Stom Glas S COBISS. SR-ID 8417026 UDC 616.31 ISSN 0039-1743

STOMATOLOŠKI GLASNIK SRBIJE

SERBIAN DENTAL JOURNAL

Vol. 64 • Number 4 • October-December 2017

http://www.stomglas.org.rs

Stom Glas S COBISS. SR-ID 8417026 UDC 616.31 ISSN 0039-1743

STOMATOLOŠKI GLASNIK SRBIJE

SERBIAN DENTAL JOURNAL

Vol. 64 • Number 4 • October-December 2017

www.stomglas.org.rs

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Časopis izlazi četiri puta godišnje.

The journal is published four times a year.

Cene pretplate za 2017. godinu su: 2.400 dinara za pojedince, 4.800 dinara za ustanove i 50 evra za čitaoce van Srbije. Pretplata se može uplatiti Srpskom lekarskom društvu, ul. Džordža Vašingtona 19, 11000 Beograd, na tekući račun 205-8041-21 (Komercijalna banka AD, Beograd), sa pozivom na broj 04/1710, imenom časopisa i godinom za koju se pretplata uplaćuje.
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Subscriptions prices for the year 2017 are: 2,400 RSD for individuals, 4,800 RSD for institutions, and 50 Euros for readers outside Serbia. Subscription order: Serbian Medical Society, Džordža Vašingtona 19, 11000 Belgrade; details of payment: bank account number 205-8041-21 (Komercijalna banka AD, Belgrade), invoice number 04/1710, with the name of the journal and the year for which you subscribe; beneficiary: Serbian Medical Society.
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Finansijsku podršku izdavanju časopisa pruža Ministarstvo prosvete, nauke i tehnološkog razvoja Republike Srbije.

The publishing of the Journal is financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

DE GRUYTER
OPEN

ISSN 0039-1743
ISSN Online 1452-3701
COBISS. SR-ID 8417026
UDC 616.31

www.stomglas.org.rs

Stomatološki glasnik Srbije
Serbian Dental Journal

Izdavač
Publisher
Srpsko lekarsko društvo
Serbian Medical Society

Osnivač
Founder
Stomatološka sekcija Srpskog lekarskog društva
Dental Section of the Serbian Medical Society

Prelom teksta i priprema za štampu
Layout & Prepress
Jasmina Živković

Štampa
Printed by
JP „Službeni glasnik", Beograd

Broj primeraka
Number of copies
500

DE GRUYTER
OPEN

Contents / Sadržaj

Serbian Dental Journal, vol. 64, N° 4, 2017

Jedino je glupost dovoljno hrabra
da se predstavlja kao savršenstvo.
Tomas Man

Najvažniji kvalitet svakog čoveka je upravo on sam, odnosno njegova nadarenost da kritički misli i odgovorno stvara. Kada se u centar svekolikog bitisanja postavi unutrašnja hrabrost, onda se umesto grčevite borbe za poznato i već viđeno mogu probuditi i novi vidici, ali i pružiti prilika za avanturu i produbljivanje sopstvenih saznanja o nama samima ali i svetu oko nas. Upravo ta unutrašnja hrabrost nam omogućava autentične i ispunjene živote u svakom segmentu naše stvarnosti, ali i daje odgovore na neodgovoreno i pruža priliku da ukrotimo beskraj sopstvenog života.

Naravno, u aktuelnoj svakodnevici sve je drugačije. Mi kao da lebdimo između društvene realnosti i medijskog propagiranja stvarnosti, jer naše živote oblikuju „svemogući", „podobni" i „poslušni" i najčešće bez ikakvih vrednosnih potvrda.

U aktuelnim okolnostima naš život podseća na crno-beli film sa specifičnom scenografijom i režijom, ali i beznačajnom ulogom glumaca. Film je u vrednosnom smislu civilizacijska inverzija jer redovno dobija nagrade za glumačka ostvarenja, a glumci su umesto da žive na „lovorikama" marginalizovani u obične statiste.

Možda je zato citat s početka ovog komentara najbolji odraz naše sadašnjice. Tamo gde se „glupost" predstavlja kao „savršenstvo" i gde „svemogući" (čitaj neuki i bahati) odlučuju o svemu, tamo gde „moć" nadomešta znanje, svetla budućnost je daleka destinacija.

