduces the strength of the tooth and increases the possibility of vertical fracture of the root. The irrigation agents and the cementation materials also contribute to increasing the longevity of an endodontically treated tooth, as well as to the improvement of the bond strength of the composite post with the dentin[13,14].

The use of irrigation agents, before the bond process begins, may have an effect on the adhesion because it alters the properties of the hydrophilic resins.

Depending on the bond method, composite cements can be light-polymerizing, dual-polymerizing or chemical polymerizing. In addition, modern composite cements can be divided into the following three groups according to the adhesive system they use: cements used with Total etch adhesives, cements used with self-etching adhesive and self-adhesive cements[15].

Due to the depth of preparation for the posts, the use of dual-polymerizing or chemical polymerizing materials is recommended, instead of light-polymerizing adhesives and cements[16].

The advantage of dual-polymerizing cements is the sufficiently long working time and the possibility for faster bonding with light-polymerization in clinically unfavourable situations, i.e. in places, in regions where light-polymerization is not available, the material bonds chemically.

Aim

Evaluate the effect of irrigation agents and cementation materials on the bond strength of the composite post with the dentin.

Material and methods

For this in vitro study, 48 single-rooted teeth were used (incisions, second premolars with one root) extracted for orthodontic and periodontal reasons. During endodontic treatment, the root canals were prepared manually using the step-back technique up to the apical size of ISO 40. After changing each instrument, the root canals were rinsed with 2 ml of 2.5% NaOCl solution. The root canals were dried with paper points (Dentsply Maillefer, Tulsa, Okla., USA) and filled with gutta-percha and AH Plus definitive filling material (Dentsply Caulk, Milford, Del., USA) using the cold lateral-compaction technique.

The teeth were then divided into 2 groups of 24 teeth depending on the irrigation agent used, and each group was divided into 2 subgroups of 12 teeth depending on the cementation agent. For the teeth from the first group, and a subgroup after the preparation of the root canal for application of the composite post (GC EverStick), we used 2.5% sodium hypochlorite and 17% EDTA for irrigation, then the technique of complete etching with 37% orthophosphoric acid in the root canal was applied, and after rinsing and drying we applied Excite adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein), and cemented the composite post (GC EverStick) with Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein).

For the teeth from the first group, subgroup 1 b, after the preparation of the root canal for application of the composite post (GC EverStick we used 2.5% sodium hypochlorite and 17% EDTA) for irrigation. After processing and drying the root canal we applied Excite self-etching adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein), and cemented composite post (GC EverStick) with Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein).

For the teeth from the 2 group, subgroup a, during the processing of the root canal for application of the composite post (GC EverStick) we used 2.5% sodium hypochlorite for irrigation.

Then the technique of complete etching with 37% orthophosphoric acid in the root canal was applied, and

after rinsing and drying we applied Excite adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein). We cemented the composite post (GC EverStick) with Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein).

For the second subgroup 2 b on 12 teeth, after the preparation of the root canal for application of the composite post (GC EverStick) we used 2.5% sodium hypochlorite for irrigation, then the technique of complete etching within the root canal was applied, and after drying the root canal we applied Excite self-etching adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein), and cemented the composite post (GC EverStick) with SpeedCEM™ dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein).

After the application of the composite post in the root canal and the restoration, we first placed all the samples in plastic molds (FIXI FORM, STRUCTURES), that have an inner diameter of 25 mm, and a height of 25 mm and they are made of PVC (polyvinyl chloride) ISO 3698, grade 3.

Two-component transparent acrylate ORTO POLI was used for placing the samples. The placed samples were left to harden for 3 hours at room temperature, then they were taken out of the molds.

Each sample was placed on a specially designed bearing of the universal testing machine, Instron 1122, with the apical, smaller surface facing up. The diameter bar is 1.2 mm and is positioned so that it only touches the filling. The force is applied in the apical-coronary direction to avoid jamming due to the final sample. The technique used is the Push-Out Method for the tissue bond strength which is used in many other variations but also in medicine or dentistry to prove the bond strength between the post and the dentin after endodontic treatment.

To show the bond strength as a pressure in MPa, the breaking force (F) N is divided by the adhesion surface of the sealers (mm2) and is represented by the formula:

$$P(MPa) = \frac{F\ (N)}{S(mm^2)}$$

The adhesion surface of the sealers (S) (mm2) is calculated according to the formula $S = \pi\ (R + r)\ h$ where $\pi = 3{,}14$ R is the diameter of the coronary side of the channel filling, r is the diameter of the application side of the filling and h is the thickness of the sample that is 1mm.

The test is performed at a speed of 0.5 mm / min until the moment of termination of bond. The bond is considered to be terminated when there is extrusion of the sample materials. The force that caused the bonds between the fillings and the dentin to break is recorded in dkN on the test machine graph.

For this study, a descriptive statistical analysis was used, which was implemented on the obtained results, and was made in a Excel ANOVA 2016 statistical package, where the test strength was done with Push-out testing.

Results

The results obtained from this study show us the effect of irrigation agents and cementation materials on the bond

Table 1

Groups	Irrigation agent	Cementation agent	μTBS (MPa)	Minimum value	Maximum value
GC Ever stick Group 1 a	Sodium hypochlorite and EDTA	Excite and Variolink II (complete etching with acid)	2.185	1.09	3.12
GC Ever stick Subgroup 1b	Sodium hypochlorite and EDTA	Excite and Speed cement (self-etching)	1.536	0.96	2.27
GC Ever stick Group 2 a	Sodium hypochlorite	Excite and Variolink II	1.383	0.86	2.19
GC Ever stick Subgroup 2 b	Sodium hypochlorite	Excite and Speed cement (self-etching)	1.11	0.55	1.54

strength of composite post with dentin and are shown in Table 1.

For the first group, where 2.5% sodium hypochlorite and 17% EDTA were used as irrigants, where we made complete etching with 37% orthophosphoric acid, and we used Excite adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein) and Variolink II dual polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein) the pressure, i.e. the bond strength obtained by push-out testing is the highest, i.e. 2,185 MPa.

For the first subgroup, where 2.5% sodium hypochlorite and 17% EDTA were used as irrigants, and we applied Excite self-etching adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein), and Variolink II dual polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein), the pressure, i.e. the bond strength obtained by push-out testing is lower than the result obtained in the first group, i.e. 1,536 MPa.

For the second group of teeth, where 2.5% sodium hypochlorite was used as irrigant, where we made complete etching with 37% orthophosphoric acid, and we used Excite self-etching adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein) and Variolink II dual polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein), the pressure, i.e. the bond strength obtained by push-out testing is lower than those obtained in the first and second subgroups, i.e. the strength is 1,383 MPa.

For the second subgroup of teeth, where 2.5% sodium hypochlorite was used as irrigant and Excite self-etching adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein) and SpeedCEM™ dual polymerizing

Statistics according to ANOVA

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	4	6.214	1.5535	0.208287
Column 2	4	3.46	0.865	0.052967
Column 3	4	9.12	2.28	0.420467
Column 4	4	6.214	1.5535	0.208287

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups 1a and 2b	4.005894	3	1.335298	6.00129	P<0.05155	P<3.490295
Within Groups	P<2.670022	P<12	P<0.222502			
Between Groups 1b and 2a	P<1.33101	P<3	P<0.001212	P<2.11010	P><0.05578	P<1.230453
Within Groups	P<2.670022	P<12	P<0.222502			
Total	P<6.675916	P<30				

cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein), the pressure, i.e. the bond strength obtained by push-out testing is the lowest of all groups by comparison, i.e. the strength is 1,110 MPa.

According to the statistics, the difference is the largest between groups 1 and 4 in terms of the degree of bond, i.e. group 1: Sodium hypochlorite and EDTA in combination with Excite and Variolink II (complete etching with acid) have a bond value of 2.185, and group 4: Sodium hypochlorite in combination with Excite and Speed cement (self-etching) has a bond value of 1.11. The P-value is less than 0.05 ($P < 0.05155$) which means that there is a significant difference in the bond strength.

According to the statistics, the lowest significant difference is between the second and third group, which can be seen from the summary ANOVA table. Here the R-value is greater than 0.05 ($P>0.05578$).

Discussion

In our study, the highest bond strength is shown by the root canals where 2.5% sodium hypochlorite and 17% ETDA are used as irrigation agents, and adhesive technique of complete etching, and the lowest is shown by those where 2.5% sodium hypochlorite is used in the preparation of the root canal of the tooth as an irrigation agent, and an adhesive technique of etching.

From the obtained results, we can see that EDTA as an irrigant has a tendency to remove more smear layer from the tooth canal, and with increased removal of the smear layer, a greater bond strength is obtained.

The obtained results show that the use of sodium hypochlorite as an irrigation agent reduces the bond strength by applying self-etching adhesive and SpeedCEM™ dual polymerizing cement, in comparison with the first group where 2.5% sodium hypochlorite and 17% EDTA were used as irrigation agents, which correlates with the study of Elnaghy et all. which showed that the use of 5.25% sodium hypochlorite during spatial preparation for placement of the composite post reduces the bond strength in comparison with complete etching with 37% orthophosphoric acid.

The application time of sodium hypochlorite is one of the important factors to consider. Morris et al. reported that treatment with sodium hypochlorite for 15 to 20 minutes reduces the bond strength with the radical dentin by up to 67% of value. It is likely that there is a connection between the application time of sodium hypochlorite and the bond strength, and as the application time increases the bond strength reduces[26].

For the groups where 2.5% sodium hypochlorite and 17% EDTA were used as irrigation agents, we obtained a higher bond strength in the total self-etching adhesive system, than in the self-etching adhesive system, which is still in correlation with the study of Zorba et al., who concluded that the application of 17% EDTA with 5.25% sodium hypochlorite after spatial preparation for composite post upgrade increases the strength of self-adhesive cement more than the strength of self-etching cement. The explanation for the reasons was the removal of the secondary residual layer before the cementation of the composite post and the chemical bond of the self-adhesive cement.

In contrast, Ari et al. and Demiryürek et al. concluded that sodium hypochlorite reduces the bond strength of self-etching cement.

Conclusion

In endodontic treatment, the processing of the root canal of the tooth reduces the strength of the tooth, which increases the possibility of vertical fracture of the root. Irrigation agents and cementation materials have a very important role in this treatment, as they have a significant impact on the bond strength of the composite post with the dentin. From the results obtained from this study we can conclude that the bond between the composite post and the dentin is the strongest with the application of 2.5% sodium hypochlorite and 17% EDTA as irrigation agents, and complete etching with orthophosphoric acid in combination with Excite self-etching adhesive, and Variolink II dual-polymerizing cement; and the weakest bond was obtained when we used only 2.5% sodium hypochlorite as an irrigant, applying Excite self-etching adhesive and SpeedCEM™ dual-polymerizing cement.

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EFFICIENCY OF ORTHOPANTOMOGRAM AND CONE BEAM COMPUTED TOMOGRAPHY WHEN PLANNING IMPLANTS IN ANTERIOR MANDIBLE

ЕФИКАСНОСТА НА ОРТОПАНТОМОГРАМ И КОНУСНО ЗРАЧНА КОМПЈУТЕРИЗИРАНА ТОМОГРАФИЈА ПРИ ПЛАНИРАЊЕ ИМПЛАНТИ ВО АНТЕРИОРНА МАНДИБУЛА

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Abstract

Background: The success of dental implants relies on efficiently realised treatment plan. The treatment plan is impossible without radiographic evaluation of the region planned for implant placement. **Aim:** To investigate the efficiency of cone beam computed tomography (CBCT) versus orthopantomogram, when planning implants in anterior mandible. **Materials and methods:** The participants in the study had absence of at least one tooth in the anterior mandible region. Each participant was scanned with orthopantomogram and CBCT method. Using orthopantomogram on the regions planned for dental implants, the alveolar ridge height was measured, while the alveolar ridge height and width was measured using CBCT method. Thereby, the results obtained from the two methods were compared. **Results:** Using the CBCT method, the highest mean value for vertical dimension of the alveolar ridge resulted in the left canine region (3.3): 15.33 mm. ± 3.32, and the lowest mean value resulted in the left lateral incisor region (3.2): 14.11 mm. ± 4.04. While using orthopantomogram method, the highest mean value for vertical dimension of the alveolar ridge resulted in left canine region (3.3): 15.69 mm. ± 3.68, and the lowest mean value resulted in the left lateral incisor region (3.2): 14.29 mm. ± 3.69. Thereby, the difference was not significant. Using the CBCT method, the highest mean value for horizontal dimension of alveolar ridge resulted in the right canine region (4.3): 9.52 mm. ± 1.53, and the lowest mean value resulted in the left lateral incisor region (3.2): 9.14 mm. ± 1.58. **Conclusion:** The orthopantomogram is a reliable method for determining the bone height, in the regions planned for implant placement. The CBCT method is a priority method when planning implants, because it enables measuring not only the bone height, but also the bone width. **Keywords:** Dental implants, orthopantomogram, cone beam computed tomography, anterior mandible.