Besmislena obrazloženja još besmislenijih predloga, kao i „inovativne" metode ulepšavanja stvarnosti i narcisoidna potreba za objašnjavanjem svega postojećeg, sahranjuju i etiku i čast i elementarno dostojanstvo.

Tamo gde su nauka i kultura na rubu svih krajeva, tamo gde o reformama o obrazovanju odlučuju oni bez diplome ili oni sa sumnjivim diplomama, tamo gde su bahatost i primitivizam važni društveni kvaliteti, tamo gde se svima koji su drugačiji šalje poruka da „realnije" razmišljaju o svojoj budućnosti, hrabrost je vrlina učenih, slobodnih i slobodoumnih jer je znanje najvažnija odlika hrabrosti. Čak i u vremenu svekolike regresije u društvu, kada je znanje na podu a poslušnost na vrhu, najvažnije odgovore mogu dati samo obrazovani, kompetentni i nadasve moralni.

Jedino ispravne odgovore na svekolike izazove vremena sadašnjeg mogu dati samo oni koji su u osnovi svog postojanja postavili postulate ličnog usavršavanja, bespoštedne borbe za istinu i moralna načela i pritom znanje izdigli visoko na pijedestal.

Urednički komentar ću i ovog puta završiti onako kako sam i počeo, ali ovog puta citatom lorda Bajrona: „Ne plaši se neznanja, čuvaj se lažnog znanja, jer od njega dolaze sve nedaće na svetu".

Prof. dr Slavoljub Živković

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ORIGINAL ARTICLE
ORIGINALNI RAD

DOI: 10.1515/sdj-2017-0016
UDC: 616.314.163-78

The efficacy of XP-endo SHAPER (XPS) in cleaning the apical third of the root canal

Slavoljub Živković[1], Jelena Nešković[1], Milica Jovanović-Medojević[1], Marijana Popović-Bajić[1], Marija Živković-Sandić[2]

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SUMMARY

Introduction The aim of this study was to evaluate the efficacy of new rotary NiTi instrument XP endo SHAPER (XPS) used with conventional irrigation protocol on the root canal cleaning in the apical area.

Material and methods The research was conducted *in vitro* on 40 extracted single-rooted teeth divided into the four groups. Instrumentation in the first group was performed using iRa Ce NiTi rotary instruments, in the second group the same instruments were used plus XP endo FINISHER (XPF) for smear layer removal. In the third group, canal instrumentation was done using new instrument XPS, and in the fourth XPS instruments plus XPF was used. During the instrumentation 2% NaOCl solution was used for rinsing canals. The SEM analysis of the cleaning quality in the apical third of the canal was performed on longitudinal root cross-sections and standardized microphotography with a 2000x magnification.

Results The thickest smear layer in the apical third was recorded in the first group (iRa Ce) NiTi instruments (2.12), and somewhat less in the group with the new XPS instrument (1.95). An identical and somewhat smaller amount of smear layer was registered in the second and fourth groups where XPF was used with the final irrigant (1.64) ($p<0.001$).

Conclusion The application of only one instrument (XPS) in the canal enabled efficient cleaning of a very complex apical third. Cleaning was more efficient when XPF was used with final irrigant after the canal instrumentation.

Keywords: XP endo SHAPER; XP endo FINISHER; smear layer; conventional irrigation

INTRODUCTION

Complex anatomy of the root canal system and inadequate cleaning using the existing instruments and techniques are still significant and current problems of endodontic treatment [1, 2]. It has been confirmed that even after careful selection of hand or rotary files, almost 30-50% of the wall surface remains untouched [3].

Cleaning the apical third of the root canal is a challenge due to anatomical specificities (constrictions, ramifications, additional canals) [3] and due to small diameter of the apical preparation that additionally complicates canal debridement [4]. The quantity of irrigants, technique and irrigation protocol are very important for efficient cleaning of the root canal system, since it is the only way to reach untouched and inaccessible areas of the canal [5, 6].

Chemo-mechanical procedures provide significant reduction in the number of bacteria in the main canal, but not complete disinfection of the canal system [7]. Therefore, the realistic goal of endodontic treatment is to reduce the number of bacteria in the canal system on the level that enables effective reparation of damaged periapical tissues [8, 9]. Mechanical instrumentation with copious irrigation removes the largest number of bacteria from the canal, but irrigants with antibacterial properties are necessary for optimal canal disinfection [10, 11, 12]. The most frequently used root canal irrigants are NaOCl (due to the strong antibacterial effect [13] and exceptional solvent effect of the organic part of dentine [14]), or chlorhexidine (due to prolonged antibacterial effect on numerous bacteria in the canal) [15, 16, 17].

It has also been confirmed that irrigation techniques based on solution activation in the canal (passive ultrasonic irrigation [18, 19], agitation with new instruments - XP Endo FINISHER (XPF) [6, 20] or laser [21]) provide more efficient penetration of irrigants, and more efficient cleaning of the complete root canal system. The research has also confirmed that physical and chemical properties of irrigants enable smear layer dissolution on the canal walls and significantly contribute to its removal [22, 23]. This significantly increases the quality of bond between the sealer and dentin walls and significantly affects the quality and outcome of the endodontic treatment [24, 25].

The aim of this article was to evaluate (using SEM) the efficacy of new rotary NiTi instrument XP endo SHAPER (XPS) used with conventional irrigation protocol on the root canal cleaning in the apical area.

MATERIAL AND METHODS

The study was conducted on 40 extracted human teeth (upper incisors), which were stored up to the experiment in a 0.01%

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solution of NaOCl at the temperature of 4 °C. After forming out the access cavity and checking the passage of the canal with hand instrument (ISO 15) in all teeth, the working length (1 mm shorter than the length at which the tip of the hand-file appears on the apex) was determined. Pink wax ball was placed at the top of each root to prevent leakage of the irrigants during instrumentation.

Teeth were divided into the 4 groups (10 teeth each) using the method of random choice. One researcher performed all root canal preparations. Plastic syringes of 2 ml volume and the appropriate needles gauge 27 were used for irrigation.

Group 1- in the first group preparation was formed using the basic set of NiTi rotating instruments iRaCe (FKG, Dentaire, Swiss) [26] with 3 instruments (R1 # 15/06; R2 # 25/04, R3 # 30/04) and conventional irrigation of 2% NaOCl solution (Chloraxid 2%, Cerkamed, Poland). The canal was irrigated with 2 ml of NaOCl solution before each and after the last NiTi instrument (total of 8 ml per canal).

Group 2- in the second group the canal instrumentation was done identically as in the first group, but after the preparation, XPF (FKG, Dentaire, Swiss) was used. After the canal was filled with irrigant (1 ml NaOCl) XPF was used with slow pulling in and pulling out movements for 1 minute and at the speed of 800 rpm. After the withdrawal of the instrument, the canal was irrigated with one more milliliter of solution.

Group 3- in the third group canal preparation was performed with new NiTi rotary instrument XP endo SHAPER (FKG, Dentaire, Swiss) [26] (one instrument # 30/04) with constant irrigation with 2% NaOCl solution before and after the instrumentation (total 4 ml per canal). The instrument was placed into the canal filled with irrigant and with gentle movements of pulling in and pulling out at the speed of 800 rpm, the canal was prepared to the working length.

Group 4- in the fourth group instrumentation of the canal was done using XP endo SHAPER, and for more efficient cleaning after instrumentation, XP endo FINISHER was used.

The crowns of all teeth were cut at the enamel-cement joint, and then the roots were separated into the two halves with the diamond disc and sharp knife. The halves were prepared for SEM analysis (JOEL, JSM 6460LV, Japan). The apical third of the canal (3mm from the apical preparation) was analyzed, so that 5 standardized microphotographs were taken at 2000x for each sample (half of the tooth). For qualitative evaluation of the residual smear layer on dentin walls in the apical segment of the canal, Hilsman and al. criteria [27] were used:

1- no smear layer, dentinal tubules open
2- small amount of smear layer, several dentinal tubules open
3- non-homogeneous smear layer covers the canal wall, small number of dentinal tubules open
4- the entire wall of the canal covered with smear layer, no open dentinal tubules
5- non-homogeneous smear layer covering the entire wall of the canal

SEM images (400 in total) were evaluated by two independent researchers. The obtained results were analyzed in the SPSS program using the parameters of descriptive statistics and analysis of variance.