Апстракт

Вовед: Успехот со дентални импланти зависи од ефикасно изведен план на третман. Планот на третман е невозможен без радиографска евалуација на регијата планирана за импланти. **Цел:** Испитување на ефикаситетот на конусно зрачна компјутеризирана томографија (КЗКТ) спроти ортопантомограмот, при планирање импланти во антериорна мандибула. **Материјал и метод:** Испитаниците вклучени во студијата, имаа отсуство на најмалку еден заб во регија на антериорна мандибула. Секој испитаник се снимаше со ортопантомограм метод и метод на КЗКТ. Со користење на ортопантомограм, кај регии планирани за импланти се одредуваше висината на гребен, додека со метод на КЗКТ се одредуваше висината на гребен и ширината на гребен. Притоа се споредуваа резултатите добиени преку двете методи. **Резултати:** При користење на метод на КЗКТ, најголемата средна вредност за вертикална димензија на гребен, резултира во регија на лев канин (3.3): 15.33 mm. ± 3.32, а најмала средна вредност во регија на лев латерален инцизив (3.2): 14.11 mm. ± 4.04. При користење на ортопантомограм, најголемата средна вредност за висина на гребен резултира во регија на лев канин (3.3): 15.69 mm. ± 3.68, а најмала средна вредност во регија на лев латерален инцизив (3.2): 14.29 mm. ± 3.69. При што разликата не беше значајна. Најголема средна вредност за хоризонтална димензија на гребен, резултира во регија на десен канин (4.3): 9.52 mm. ± 1.53, а најмала средна вредност во регија на лев латерален инцизив (3.2): 9.14 mm. ± 1.58. **Заклучок:** Ортопантомограмот е сигурен метод за одредување на висина на гребен, во регии планирани за импланти. Методот на КЗКТ е приоритетен метод при планирање импланти, бидејќи овозможува одредување на висина на гребен и на ширина на гребен. **Клучни зборови:** Детални импланти, ортопантомограм, конусно зрачна компјутеризирана томографија, антериорна мандибула.

Introduction

The therapy for partial and total edentulism, still presents a challenge for the dental discipline. The treatment options for partial and total edentulism are the classical prosthesis and the implant retained prosthesis[1]. The implant retained prosthesis are more efficient option for the treatment of partial and total edentulism compared

with the classical prosthesis, because they protect the natural teeth from invasive prosthetic procedures, and also they reduce the bone tissue resorption process[2]. The bigest challenge even from the implantation procedure, is the dental implant treatment plan, whose goal is the placement of implants in the most optimal number, dimension and position[3]. The dental implant treatment plan is formulated based on the information gathered from the anamnesis, clinical examination and radiographic evaluation[4]. Radiographic evaluation for planning of the implantation procedure, is performed with the use of different radiographic modalities, which have undergone development paralleling the technological development of implantation techniques and implant designs. Till the 1990-is the two-dimensional orthopantomogram method was accepted as a standard method during planning of an implantation procedure[3]. In the latter years, as a radiographic method of choice for implant planning, is recommended the three-dimensional method of cone beam computed tomography (CBCT). Through this method are obtained number of images that is cross sections, in vertical, antero-posterior and horizontal plan of the maxillofacial region[5]. Dental implants are produced in different diameters and lengths, so the diameter varies from 3 to 7 mm., and the length varies from 6 to 18 mm.[6]. Key positions for the placement of implants, are the end retainers for the prosthetic suprastructure, and the jaw regions with reduced biomechanical forces that are damaging for the implant and the surrounding bone[7]. When planning implants in edentulous regions, the height of the residual alveolar ridge, determined through radiographic methods, presents the distance from the crestal part of the alveolar ridge to the neighbouring anatomical structure,while the width of the residual alveolar process presents the distance from the buccal side of the alveolar ridge to the lingual side of alveolar ridge[8]. Radiographic evaluation in the regions planned for implant placement, plays a crucial role in identification and analysis of anatomical-sceletal relationship of important neighbouring anatomical structures. Respectively in the mandibular jaw, the focus is directed on these structures: canalis nervus alveolaris inferior, anterior loop of canalis nervus alveolaris inferior, foramen mentalis, and mandibular incisive canal[2]. The mandibular incisive canal is characterised with anatomical variations in the aspect of number, location and dimensions of the neurovascular bundle. Thereby injuring this anatomical structure should be avoided during implantation procedure in the anterior mandible region[9]. According to some authors, orthopantomogram is an efficient method for implant planning, but according to other authors this method can lead to falsely chosen implants' length. The CBCT method improves the ability for planning of implants` length[10]. Orthopantomogram as a two-dimensional method, does not offer information about the width of the alveolar ridge, and does not allow choosing the appropriate diameter of implants[11]. The CBCT method as a three-dimensional method offers detailed information on the anatomical variations and pathologies, that orthopantomogram cannot offer, and in this way increasing the precision during the planning of the implantation procedure[12].

Aim

The aim of this study was investigation of the efficiency of the CBCT method and orthopantomogram when planning implants in the anterior mandible.

Material and methods

I individuals from both genders (men and women) with over 18 years of age were included in the study. Every individual had absence of at least one tooth in the anterior mandibular region, and absence of absolute contraindications for dental implants placement. Each participant in the study underwent an orthopantomogram scanning and CBCT scanning. The device "Rotograph Prime 3D" was used to perform the scanning, in the private dental clinic "Nova Dental Group" in Skopje. The device used electricity from 2 mA-12 mA, and voltage from 60 kV-86 kV. The orthopantomogram presented a single image for the maxillofacial region, while numerous images (cross sections) in vertical, antero-posterior and horizontal plan for the maxillofacial region were obtained through the CBCT method. The pixels dimension in orthopantomogram image, and in the CBCT images was 120 μm., and the voxels dimension in the CBCT images was 0.175 mm.. The number of shades of gray in orthopantomogram images, and the CBCT images was 65536. Implant planning through orthopantomogram was performed using the software "Villa Quickvision" and implant planning through CBCT images was performed using the software "3D Planner". The planned implants had diameter from 3 to 7 mm., and length from 6 to 18 mm., depending on the given case. When planning implants in orthopantomogram images, we used the tool "ruler", respectively for determining the vertical dimension of the alveolar ridge we measured the distance from the crestal part of the alveolar ridge to the roof of the mandibular incisive canal. When planning implants in CBCT images we used the tool "point to point measurements". Respectively, using this tool we measured the vertical dimension of the alveolar ridge, and also the horizontal dimension of the alveolar ridge. For determining the horizontal dimension (width) of the alveolar ridge we

measured the distance from the buccal side of the ridge to the lingual side of the ridge.

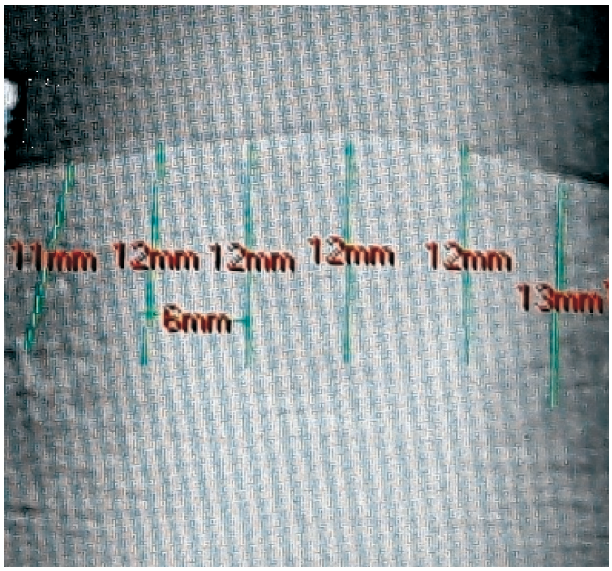

Figure 1. *Vertical dimension of the alveolar ridge in the anterior mandibular region (orthopantomogram).*

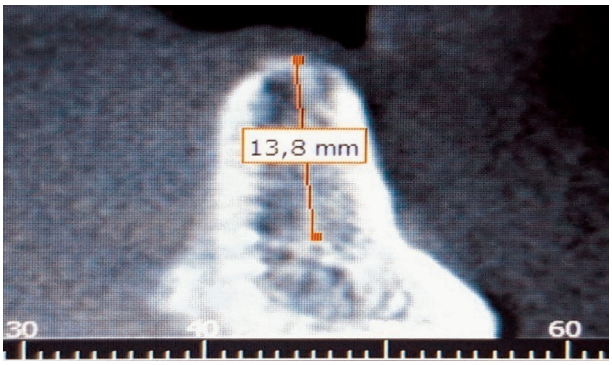

Figure 2. *Vertical dimension of the alveolar ridge in the anterior mandible region. (CBCT image).*

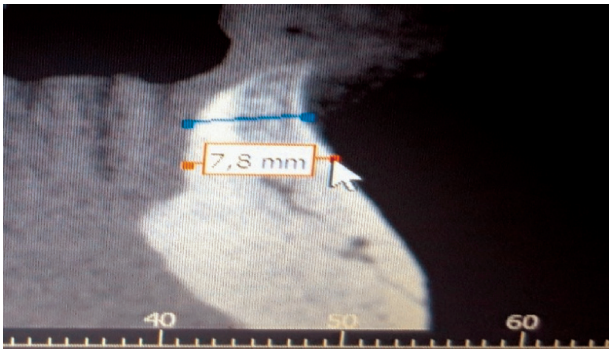

Figure 3. *Horizontal dimension (width) of the alveolar ridge in the anterior mandible region (CBCT image).*

Results

With orthopantomogram and CBCT method, implants in 21 individuals in the region of anterior mandible were planned, from which 13 men and 8 women. The age of the individuals varied from 40 to 75 years (mean 61).

Table 1 shows the minimum value, the maximum value, and standard deviation, for vertical dimension in the anterior mandible region, using the CBCT method. Respectively, the highest mean value resulted in the left canine region (3.3): 15.33 mm. ± 3.32, and the lowest mean value resulted in the left lateral incisor region (3.2): 14.11 mm. ± 4.04.

Table 1.

Variable	N	Mean	Min.	Max.	Std.Dev.
6.3.1	17	14,25	9,00	20,00	3,39
6.3.2	16	14,11	8,00	20,60	4,04
6.3.3	12	15,33	9,00	19,50	3,32
6.4.1	16	15,04	9,00	20,00	3,75
6.4.2	15	14,20	9,00	21,00	3,46
6.4.3	13	14,38	8,00	20,50	4,03

Table 2 shows the mean value, the minimum value, the maximum value and the standard deviation for vertical dimension of the residual alveolar ridge, measured in orthopantomogram images. Respectively the highest mean value resulted in the left canine region (3.3): 15.69

Table 2.

Variable	N	Mean	Min.	Max.	Std.Dev.
6.3.1	18	15,06	9,00	20,00	3,21
6.3.2	17	14,29	7,00	21,00	3,69
6.3.3	13	15,69	7,00	20,00	3,68
6.4.1	18	14,72	9,00	20,00	3,53
6.4.2	17	14,65	9,00	22,00	3,37
6.4.3	14	14,71	8,00	23,00	4,08

mm. ± 3.68, and the lowest mean value resulted in the left lateral incisor region (3.2): 14.29 mm. ± 3.69.

Table 3 shows the analysis of differences for vertical dimension of the alveolar ridge, measured with the CBCT method and the orthopantomogram method. Whereby the results obtained using the orthopantomogram were higher compared with those using the CBCT method (with the exception of the right central incisor region). But for all the regions, for p>0.05, the differences in results obtained using CBCT method and orthopantomogram, were not statistically significant.

Table 3.

Variable	Mean CBCT	Mean Ortho.	t-value	p
6.3.1	14,25	15,06	-0,72	0,48
6.3.2	14,11	14,29	-0,13	0,89
6.3.3	15,33	15,69	-0,26	0,80
6.4.1	15,04	14,72	0,26	0,80
6.4.2	14,20	14,65	-0,37	0,71
6.4.3	14,38	14,71	-0,21	0,83

Table 4 shows the mean value, the minimum value, the maximum value and standard deviation, for the horizontal dimension of the alveolar ridge in the anterior mandible region, using the CBCT method. Respectively, the highest mean value resulted in the right canine region (4.3): 9.52 mm. ± 1.53, while the lowest mean value resulted in the left lateral incisor region (3.2): 9.14 mm. ± 1.58. The minimum value was registered in the right central incisor region (4.1): 5.50 mm., and the maximum value was registered in the left central incisor region (3.1): 13.00 mm.

Table 4.

Variable	N	Mean	Min.	Max.	Std.Dev.
6.3.1	17	9,39	6,00	13,00	1,83
6.3.2	16	9,14	6,70	11,70	1,58
6.3.3	12	9,17	7,40	11,50	1,31
6.4.1	16	9,36	5,50	12,00	1,77
6.4.2	15	9,32	6,70	12,20	1,72
6.4.3	13	9,52	7,30	12,30	1,53

Discussion

When we were planning implants in the anterior mandible region with the use of the CBCT method, we measured the height and the width of the residual alveolar ridge. While when we planned implants using the orthopantomogram, we measured only the height of the alveolar ridge. Using the CBCT method we planned 89 implants in total, that is, in the central incisor region, in the lateral incisor region, and in the canine region. Using the CBCT method, the highest mean value for the height of the alveolar ridge in the anterior mandible region resulted in the left canine region (3.3): 15.33 ± 3.32 mm., while the lowest mean value resulted in the left lateral incisor region (3.2): 14.11 ± 4.04 mm. Therefore, the analysis for the differences in results for the vertical dimension measured with the CBCT method and the orthopantomogram, showed that greater values for alveolar ridge height, compared with the CBCT method (exeption the right central incisor region) were measured using the orthopanomogram. For all the regions, the differences were not statistically significant. These results of our study, are in agreement with the those of the authors Dagassan-Berndt et Zitzmann[13] who presented significantly higher values for the alveolar ridge height obtained with orthopantomoram, compared with the use of the CBCT method, while the author Guerrero[14] concluded that in the anterior mandible region, the differences in implant length, planned using orthopantomogram and the CBCT method, were not significant. In the study of the author Hu et al.[15] a comparison of the alveolar ridge height measured with orthopantomogram and CBCT method with the implants length placed in jaw samples was made. It showed a significant difference in alveolar ridge height using the orthopantomogram method and the CBCT method, in relation to the implants' length placed in the jaw samples. But the differences were greater using the orthopantomogram, compared with the CBCT method. The author Brito[16] concluded that using the orthopantomogram, the mandibular incisive canal was observed in 5.5% of the cases, and by using the CBCT method the same was observed in 24.4% of the cases. And the differences were statistically significant. Mello[17] showed that the length of the implants planned using orthopantomogram and those planned using CBCT, agreed in 50.5% of the cases. While the length of the implants planned using orthopantomogram agreed with the length of the implants placed in the surgical phase in 40% of the cases, while using the CBCT method this agreement was in 69.5% of

the cases. Luangchana[18] investigated the absolute error during measurements for the vertical dimension of the alveolar ridge using the orthopantomogram and the CBCT method, versus the physical measurements for the vertical dimension of the alveolar ridge in jaw samples. Where the absolute error in measurements using CBCT in the mandible resulted in values ranging from 0.39 to 0.66. While the absolute error in measurements using orthopantomogram resulted in values ranging from 1.11 to 1.53. Also, the errors in measurements in the mandible were lower, in relation to those measured in the maxilla. Also, the errors were lower using the CBCT method compared with those using orthopanotmogram. In our study, when measuring the horizontal dimension of the alveolar ridge using the CBCT method, the highest mean value for the width of the alveolar ridge resulted in the right canine region (4.3): 9.52 mm. ± 1.53, while the lowest mean value resulted in the left lateral incisor region (3.2): 9.14 mm. ± 1.58. While using the CBCT method, we planned implants in edentulous regions where there was a presence of miminum 5 mm. of bone width and minimum 7 mm. of bone height. When planning implants using orthopantomogram, we were basing only in the presence of minimum 7 mm. bone height, not having information about the bone width in that region. Goller et al.[19] concluded that the width of the alveolar process in the anterior mandible region, measured using the CBCT method, varied in values from 3.3 to 13.4 mm.. Mello[17] concluded that narrower implants were planned using orthopantomogram, compared with those planned using CBCT. Hu et al.[15] suggests using osteometer (intraoraly on exposed bone, or extraoraly on study models), for determining the alveolar ridge width, in cases where orthopantomogram is used for implant planning. In the study of Jalaluddin[20] it was concluded that the CBCT method is highly precise in determining of the alveolar ridge width, same as the method which uses osteometer for determining the width of a surgically exposed alveolar ridge. Dagassan-Berndt et al.[21] showed that the dimensions of the implants planned using orthopantomogram were in agreement with the dimensions of the implants placed in the surgical phase in 34.4% of the cases, while the dimensions of the implants planned using CBCT were in agreement with the dimensions of the implants placed in the surgical phase in 46% of the cases. Guerrero[14] showed that the diameter of the implants planned using CBCT remained unchanged with that of the implants placed in the surgical phase in 88.5% of the cases. While the diameter of the implants planned using orthopantomogram remained unchanged with that of the implants placed in the surgical phase in 92.1% of the cases. But there was not a significant difference in the results, between the two methods used.

Conclusion

Orthopantomogram is an efficient method for determining the alveolar ridge height, in regions planned for implant placement. The CBCT method is a priority method in formulating implant treatment plan because it allows measuring not only the alveolar ridge height, but also the alveolar ridge width, therefore increasing the precision when choosing the adequate dimensions of implants.

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FABRICATING COMPLETE DENTURES WITH THE COPY-DENTURE TECHNIQUE – A CASE REPORT

ИЗРАБОТКА НА ТОТАЛНИ ПРОТЕЗИ СО ТЕХНИКА НА КОПИРАЊЕ – ПРИКАЗ НА СЛУЧАЈ

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Abstract

The copy-denture technique is a method for replacing complete dentures as a therapeutic solution for elderly patients, where there are imposed requirements for a specific approach in rehabilitation. Copy dentures are most advantageous for physically-frail elderly patients, as their adaptive potential and neuromuscular coordination decrease with age. Replicating the polished surfaces and contours of the existing denture is the favorable aspect of this technique, facilitating adaptation and contributing to an easier transition to the new dentures. This technique aims to replicate the positive characteristics of the existing dentures and to improve deficiencies, usually in occlusal and fitting surfaces. The clinical evaluation of the existing dentures and the degree of required alterations that have to be incorporated in the new dentures is crucial in deciding to utilize the copy-denture technique, and in treatment planning. Over the past 60 years, various techniques for replicating complete dentures have been developed, leading to methods based on CAD/CAM technology. This case report presents a method of the copy-denture technique, along with its clinical and laboratory steps. The outcome was a new set of dentures, where the teeth position, contours and the polished surfaces of the old dentures were copied, and changes of the vertical dimension and the dentures' fitting surfaces were made. **Key words:** complete dentures, replica dentures, copy dentures, copy-denture technique.

Апстракт

Техниката на копирање на тотални протези е метод на изработка на нови протези, како терапевтско решение кај возрасни пациенти, каде постои потреба од специфичен пристап во рехабилитацијата. Копираните протези носат поволности за повозрасните пациенти, поради тоа што во напреднатата возраст потенцијалот за адаптација и невромускуларната координација се намалуваат. Репликацијата на полираните површини и контури на постоечките протези е поволниот аспект од оваа техника, со што се олеснува процесот на адаптација и доприносува до полесно прифаќање на новите протези. Целта на оваа техника е при изработка на новите протези да се реплицираат и задржат добрите карактеристики на постоечките протези и да се коригираат негативните, најчесто базата на протезата или оклузалните површини на забите. Проценката на постојните протези и степенот на потребни промени кои треба да бидат инкорпорирани во новите протези е од круцијално значење во одлуката за употреба на техниката на копирање и планирање на начинот на изработка на тоталните протези. Во изминатите 60 години развиени се различни техники на реплицирање на протезите, сé до најновите методи кои се темелат на CAD/CAM технологијата. Овој приказ на случај презентира метод на копирање на тотални протези, со сите клинички и лабораториски фази. При изработка на новите протези беа копирани позицијата на забите, контурите и полираните површини на постоечките протези, а беа коригирани гингивалните површини и беше зголемена вертикалната димензија на меѓувиличниот однос. **Клучни зборови:** тотални протези, реплика протези, техника на копирање протези.

Introduction

The extension of the lifespan of the population in developed countries proportionally increases the need for prosthodontic treatments in edentulous patients. Despite the advancements in treatment possibilities, complete dentures remain the primary choice for edentulism. Providing complete dentures to elderly patients is very challenging for the clinician, and imposes the need for a specific approach during the rehabilitation.

As a common problem in approximately 25% of complete denture wearers, dissatisfaction with complete dentures is emphasized in the elderly population. According to Makila, even 71% of the elderly (aged 65 years and over) had adaptation problems after one year of wearing the new dentures[1,2]. The rationale for the difficulty in adapting to new dentures is based on the evidence that learned reflexes are harder to be adopted with age[3,4]. Due to muscular control developed over years of wearing dentures, patients with old and even inadequate existing dentures will continue to persevere with them, rather than take on new and improved dentures[5]. In this context, replacing the existing complete dentures with the copy-denture technique for elderly patients is very

advantageous since it overcomes the problem of them adapting to new dentures. Replicating the polished surfaces and contours of the existing denture is the favorable aspect of this technique, facilitating adaptation and contributing to an easier acceptance of the new dentures[6,7].

Although the term "copy-denture technique" is used in our literature, it is not the appropriate term because this technique aims to replicate the positive features of existing dentures and make minor alterations to the negative ones, usually occlusal and fitting surfaces. The decision to advocate this method should be based on the clinician's perception that the patient might not be able or willing to adapt to new dentures, as well as on the assessment of the existing dentures. Evaluation of the three denture surfaces (occlusal, polished, and fitting surface), and the degree of required alterations that have to be incorporated in the new dentures is essential information for treatment planning. If the existing dentures have many errors and require a significant change in vertical and horizontal jaw relationship, and in the base extension, the new dentures cannot be considered to be copy dentures[4].

Since their first introduction in the 1960s, a variety of methods and procedures of the copy-denture techniques have been published[8-12]. Nowadays, there is no standard procedure for replicating the dentures, and various materials and methods are employed.

This case report presents a method of fabricating complete dentures with the copy-denture technique to a patient who has been wearing old dentures for a long time and is satisfied with them.

Clinical report

A 72-year-old female patient has reported to the Department of Prosthodontics at the University Clinic for Prosthodontics in Skopje to receive a new pair of dentures. The patient had been using her existing dentures for 14 years, satisfied with their aesthetics and function (Figure 1).

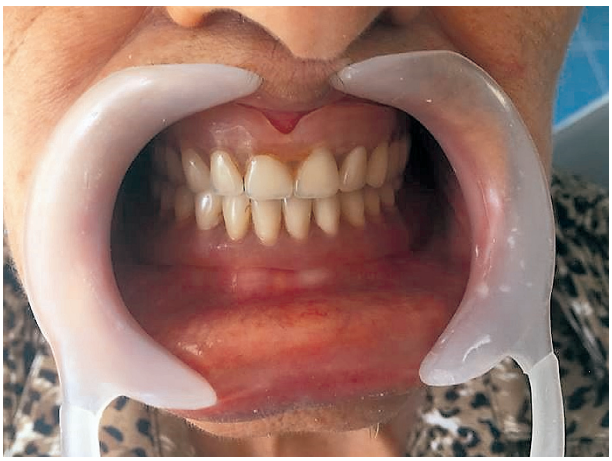

Figure 1. *Intraoral view of the patient's existing dentures*

The main complaint was poor retention of the upper denture, and the patient wanted a replacement set of dentures without other changes. Her medical history revealed depression, treated with prescribed medications. The extraoral evaluation revealed a decrease of occlusal vertical dimension (OVD). The dentures showed a lack of retention and stability during the intraoral examination, reduced OVD through teeth wear, and noted midline discrepancy. There was no intraoral pathology. The upper and the lower arch were evenly and highly resorbed.