RESULTS

The results of SEM analysis are shown in Table 1 and Figures 1-4.

The most smear layer in the apical third was recorded in the group where the instrumentation was done only by NiTi rotating instruments iRaCe (2.12), then in the group where XP endo SHAPER (1.95) was used. In the second (iRaCe and XP endo FINISHER) and the fourth group (XP endo SHAPER and XP endo FINISHER), an identical and slightly less amount

Table 1. Smear layer removal in the apical third of the root canal
Tabela 1. Procena razmaznog sloja u apeksnoj trećini kanala korena zuba

Group Grupa	N	x	SD	Med	Min	Max
iRaCe	100	2.12	1.00	2.00	1.00	4.00
iRaCe+XPF	100	1.64	0.70	2.00	1.00	3.00
XPE	100	1.95	0.98	2.00	1.00	4.00
XPE+XPF	100	1.64	0.72	1.50	1.00	3.00
Total Ukupno	400	1.84	0.88	2.00	1.00	4.00

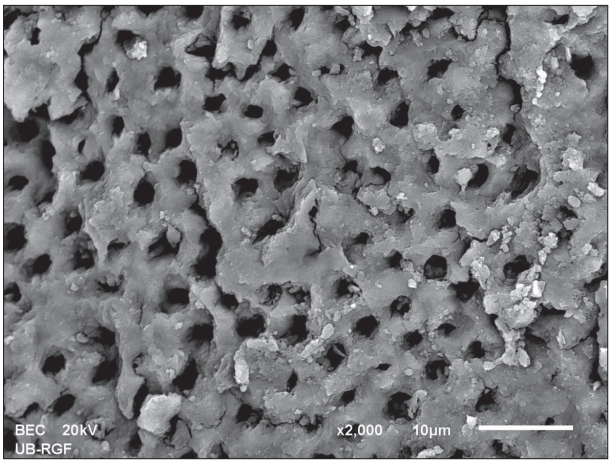

Figure 1. Representative microphotography of the apical third of the group 1 (iRa Ce). Small amount of smear layer (grade 2) (SEM ×2000)
Slika 1. Reprezentativna mikrofotografija apeksne trećine iz grupe 1 (iRa Ce). Mala količina razmaznog sloja (ocena 2) (SEM ×2000)

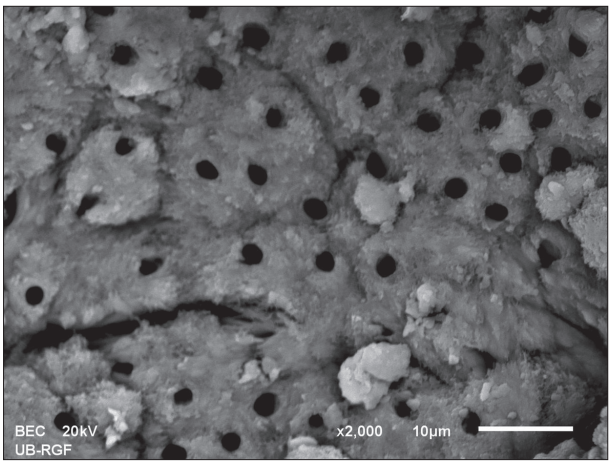

Figure 2. Representative microphotography of the apical third of the group 2 (iRa Ce + XPF). Small amount of smear layer with great number of open dentinal tubules (grade 2) (SEM ×2000)
Slika 2. Reprezentativna mikrofotografija apeksne trećine iz grupe 2 (iRa Ce + XPF). Mala količina razmaznog sloja sa dosta otvorenih tubula (ocena 2) (SEM ×2000)