Taking into consideration all the mentioned circumstances, the treatment plan was to fabricate new upper and lower dentures using the copy-denture technique. The objective was to replicate polished surfaces and tooth position, make minor changes in tooth arrangement, increase OVD, and improve the fit in all areas.

Treatment

First clinical visit

A two-part impression of the existing dentures was taken extraorally to form stable moulds to fabricate the upper and the lower copy dentures. Initially, the polished and occlusal surfaces of the dentures were embedded in silicone putty impression material (Zetaplus, Zhermack SpA) filled in stock trays; once the silicone was set, the impression's borders were trimmed 3-4 mm below the denture border, and triangle notches were made so that the other part of the mould would be able to assemble in it; the borders of the silicone impression were smeared with petroleum jelly. (Fig: 2a, 2b) Subsequently, the dentures' fitting surface was recorded; the first impression with the denture was pressed into the second mix of silicone putty. (Fig. 3,4) After setting the material, the mould's silicone halves were separated, and the dentures were removed, cleaned, and returned to the patient unmodified.

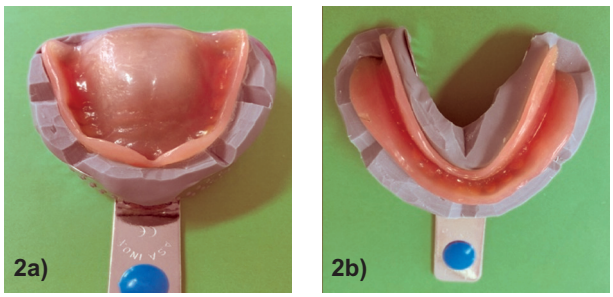

Figure 2. *Impressions of the polished and occlusal surfaces; a) upper denture; b) lower denture*

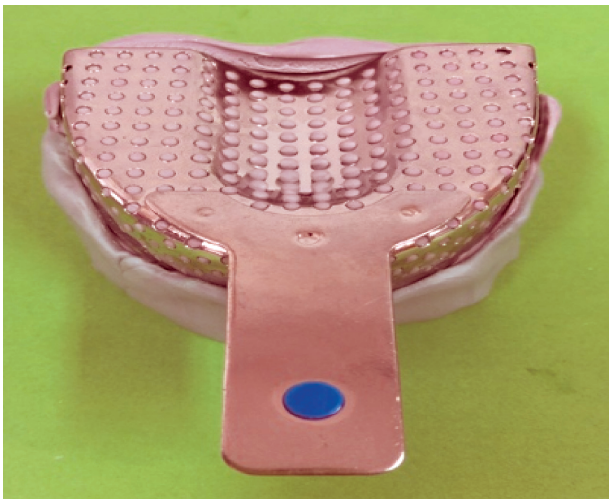

Figure 3. *An impression of the fit surface of the upper denture*

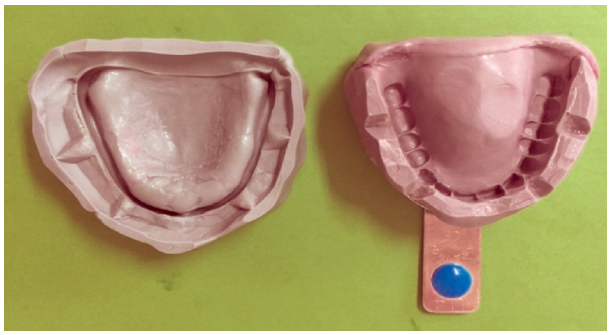

Figure 4. *The two halves of the mould of the upper denture*

First laboratory stage

Replica dentures were constructed with a rigid denture base and wax teeth. First, the technician adapted a light-cured base plate material (Hoffmann Ultra Violet Base Plates, Hoffmann Dental Manufaktur GmbH) over the fit surface into the mould; the mould was closed and the excess material removed; when the light-cured base plate was set, sprue channels were made at the posterior border behind the teeth, and molten wax was poured into impressions of the teeth; the moulds were closed, and secured with a rubber band, so as not to open during the cooling of the wax. After cooling, the template replica dentures were removed from the moulds, and the excess wax was trimmed. (Fig. 5, 6)

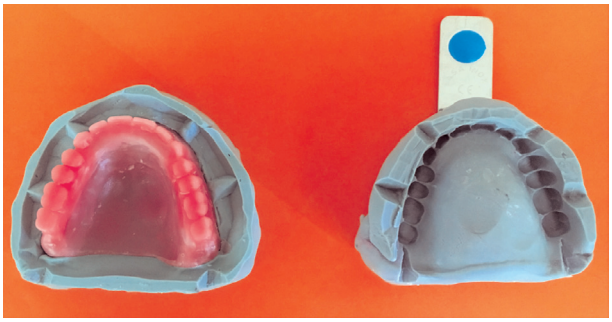

Figure 5. *Upper replica denture in the silicone mould*

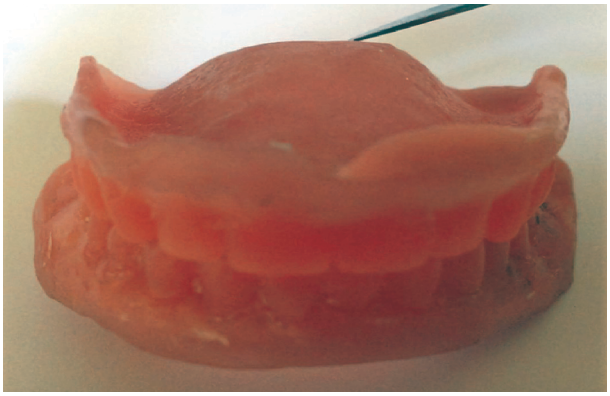

Figure 6. *Upper and lower replica denture*

Second clinical visit

Wash impressions and occlusal records were made using the replica dentures, which served as special trays and a registration block. (Fig. 7) Wash impressions were taken with a low-viscosity wash elastomeric material (Xantopren L blue, Heraeus Kulzer GmbH) due to its long-term stability since it will be retained in the denture bases in the next steps of the fabrication process. The conventional jaw relationship record was taken after the impressions were made (modified protocol because of the existing dentures' instability). In the initial analysis, it was defined to increase the OVD by 2 mm; the position of the occlusal plane, the OVD, horizontal jaw relationship, and the midline were checked; a necessary thickness of 2 mm

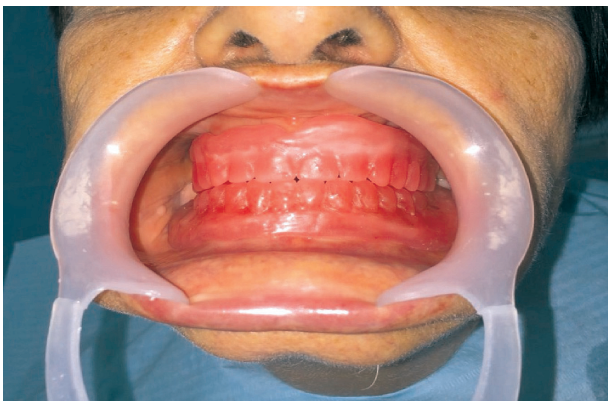

Figure 7. *Replica dentures in situ*

wax was added to the lower occlusal surfaces to achieve a pre-determined increase in OVD. (Fig. 8) The patient requested one shade lighter teeth from her existing dentures.

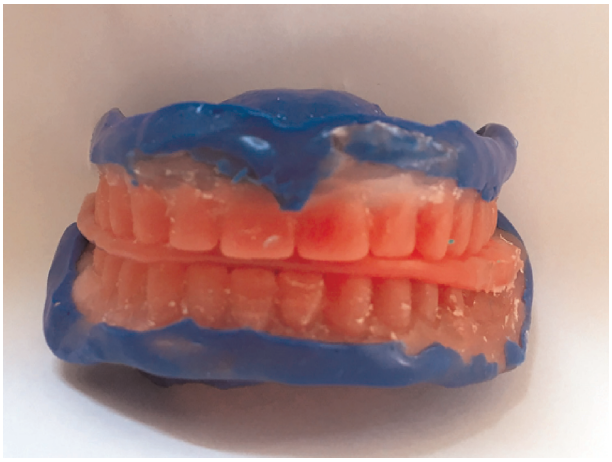

Figure 8. *Jaw registration with wash impression*

Second laboratory stage

The wash impressions were cast, and the casts were mounted on the articulator; the lower cast was mounted using the jaw relationship record; excess wash material from the polished surfaces of the replicas was trimmed with scissors. The teeth were set up by removing the wax teeth from the replicas, one by one, and replaced with acrylic teeth.

Third clinical visit

Trial placement procedures were carried out on replica dentures with acrylic teeth and still retained wash material; maxillomandibular relationship and occlusion were assessed, and the esthetics was discussed with the patient.

Third laboratory stage

The trial placement dentures were invested in flasks with the impression material (it is removed along with the wax at the boil-out stage); packed, processed, and finished conventionally, and the new dentures were ready for insertion.

Fourth clinical visit

Clinical evaluation of the fit, retention, stability, and the occlusal relationship of the new complete dentures was carried out, which showed satisfactory results. After minor adjustments, the dentures were delivered to the patient, and routine follow-up visits were scheduled after one day and after one week.

The patient was pleased with the esthetics, function, and comfort of the outcome.

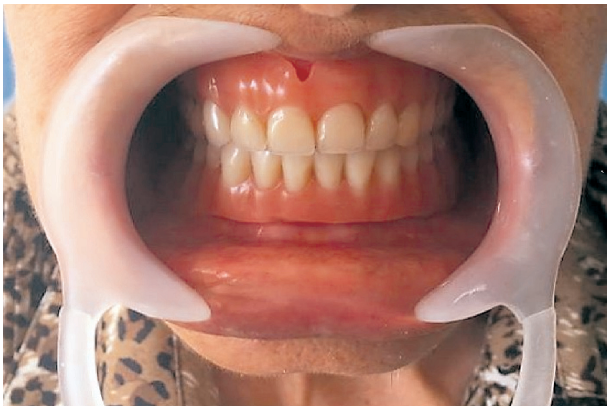

Figure 9. *New dentures in situ*

Discussion

The set aim for the replacement of dentures with improved characteristics of the old ones was achieved. The outcome was retentive complete dentures with increased OVD, improved aesthetics, mildly corrected midline discrepancy, better chewing efficiency, and fabricated with reduced clinical chair time and number of visits.

Since there is no standardized method for the copy-denture technique, the presented method proved appropriate. The common starting point for all methods is forming a mould from the dentures to be copied, the only difference being the materials used[13]. For clinical chair-side use, when the patient is not willing/cannot leave their dentures, the most suitable and precise material is the heavy-bodied silicon putty, for which flasks or rigid containers are not needed. After mould formation, in a laboratory, the replica dentures can be made by auto-polymerizing acrylic resin, shellac or, as in this case, with a base of photopolymerizing acrylic resin and waxed teeth. In the present method, first, the impressions were taken with the replica dentures with wash elastomeric material. Consequently, the jaw relationship was recorded, because of the insufficient retention of the upper denture and the possibility of faults while recording the jaw relationship. As suggested by Duthie and Yemm, the impressions may be taken just before the final adjustment and recording of the horizontal jaw relationship only if the existing dentures' retention and stability are acceptable[10]. This copy-denture method excludes the usage of conventional wash material ZnOE

since the wash material has to remain retained on the replica dentures during the next laboratory stage and clinical try-in stage.

The copy-denture technique is only one approach in the treatment of edentulism in elderly patients, where the ability to re-learn developed neuromuscular control and adaptation is decreased. Grant et al. suggests this procedure for replacing dentures with the provision of new impression surfaces, or new occlusal surfaces, or slight modification to the OVD. The technique is also suitable for replicating dentures for a "spare set", when the denture base material has deteriorated, and for the fabrication of temporary dentures that can be progressively modified if the patient's capacity to adapt is in doubt[14]. This technique should not be considered a shortcut for the fabrication of complete dentures. For the clinical and technical procedures to result in successful complete dentures, the decision to utilize this technique must be based on accurate diagnosis[15]. When major changes in tooth position, that will alter denture contour, or corrections of vertical dimension greater than 3mm, are needed, this technique should not be used[14,15].

Conclusion

The present copy-denture technique was used to make new complete dentures, an improved version of the old ones. The teeth position, contours, and polished surfaces of the old dentures were copied, and changes of the vertical dimension and the dentures' fitting surfaces were incorporated into the new set of complete dentures.

Proper application of the copy-denture technique, based on the exact diagnosis of the problem and understanding the advantage of copying dentures' contours, is a useful approach for elderly patients.

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ATRAUMATIC RESTORATIVE TREATMENT USING HIGH-VISCOSITY GLASS-IONOMER CEMENT IN POSTERIOR PRIMARY TEETH: A CASE REPORT

АТРАУМАТСКИ РЕСТАВРАЦИОНЕН ТРЕТМАН ВО ДЕТСКАТА СТОМАТОЛОГИЈА: ПРЕКУ ЕВОЛУЦИЈАТА НА ПРЕГЛЕДОТ НА ЛИТЕРАТУРАТА

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Abstract

Atraumatic Restorative Treatment (ART) is an alternative approach for improving the accessibility of oral care for underprivileged regions. The **aim** of this study was to report a case in which the technique used was the ART. The study was approved by the Research Ethics Committee from the Faculty of Dentistry of Ss. Cyril and Methodius University in Skopje (N#02-264383), and the Research Ethics Committee of the Dental Chamber of Kosova, Republic of Kosova (N#07). Signed informed consent was obtained from the parent of the participating child. A 7-year-old female child, with complaint of multiple decayed teeth fulfilled the inclusion criteria for ART restoration. The tooth d.64 was prepared according to the ART approach proposed by Frencken et al. ART, with its low cost and atraumatic nature, can be a means to alleviating the problem of access to dental care among underserved populations in Kosova. **Keywords:** Atraumatic Restorative Treatment, high-viscosity glass-ionomer cement, primary teeth

Апстракт

Забниот кариес е една од најраспространетите мултифакторијални болести во светот. Во областа на менаџирањето на забниот кариес, АРТ пристапот е познат по минималната интервенција и како минимално инвазивна процедура која се покажала успешна како во развиените земји, така и во земјите во развој. АРТ е техника која се состои во отстранување на кариесот само со употреба на рачни инструменти, без употреба на анестезија или опрема која функционира со електрична енергија, по кое следи реставрација на кавитетот со леплив материјал за полнење, како што е стаклено јономерниот цемент со висок вискозитет (high-viscosity glass-ionomer cement (HVGIC)). Едноповршинските АРТ реставрации покажале висок процент на ефикасност како кај млечните така и кај постојаните заби, за разлика од мултиповршинските реставрации. АРТ заптивките се покажаа како доста ефективни при превенција на кариесот. Истражувачите треба да се фокусираат во подобрувањето на материјалите за реставрација, и да ги прошират своите знаења за АРТ техниката во однос на болката и аксиозноста и да ја охрабрат употребата на АРТ пристапот во националните системи за орално здравје. **Клучни зборови:** Атрауматски реставрационен третман, забен кариес, стаклено јономерен цемент.

Introduction

Dental caries is one of the most worldwide spread multifactorial diseases[1,2]. In low-budget countries, less investment is made in health care and prevention, therefore people have limited access to oral health, and teeth stay untreated for a long period of time, or very often the main method of treating is the extraction[2].

Atraumatic Restorative Treatment (ART) is an alternative approach for improving the accessibility of oral care for these children[3,4]. ART is a treatment that involves removing carious tooth tissues using hand instruments only, without the use of anesthesia and electrically-driven equipment, and restoring the cavity with adhesive restorative material, usually a high-viscosity glass-ionomer cement (HVGIC)[5,6].

Therefrom, we can talk about the "atraumatic" component of ART, which consists of a low level of pain or discomfort[7,8] and minimal destruction of tooth tissue[9]. The "atraumatic" component of ART makes it a clinically acceptable restorative approach among children, anxious patients, and people with special needs[10,11]. Besides the above, this approach is also considered to be quite economical because it is performed using a simple device[12].

HVGIC is the material of choice for ART - approach because of their biological, physical, chemical properties

as well as because they stand as a rechargeable fluoride release system[13,14].

The systematic reviews and meta-analyses show that the longevity of ART/HVGIC restorations in primary teeth is no different from the one composed using conventional methods with either amalgam or resin composite15,16,17,18.

de Amorim et al.[19] came to the conclusion that ART single-surface restorations presented high survival percentages in both primary and permanent posterior teeth, while ART multiple-surface restorations presented lower survival percentages.

The aim of this study is to report a case in which the used technique was the ART.

Methods

The case presented in the current report participated in the study approved by the Research Ethics Committee of the Faculty of Dentistry of Ss. Cyril and Methodius University in Skopje (N#02-264383), and the Research Ethics Committee of the Dental Chamber of Kosova, Republic of the Kosova (N#07).

Signed informed consent was obtained from the parent of the participating child.

The study was conducted in Ferizaj (Republic of Kosova). Specific location was a village called Jezerc (Figure 1) which is characterized by low economical and infrastructural development where children do not have access to dental care.

Figure 1. *Jezerc, October 2020*

The inclusion criteria for participation in the study were: a) children whose parents or legal guardians accept and sign the consent form; b) children who assent to participation; c) children aged 3 - 8 years; d) cooperative children; e) with good general health conditions; f) children with high risk of caries g) presenting at least one occlusal lesion in a primary teeth molar.

Tooth inclusion criteria were: a) caries involving dentin, b) accessible to hand instruments used in ART c) absence of pain, fistula, or abscess near the selected tooth, d) absence of pulp exposure; e) absence of pathological mobility.

Children were assessed at school in empty classrooms, prepared for the oral-examination, and have received instructions on oral health, particularly in relation to oral hygiene/toothbrushing and sugar consumption.

Case report

A 7-year-old female child, with multiple decayed teeth, had fulfilled the inclusion criteria for ART restoration. Data collection (Figure 2) has been included, social demographic data and dental history. The examinations were performed using ambient light, mouth mirrors, and standard explorers.

Because of low economic conditions and lack of dentists in the area, the child has never been to a dental treatment. The present case had shown no systemic disease and no fluoride exposure. The diet frequency was a maximum of five meals per day and low fermentable carbohydrates. The patient reported that she had brushed her teeth one time per day with irregular technique. The dmft index was 11 (d=9, m=2, f=0), and plaque index (Silness and Loe) index was 1.2.

Figure 2. *Data collection*

The essential instruments for ART technique are: examination dental set, ART instruments (Kit® Duflex® - Rio de Janeiro, Brazil), glass slab or paper mixing pad, spatula.

The essential materials include: cotton wool roll, cotton wool pellet, water, glass-ionomer restorative (GC Fuji

IX GP (EU, Leuven, Belgium), dentine conditioner (GC Cavity Conditioner® (EU, Leuven, Belgium), petroleum jelly, wedge plastic strip, articulation paper. Other instruments and materials include: examination gloves, mouth mask operating light, operation bed/headrest extension, stool, methylated alcohol, pressure cooker, instrument forceps, soap and towel sheet of textile, sharpening stone, and oil.

Figure 3. *Clinical examination under ambient light*

The tooth d.64 was prepared according to the ART approach proposed by Frencken et al.[20,21].

1. A mattress was placed on a table, on which the child has stayed in supine position. All procedures were performed under ambient light (Figure 3).
2. The tooth was isolated with cotton rolls (Figure 4). The tooth surface was cleaned with a wet cotton wool pellet. The cavity was opened with an opener (ART Kit® Duflex® - Rio de Janeiro, Brazil), and the entrance of the lesion was widened with hatches (Kit ART, Duflex® - Rio de Janeiro, Brazil) if necessary, in order to start the excavation. The excavation was performed at the dentin-enamel junction (DEJ) with an excavator: (small, medium, large) before removing caries from the floor of the cavity, which is closest to the pulp. This sequence was performed to minimize sensitivity or discomfort during the excavation procedure.

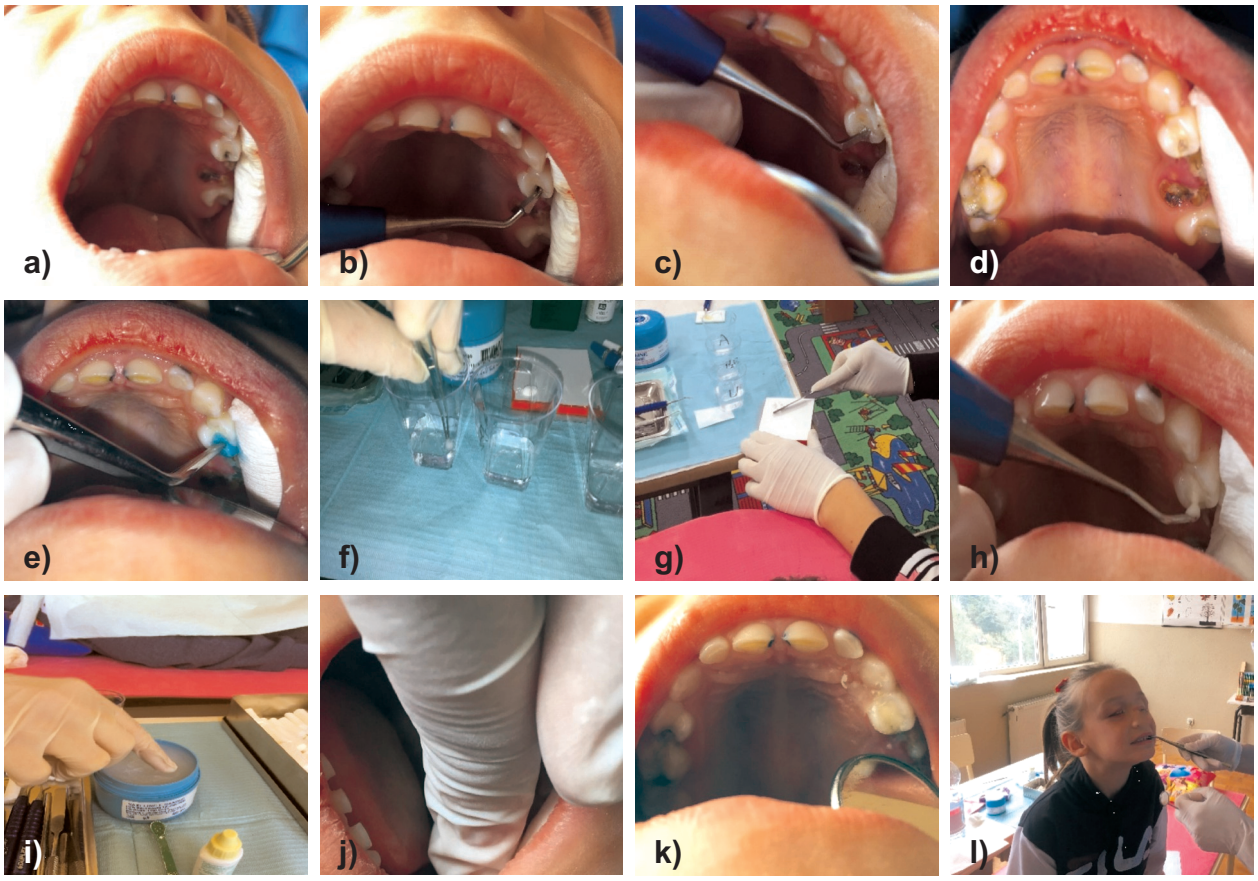

Figure 4. *a) tooth 64, isolated with cotton rolls; b) opening the cavity with opener; c) excavation of lesion; d) cavity after excavation; e) conditioning dentinal surface; f) cavity washed with water and cotton pellet; g) mixing GIC; h) applying GIC; i) finger coated with petroleum jelly; j) application of light pressure with glove; k) finished ART restoration; l) checking the occlusion.*

3. After excavation, the cavity was washed with water on a cotton pellet and was checked for any soft remaining dentin. This verification was carried out with excavators or probes, seeking soft tissue.
4. The cavity was conditioned with GC Cavity Conditioner® (EU, Leuven, Belgium) using a cotton pellet for 10 s. and was washed with water. After washing the cavity with a cotton wool pellet soaked in water, the cavity was isolated with a cotton roll and was dried with dried cotton pellets.
5. The glass ionomer cement GC Fuji IX GP (EU, Leuven, Belgium) was mixed according to the manufacturers' instructions and was inserted into the cavity with the ART applier/carver instrument (ART Kit®). The cavity was slightly overfilled and the material was placed over pits and fissures. The operator had applied light pressure with a gloved and petroleum-jelly-coated finger on the top of the material during the initial setting. This procedure had promoted a better GIC adaptation to the cavity walls and a smoother surface which had facilitated the removal of the excess material.
6. The bite was checked using articulating paper and any premature contact was removed with the ART applier/carver instrument (ART Kit®). Subsequently, a protection varnish was applied on the glass ionomer cement surface aiming to prevent gain or loss of water. The patient was oriented not to eat or drink at least during the first hour after the restoration placement.

Discussion

In the field of dental caries management, the ART approach is known as a minimal intervention and minimally invasive procedure and has shown to be successful in both, developed and developing countries[21].

In developing countries where children have limited access to a dentist, dental caries stays untreated, which can harm the patient on many levels. Mainly, dental caries can cause functional, aesthetic and psychosocial disorders especially in young people and children[22].

Such untreated condition can be a serious health threat to children's general health, there is a huge risk of developing other diseases and conditions such as systemic sepsis, osteomyelitis, and infection of the neck and the floor of the mouth[23].

The ART approach does not require electricity or piped water systems, therefore, is a possible solution for the regions where electricity and piped water system is not available or, in areas where the community cannot provide expensive dental devices. The application of the ART procedure in these areas would have an impact on decreasing the number of tooth extractions and increasing the proportion of teeth that are restored, furthermore, it would promote a better life quality.

Another benefit of the ART procedure is that, as a part of minimal intervention dentistry, preserves the structure of tooth tissue as much as possible[24]. This also approves the atraumatic nature of procedure.

As we have stated previously, the ART approach uses HVGIC as a restorative material. HVGIC possesses chemical bonding and fluoride-releasing properties[25]. It has been shown that glass-ionomer has the potential to enhance remineralization and that these restorations may act as a rechargeable fluoride-release system by first absorbing the fluoride and then releasing it gradually[26]. When compared to amalgam, it has been concluded that glass-ionomer has a higher caries-preventive effect than amalgam for restorations in permanent teeth, and primary teeth, as well[27].

Additionally, children's fear of dental procedures is caused by using needles and drills[28], which are eliminated in the ART treatment. The ART technique has proven to be more acceptable in children as it causes less pain and discomfort compared to other traditional methods[29,30].

Conclusion

Atraumatic Restorative Treatment is a patient-friendly approach that preserves tooth structure and controls caries` lesions economically. Kosovo is a low economic country where a lot of children do not have access to dental care.

The ART, with its low cost and atraumatic nature, can be a tool for alleviating the problem of access to dental care among underserved populations in this country.

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LOCAL EFFECTS OF USAGE OF OROPHARYNGEAL ANTISEPTICS (CETYLPYRIDINIUM CHLORIDE) IN ORAL INFLAMMATORY CONDITIONS AND ORAL SURGICAL INTERVENTIONS

ЛОКАЛНИ ЕФЕКТИ ПРИ УПОТРЕБА НА ОРОФАРИНГЕАЛНИ АНТИСЕПТИЦИ (CETYLPYRIDINIUM CHLORIDE) ПРИ ОРАЛНИ ИНФЛАМАТОРНИ СОСТОЈБИ И ОРАЛНОХИРУРШКИ ИНТЕРВЕНЦИИ

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Abstract

Cetylpyridinium Chloride belongs to a group of cationic quaternary ammonium compounds. Its properties are widely used for local treatment of inflammatory conditions in the oral cavity, as well as for a complementary treatment after oral surgical interventions to ease the postoperative pain and reduce the postoperative inflammation. The examined sample consisted of sixty patients divided into two main groups. The first group consisted of examinees in which an oral surgery with cumulative soft tissue and bone trauma was indicated, while the second group included examinees with symptoms of pericoronitis. During the study, the parameters we examined were: pain, inflammation, index of gingival bleeding, index for determining the depth of the pericoronary pocket and we compared the values obtained at the first, second and third visit. During that period, solutions based on cetylpyridinium were used for rinsing. The results were statistically processed and on that basis, a definite standpoint was taken for the therapeutic efficacy and safety in treated patients. Clinically verified results from this study confirm the properties of cetilpyridine and its ability to reduce pain in the postoperative period and reduce local tissue inflammation. These data encouraged us to propose topical application of antiseptic solutions in the preoperative period for conditioning oral tissues and reducing microbial load and plaque control as well as its prolonged use 7 days after oral surgery. **Keywords:** local treatment, inflammation, antiseptics, perioperative management.

Апстракт

Цетилпиридин хлоридот (Cetylpyridinium Chloride) припаѓа на групата катјонски квартерни амониумски соединенија. Неговите својства се широко применети за локален третман на воспалителни процеси во оралната празнина и како комплементарен третман по оралнохируршка интервенција за ублажување на постоперативната болка и намалување на постоперативната инфламацијата. Во истражувачкиот примерок беа опфатени вкупно шеесетина пациенти и истиот беше поделен на две групи испитаници. Првата група се состоеше од испитаници со индицирана оралнохируршка интервенција со кумулирана ткивна траума на меки ткива и коска, додека втората група вклучуваше испитаници со симптоми на перикоронитис. Во текот на студијата, предмет на евалуација беа испитуваните параметри: болка, инфламација, индекс на крварење на гингивата, индекси за одредување длабочина на перикоронарен џеб и нивна компарација со вредностите за истите добиени на првата, втората и третата визита при континуирана употреба на препарати на база на цетил пиридин.. Резултатите беа статистички обработени врз основа на што се донесе дефинитивен став за тераписката ефикасност и безбедност кај третираните пациенти. Клинички верифицираните резултати од оваа студија ги потврдуваат својствата на цетилпиридинот во способноста за намалување на болката во постоперативниот период и редукцијата на локалната ткивна инфламација. Овие податоци ни даваат за право да сугерираме локална примена на антисептички раствори во предоперативниот период за кондиционирање на оралните ткива и редукција на микробното оптоварување и плак контрола како и пролонгирана употреба 7 дена по оралнохируршката интервенција. **Клучни зборови:** локален третман, инфламација, антисептици, периоперативен менаџмент.

Introduction

According to the ADA, mouthwashes are an additional tool in standard oral hygiene or support in the perioperative period and/or conservative initial treatment of periodontal/peri-implant diseases. It is not recommended to use them immediately after using fluoride paste because they can eliminate the effect of fluoride. It is

recommended to use them passively by rinsing during the postoperative period (in oral surgery, implantology, augmentation procedures) or actively rinsing the mouth through contraction of the perioral muscles as well as for hygiene of the peritonsillar and pharyngeal region (gargle).

Generally, mouthwashes, depending on their compounds, can have:

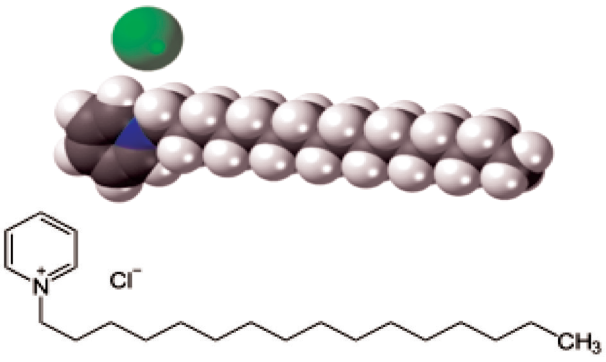
- antiseptic effect (reduction of microbial load) and antifungal effect. They control the formation of Volatile Sulfur Compound (VSC) by anaerobes (halitosis);
- anti-inflammatory effect (act on the production of proinflammatory cytokines);
- analgesic effect;
- effect as artificial saliva (in xerostomia, chemotherapy, radiotherapy) with enzymes lactoperoxidase, lysozyme, and lactoferrin.

Examples of previously known oral hygiene products are: benzydamine, chlorhexidine digluconate, essential oils (phenol, thymol, and eugenol), triclosan, fluoride, povidone/iodine, hydrogen peroxide, sodium bicarbonate, sodium chloride, etc.

There are a number of studies investigating the effect of mouthwashes on oral biofilm (chlorhexidine, cetylpyridinium chloride and antiseptics of plant origin eucalyptus, menthol, and thymol)[1,2,3].

However, in addition to therapeutic effects, oral hygiene mouthwashes can also have side effects, such as: transient disturbance of the sense of taste, tooth discoloration, dry mouth sensations[4]. Alcoholic solutions dry the oral mucosa.

Cetylpyridinium chloride (CPC) is a cationic quaternary ammonium compound[5] containing the cetyl group (derived from cetyl alcohol initially isolated from whale's fat) and the pyridine cation [C_5H_5NH] +, which is a conjugated acid of pyridine (Picture 1).



Picture 1. *Chemical formula of cetylpyridinium chloride (CPC)*

CPC has a direct effect on the bilayer lipid membrane, leading to bacterial cell lysis and releasing cytoplasmic contents (bacteria, fungi, viruses with viral envelope). The ability to bind to the bacterial membrane depends on the positive electric charge of the CPC cationic surface. Some anionic compounds can reduce the antiseptic effect by inactivating the positive electric charge of the CPC, so a brake of 30 min is recommended between mechanical brushing of teeth with toothpaste and the use of CPC-based solutions.

Oral antiseptics containing CPC in concentrations 0.05% -0.07% (cationic surface agent, reduces surface tension, bacterial surface tension - cationic surface-active agent) have a wide range of antimicrobial and fungicidal effects. CPC in concentrations 0.05% -0.07% is effective in the control of dental plaque (acts on gram + and gram in view of bacteria and fungi) and gingivitis[6].

Haps and Slot in their literature review state that "CPC-containing mouthwashes provide a small but significant benefit in reducing plaque and gingivitis, compared with groups that used only mechanical brushing or brushing and rinsing with placebo solution."[7]. In the study by Rao D. et al.,[8] the effect of 0.075% CPC solution on the biofilm was described, and was found that the number of damaged biofilm cells after using the solution was significant, compared to other tested antiseptics.

CPC solutions act on periodontopathogenic bacteria: Actinomyces, Campylobacter, Moraxella, Veillonella, Eikenella corrodens, Porphyromonas gingivalis, Prevotella intermedia and Prevotella nigrescens, Aggregatibacter, Candida and Streptococci[9]. In higher concentrations it is effective against Pseudomonas aeruginosa and Escherichia coli. The 0.1 and 0.2% CPC have also been shown to be extremely effective in eliminating Enterococcus faecalis, used as an irrigation agent in endodontic treatments[10].

In a study by PopkinL.D.et al.,[11], antiviral activity against influenza virus was demonstrated by targeting and disintegrating the viral envelope. CPC also reduces influenza-associated morbidity in vivo.

Recent studies on the effects of oral antimicrobials (especially CPC and povidone-iodine) on SARS-CoV-2, related to the degree of COVID 19 symptoms and the severity of the clinical picture are described in the work of Hererra et al.[12]. Oral viral load with SARS-CoV-2 is associated with the severity of COVID 19. Similarly, reducing viral load in the mouth significantly reduces the amount of viral units released from the mouth, thereby reducing the risk of disease transmission. According to them, during the first 10 days, the virus mainly accumulates in the nasal, oral, and pharyngeal areas. The number of angiotensin-converting enzyme (ACE 2) receptors is higher in the salivary glands compared to the lungs, so

saliva droplets are thought to be the most likely route of transmission. Use of antiseptic solutions is recommended in order to reduce viral load in the oral cavity[12].

Based on the current knowledge on the mechanism of action of CPC-based antiseptic solutions, we can suggest its clinical application:

- Reduction of the incidence of postoperative complications (alveolitis, alveolar osteitis). Alveolar osteitis is a postoperative complication that most often is a result of disintegration of the fibrin clot, which, according to some theories, occurs due to increased bacterial load (microbal load), which in turn affects the stability of the clot;
- Use in cases of halitosis. As a result of the antimicrobial action of CPC-based antiseptic solutions, the production of sulfur compounds (volatile sulfur compounds - VSCs, hydrogen sulfide, methyl mercaptan, dimethyl sulfide) by the anaerobic bacteria degrades the sulfur containing aminoacids - cistein and methionine. Sulfur compounds are responsible for the condition called halitosis, which is an alarm for disbalance in the oral microbiome;
- Achieving a high degree of plaque control through the formation of a so-called 24-hour protective shield that has effect in the prevention of soft tissue diseases (gingivitis, periodontitis, and pericoronitis). The antiseptic solution also has an anticariogenic effect;
- By reducing the microbial load, the painful conditions caused by oral infections are regulated (analgesic effect);
- New therapeutic approach in the treatment of periimplant disease;
- Prevention of more serious diseases and more severe clinical pictures in patients infected with Sars-Cov-2 (as well as other viral upper respiratory diseases), and reduced transmission of the disease between people.

In the study of De Waal Y.,[13] the effectiveness of 0.05% CPC in the surgical treatment of periimplantitis (resective method with apically repositioned flap, surgical soft tissue debridement, bone remodeling, debridement of the implant surface and its decontamination) is emphasized. The efficacy of implant surface decontamination (immediate suppression of anaerobic bacterial flora) is proved by the long-term effect of CPC on stabilization of clinical parameters: peri-implant mucosal bleeding, suppuration, depth of the peri-implant pocket, reducing the level of radiographical loss of peri-implant marginal bone (marginal bone loss).

Osteoclasts are responsible for bone resorption in diseases such as osteoporosis, periodontitis, and rheumatoid arthritis. Antiseptic solutions are more often affirmed as potential preventive and therapeutic agents. Zhen Ting's study[14] described the effect of CPC on osteoclast formation from a cell colony (mouse bone marrow-derived macrophages - BMMs). CPC inhibits the activator of the receptor of NF-κB ligand (RANKL-induced osteoclast formation) without causing cytotoxic effects. CPC inhibits osteoclast differentiation via NF-κB and reduces COX-2 (cyclooxygenase) expression. The study's author highlights the possibility of CPC being perceived in the future as a preventative measure in preventing bone loss.

Pharmacokinetics

Cetylpyridinium chloride in concentrations from 0.03% to 0.1% has therapeutic effects but no toxic effects. CPC is generally safe for patients at concentrations up to 1000 µg/mL. Prolonged exposure on the CPC solutions, above the permissible upper limit of safe concentration, is expected to raise the question of the toxicity of preparations. The fatal dose of ingested cationic detergents is 1 to 3 g. Thus, 4000 single doses are required, taking into account that the products for use have a CPC concentration of an average of 0.25 mg per single dose[15,16,17].

Aim

The aim of the study was to determine the anti-inflammatory effect of CPC on the soft tissues through reducing de novo plaque formation as well as the beneficial effect on the postoperative discomfort of the patients and the reduction of the degree of postoperative complications.

Material and methods

The research sample included a total of 60 patients and it was divided into two main groups of patients (30 patients) with two subgroups of 15 patients each.

Group I (30 patients). This group included subjects with indication for oral surgery with cumulative soft tissue and bone trauma (atypical tooth extractions and surgical extractions by creating a mucoperiosteal flap).

1. Subgroup A. Each subject was advised to apply CPC solution at home for two days preoperatively (active rinsing and gargling), perioperative rinsing with CPC solution, as well as postoperative rinsing for 7 days (passive rinsing of the operative wound), with control of the predicted parameters on the first, third and seventh day after the intervention.

2. **Subgroup B.** (control group). Patients were not advised to rinse with any oral antiseptic solution, but only to maintain proper oral hygiene and rinse with saline.

Group II (30 patients). This group included patients with symptoms of pericoronitis.

1. Subgroup A. Each subject underwent standard conservative treatment (saline rinsing and 3% hydrogen) combined with additional local rinsing with CPC solution and application of drain soaked in CPC solution. Each subject was advised to apply CPC solution at home for 7 days with control of the predicted parameters on the first, third and seventh day after the first examination.
2. Subgroup B. (control group) Each subject underwent standard conservative treatment of acute pericoronitis (rinsing with saline, 3% hydrogen and application of iodoform drain).

Inclusion criteria:

The study included patients who met the following criteria: signing an informed consent and agreeing to cooperate, i.e. respect and follow the recommendations and come back for control on the specified days.

Exclusion criteria:

- For female patients, if they pregnant or lactating;
- Hypersensitivity to any of the components of the drug;
- Cardiovascular diseases: severe uncontrolled hypertension, decompensated heart failure, unstable angina pectoris, myocardial infarction in the period of 6 months before the clinical examination or clinically significant history of arrhythmia or disorder in the ECG examination 6 months before the examination;
- Other diseases with serious pathology (brain strokes, hemodialysis patients, organ transplants, etc.);
- Application of antibiotic therapy in the previous 2 months;
- Mental dementia, reluctance or language barrier that would prevent understanding and cooperation within the examination;
- Patients under 18 years.

The dosage was according to the recommended doses, as follows: CPC 0.07% solution for mouth and throat rinsing 2-3 times a day with 15ml (1 tablespoon) pure solution.

During the study we examined the following parameters (variables):

a) Pain

We monitored the pain through a visual analogue pain scale (VAS) analysis in which patients themselves noted the level of pain from painlessness to very severe pain according to the subjective assessment of pain intensity, on a horizontal or vertical line of 10cm (100mm) with placement on a perpendicular line (dash) according to the subjective feeling of pain, but they did not have insight into the numerical part of the scale which was used exclusively by the therapist (researcher) for numerical objectification of the subjective assessment of patients. Patients described the pain as: absence (0-4mm), mild pain (5-44mm), moderate pain (45-74mm), and very strong pain (75-100mm) (18).

b) Gingival Inflammation Index by Muhleman and Cowell

We observed both parameters of this index, the color of the gingiva and bleeding from the gingival sulcus. Both parameters were measured on the gingiva and gingival sulcus of the tooth, mesially on the third molar around which there is acute pericoronitis. Regarding the color of the gingiva, the following parameters were observed: 0-pink, healthy gingiva; 1-inflamed, red marginal gingiva; 2-inflamed, red interdental papilla and marginal gingiva; 3-dark-red papilla and generalized redness of the gingiva. To examine the gingival bleeding, gingival sulcus was probed with a periodontal, graduated probe. The following parameters were observed: 0-no bleeding is observed after probing; 1-bleeding in one point in the gingival sulcus after a few seconds; 2-filling the interdental triangular space with blood after probing; 3-profuse bleeding that fills the interdental space and the gingival sulcus.

Index of gingival color
0 1 2 3
Index of gingival bleeding
0 1 2 3

c) Presence of postoperative trismus according to Ngyene et al.

We measured the interincisal distance and noted the following degrees:

0 -> 40mm - no trismus
1 - <40mm - has trismus

d) Postoperative edema and inflammation

For this purpose, evaluation of inflammation, we used the modified index of local gingival inflammation by Gonzalez-Santana et al.[19] where there are 4 degrees of

local inflammation ranging from absence of inflammation to severe extraoral swelling postoperatively.

1. no/absence of inflammation
2. mild inflammation (swelling intraorally in the operated area)
3. moderate inflammation (extraoral swelling in the operated area)
4. severe inflammation (extraoral swelling outside the surgical zone)

e) Depth of the pericoronary pocket in patients with pericoronitis (expressed in mm)

A graduated periodontal probe with a blunt tip was used to measure the pericoronal pocket. The depths of several probing paths around the crown of the tooth were measured, and the deepest value was taken as the relevant value.

The study was performed at the Clinic of Oral Surgery at the PHI University Clinical Center "St. Pantelejmon" in Skopje, as well as at the Dental Clinical Center at the European University-Skopje. We explained to the examinees the nature, duration and goals of the study, as well as any side effects that may occur as a result of the use of the test product. Then, before continuing any study-related activities, examinees who met the inclusion criteria signed an informed consent form to participate in the study (Declaration of Helsinki, Hong Kong Amendment, 1989).

The examination was performed in the following order:

First visit (day 1, start of treatment):

The patients were diagnosed after the examination by taking anamnesis, extraoral, intraoral examination and X-ray analysis. Appropriate treatment was performed (oral surgery or conservative treatment of pericoronitis). Examinees were advised to continue with regular oral hygiene.

Second visit (3 days from the start of treatment):

Examinees were asked if they experienced any adverse reactions to the solution they were using. During this visit, the researched parameters were re-noted.

Third visit (7 days from the start of treatment):

Examinees were asked if they experienced any adverse reactions to the solution they were using. An oral examination was performed, with special reference to determining the established parameters and comparing the values for the same obtained at the first, second and third visit. The parameters were noted before the sutures were removed in the same visit.

Results and discussion

The data entered in the test lists were statistically processed (Microsoft Office Excel and Statistica[7]). We present the obtained results in tables and graphs, comparing them with relevant authors from the literature. The mean value of the obtained values was performed and a statistical correlation was made between the two subgroups (A and B) in different visits. It must be emphasized that we have not come across a study similarly designed to this one, that is, a study that follows the same parameters as ours, so the comparison with other literary reviews will be empirical, i.e. indirect.

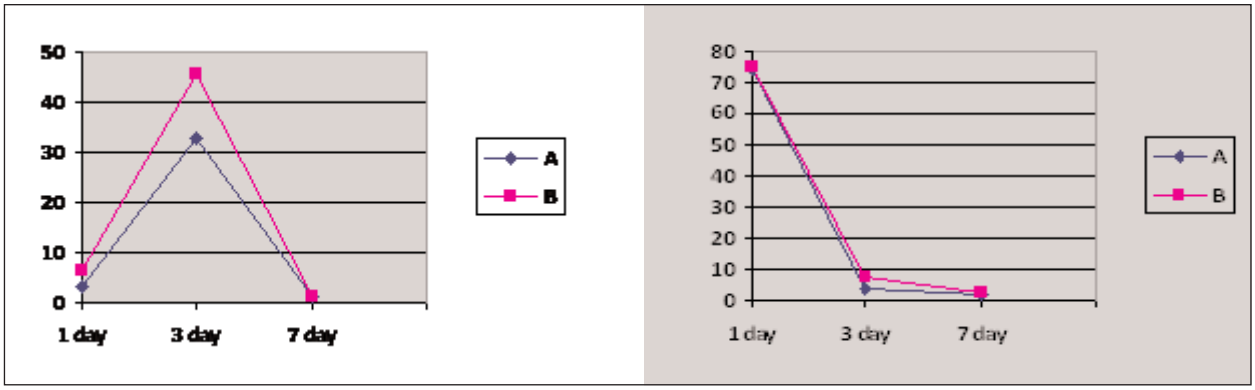
Table 1 and Graph 1 show the values for the Visual Analogue Scale (VAS) for pain expressed in mm (100 mm) for the two large groups and their subgroups, and they were compared in the three different visits. A statistical correlation of the obtained values was made and it a statistically significant difference (t - test; $p < 0.05$) was noted between the examined group A and the control group B on the first and third day in group I patients (those who underwent oral surgery). On the first day, the difference is due to the different pathology diagnosed in these patients, and hence the different symptomatology. The statistical significance of the difference in pain on the first day (day of intervention) cannot be due to the use of CPC because there is not enough time for its action. On the third day, in the stage of surgical wound healing, there is a statistically significant difference in pain, i.e. patients who have used CPC solution have expressed less symptomatology compared to the control group. Most likely, it is due to the reduced microbial load, the reduced plaque formation on the surrounding teeth, and thus the reduced local immune response.

Results in Group II (acute pericoronitis) showed a statistically significant difference (t-test; $p < 0.05$) at the second visit, which also indicates the importance of microbial load and plaque accumulation on the local immune response and release of proinflammatory mediators. It is important to say that there was no statistically significant difference on the 7th day, which indicates that for permanent relief of the symptoms of acute pericoronitis, mechanical debridement of the pericoronal space (curettage, use of H_2O_2 with its foaming characteristic), as well as placing a drain and providing a way to eliminate the exudates, it is much more important, regardless of the solutions used for irrigation. This coincides with the study of Parven and al.[20].

Tables 2 and 3 and Graphs 2 and 3 show the values of gingival inflammation expressed according to the

Table 1. VAS (Visual analogue scale) for pain

VAS (expressed in mm/100 mm)												
group (n=30)	I group-Oral surgical intervention						II group-acute pericoronitis					
visit	1 (1 day)		2 (3 day)		3 (7 day)		1 (1 day)		2 (3 day)		3 (7 day)	
subgroup (n=15)	A	B	A	B	A	B	A	B	A	B	A	B
mean value (mean)	3.07	6.53	32.87	45.53	1.13	1.06	74.33	75.13	3.87	7.8	2.2	2.6
t- test (<0,05)	0.0004		0.0002		0.85		0.87		0.02		0.45	



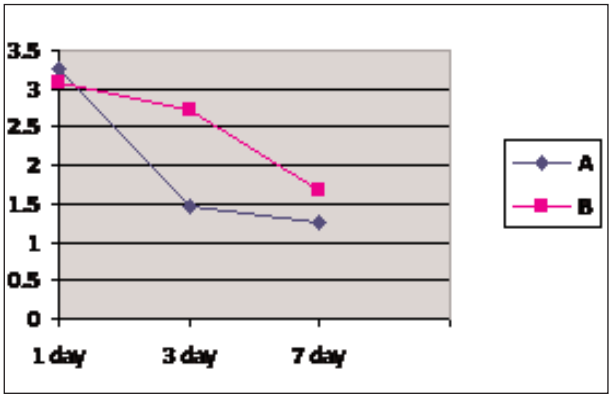
Graph 1. *VAS (Visual analogue scale) for pain*

Muhleman and Cowell index of gingival color and gingival bleeding in patients with acute pericoronitis.

In group II (acute periocoronitis), a statistically significant difference was noted between groups A and B on the third day after treatment for the color of the gingiva, but not for the gingival bleeding. This difference was not noted on the seventh day, which also indicates the importance and advantage of mechanical debridement of the periocoronary pocket.

Table 2. Index of gingival inflammation according to Muhleman and Cowell (gingival color)

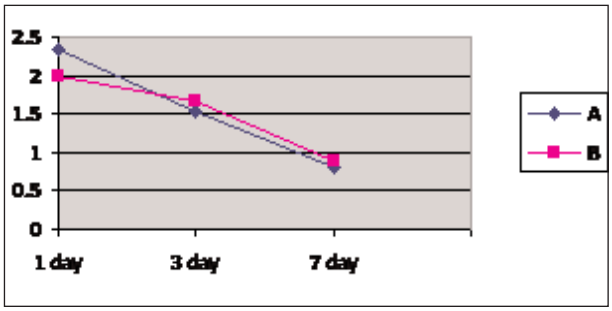
COWELL – index for gingival color						
group (n=30)	II group-acute pericoronitis					
visit	1 (1 day)		2 (3 day)		3 (7 day)	
subgroup (n=15)	A	B	A	B	A	B
mean value (mean)	3.27	3.07	1.47	2.73	1.27	1.67
t- test (<0,05)	0.57		0.006		0.33	



Graph 2. *Index of gingival inflammation according to Muhleman and Cowell (gingival color)*

Table 3. Index of gingival inflammation according to Muhleman and Cowell (gingival bleeding)

COWELL – index for gingival color						
group (n=30)	II group-acute pericoronitis					
visit	1 (1 day)		2 (3 day)		3 (7 day)	
subgroup (n=15)	A	B	A	B	A	B
mean value (mean)	2.33	2	1.53	1.67	0.8	0.9
t- test (<0,05)	0.29		0.54		0.8	



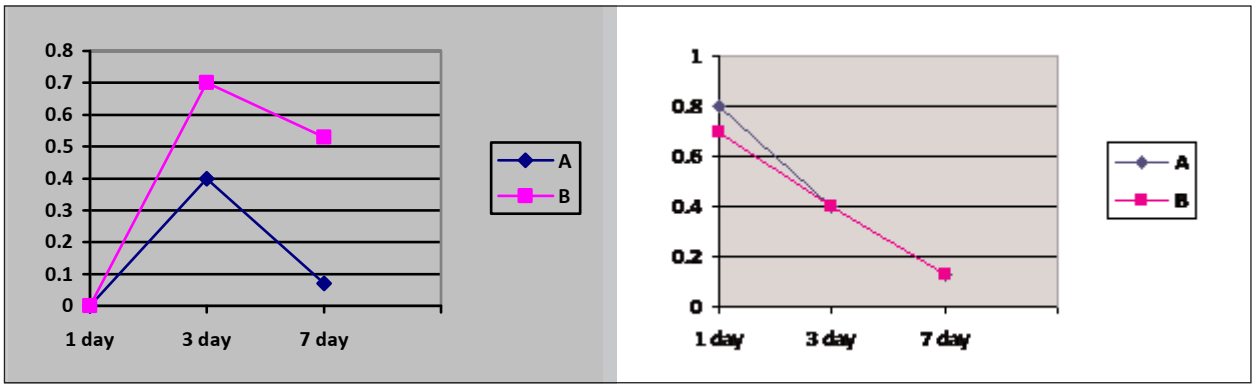
Graph 3. *Index of gingival inflammation according to Muhleman and Cowell (gingival bleeding)*

Table 4 and Graph 4 show the results obtained regarding the presence or absence of postoperative trismus (in Group I) and the presence or absence of trismus in patients with acute pericoronitis (in Group II). Trismus, as a postoperative complication, is quite common in posterior oral mandibular surgery. It is defined as a prolonged spasm of the masticatory muscles and is diagnosed as a reduced interincisal distance <40-45mm[21]. Several factors are considered to be the causes of trismus including traumatic inflammation in the pterygomandibular space, infection that spreads to the pterygomandibular space and the masticatory space, traumatic injury of the masticatory muscles during anesthesia, and self-limiting opening due to pain. In postoperative trismus, the most common cause is traumatic inflammation of the surrounding tissues, while in trismus in acute pericoronitis, the cause is usually an extended infection in the above mentioned areas.

In our study, it is vital to note that there is a statistical difference in the presence of trismus between the two subgroups (A and B) only in Group I on the seventh day postoperatively. This means that patients who have used CPC solution have a significantly reduced degree of trismus after 7 days of intervention, indicating the importance of local tissue infection and inflammation on the onset of postoperative trismus. More detailed information can be found in the graphic presentation of this parameter (Graph 4) in our study which indicates an increased occurrence of trismus on the third day postoperatively in Group I (in both subgroups), while on the other hand, in Group II (acute pericoronitis) increased incidence of trismus was observed at the first visit (before treatment) and a sharp decrease in the incidence of trismus on the third and seventh day after treatment in both subgroups. This coincides with our results from the pain parameter, shown in the first table and graph, which goes in addition to the fact that pain as a symptom plays a significant role in the occurrence and course of trismus. This is in line with the results published in Pedersen's study[22].

Table 4. Presence of trismus according to Ngyene

Presence of trismus												
group (n=30)	I group-Oral surgical intervention						II group-acute pericoronitis					
visit	1 (1 day)		2 (3 day)		3 (7 day)		1 (1 day)		2 (3 day)		3 (7 day)	
subgroup (n=15)	A	B	A	B	A	B	A	B	A	B	A	B
mean value (mean)	0	0	0.4	0.7	0.07	0.53	0.8	0.7	0.4	0.4	0.13	0.13
t- test (<0,05)			0.2		0.01		0.72		1		1	



Graph 4. *Presence of trismus according to Ngyene*

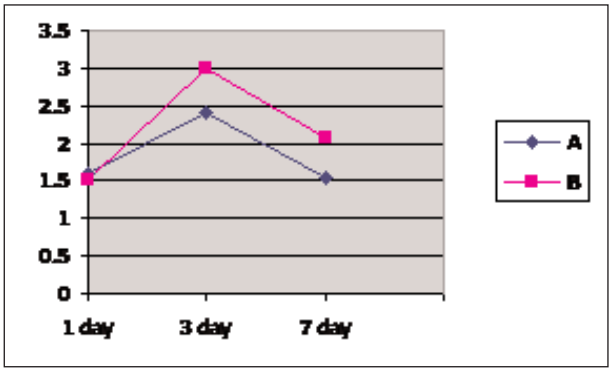
Table 5 and Graph 5 show the values of Gonzales-Santana Inflammation Index. According to this author, the degree of occurrence of tissue inflammation, swelling and the degree of its expansion are numerically expressed[19].

The results refer to the subjects from the first group (patients in which oral surgeries were performed). Our results showed a statistically significant difference between the two subgroups (examined and control), but only at the second visit (the third day). This points to the fact that local microbial load plays a significant role in the first postoperative days and in the intensity of local tissue inflammation, but does not play a significant role in the definitive healing of the postoperative wound.

The graphic presentation of Graph 5 indicates the greatest local tissue inflammation with extraoral spread in the first postoperative days. This coincides with the results expressed in the graphs above, in terms of the presence of trismus. We can see that the curve for the presence of trismus coincides with the curve for the presence of local tissue inflammation in the operative zone.

Table 5. Index of inflammation according to Gonzales-Santana

Postoperative edema and inflammation according to Gonzales-Santana						
group (n=30)	I group-Oral surgical intervention					
visit	1 (1 day)		2 (3 day)		3 (7 day)	
subgroup (n=15)	A	B	A	B	A	B
mean value (mean)	1.6	1.5	2.4	3	1.53	2.07
t- test (<0,05)	0.54		0.04		0.07	



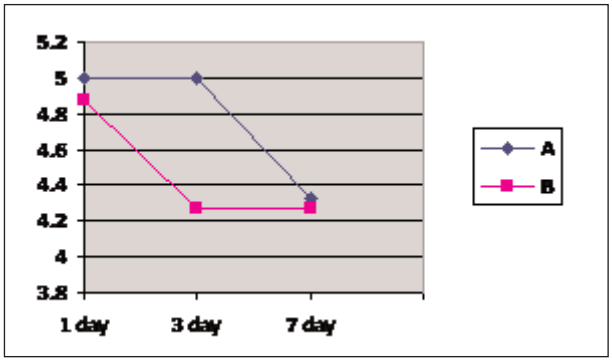
Graph 5. *Index of inflammation according to Gonzales-Santana*

The depth of the pericoronal pocket is an important parameter in patients with acute pericoronitis, which indicates the degree of edema of the pericoronary soft tissue. After conservative treatment of acute pericoronitis, a reduction in the depth of the pericoronal pocket is expected due to a reduction in swelling (volume of pericoronal tissue)[22]. The depth of the pericoronal pocket is taken to be the deepest value measured with a graduated periodontal probe measuring from the edge of the gingiva at the entrance to the pocket to the bottom of the pericoronal pocket.

CPC in combination with 3% hydrogen makes a significant difference in the reduction of inflammatory edema in the first three days of treatment due to the mechanical properties of hydrogen to remove debris from the pericoronal pocket (both antiseptics have a synergistic effect). At the third visit, no statistically significant difference was observed between the two subgroups. This is also consistent with the results of the Parveen and coop study[20].

Table 6. Depth of the pericoronary pocket (only in group II – acute pericoronitis)

Depth of pericoronary pocket (expressed in mm)						
group (n=30)	II group-acute pericoronitis					
visit	1 (1 day)		2 (3 day)		3 (7 day)	
subgroup (n=15)	A	B	A	B	A	B
mean value (mean)	5	4.87	5	4.27	4.33	4.27
t- test (<0,05)	0.697		0.01		0.72	



Graph 6. *Depth of the pericoronary pocket (only in Group II – acute pericoronitis)*

Conclusion

Clinically verified results from this study confirm the antiseptic properties of CPC solutions, particularly their effectiveness in the ability to reduce postoperative pain, microbial load reduction, and reduction of local tissue inflammation. These data encourage us to suggest topical application of CPC solutions in the preoperative period for conditioning oral tissues, intraoperative rinsing as well as prolonged use in the postoperative period. The intention is to turn these recommendations into a mandatory protocol for preoperative preparation and postoperative care of patients after oral surgery, which will minimize postoperative discomfort.

We recommend supplementing the standard protocol for conservative treatment of inflammatory conditions in the oral cavity from an oral surgical point of view, i.e. synergistic use of solutions containing CPC in combination with 3% H_2O_2 solution, which results in significant and rapid reduction of clinical symptoms of acute pericoronitis. We also suggest the use of mouthwashes containing antiseptic CPC solution in the prevention of respiratory virus infection, their transmission and the severity of the clinical picture caused by the current virus, SARS-CoV-2.

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