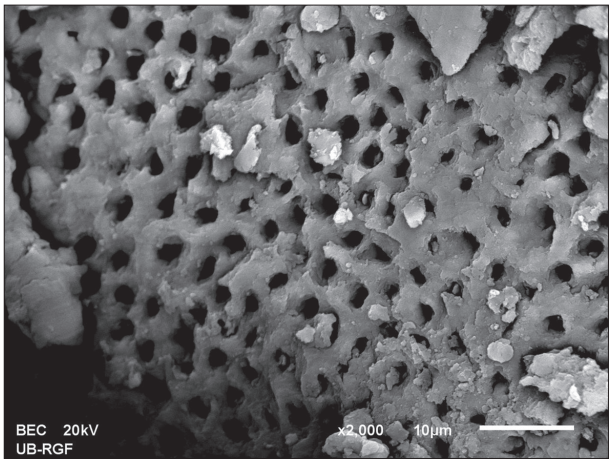

Figure 3. Representative microphotography of the apical third of the group 3 (XPS). Small amount of smear layer (grade 2) (SEM ×2000)
Slika 3. Reprezentativna mikrofotografija apeksne trećine iz grupe 3 (XPS). Mala količina razmaznog sloja (ocena 2) (SEM ×2000)

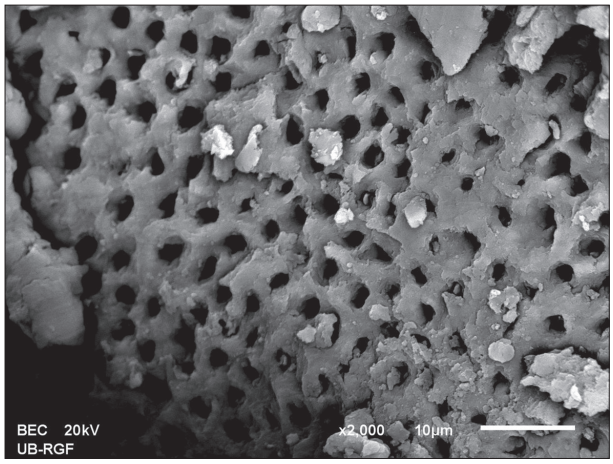

Figure 4. Representative microphotography of the apical third of the group 4 (XPS + XPF). Small amount of smear layer with the number of open dentinal tubules (grade 2) (SEM ×2000)
Slika 4. Reprezentativna mikrofotografija apeksne trećine iz grupe 4 (XPS + XPF). Mala količina razmaznog sloja sa dosta otvorenih tubula (ocena 2) (SEM ×2000)

of smear layer (1.64) was detected. A single-factor analysis of variance indicated statistically significant difference in average scores between the groups ($P < 0.001$) (Table 1). This difference was significant between the first (iRaCe) and the second group (iRaCe and XPendo FINISHER), and between the first (iRaCe) and the fourth group (XP endo SHAPER and XP endo FINISHER) (Table 1).

DISCUSSION

Chemo-mechanical preparation of the root canal is one of the essential factors in the control of endodontic infection [3, 7, 22] and the removal of smear layer from the root canal walls is significant clinical parameter for the endodontic treatment success [13, 15, 25]. The most challenging area in root canal cleaning and smear layer removal is the apical third of the canal [6, 12, 18, 21]. Inaccessibility of this segment of the canal due to inadequate diameter of the apical preparation makes difficult to achieve exposure of this part of the canal to adequate time, volume and concentration of irrigants [7, 10, 13, 28, 29, 30]. Therefore, in this study, canal instrumentation and irrigation were performed in simple canal systems (single rooted teeth), according to the same protocol (all canals were instrumented by the same practitioner) with the same irrigant (2% NaOCl) and irrigation technique (conventional, continuous).

The results indicated significantly more efficient cleaning and removing smear layer in the apical third of the root canal, when XP endo FINISHER (XPF) was used after complete instrumentation with NiTi rotating instruments (iRaCe, XP endo SHAPER). XPF enabled more effective smear layer removal from the apical third of the canal, due to its specific design and changing its shape during rotation in the canal and reaching inaccessible areas in the apical part of the canal [6, 18, 20, 26]. It also significantly reduced bacteria from the hard-to-reach areas due to irrigant activation at a speed of 800 rpm [6]. It is well known that success in root canal cleaning depends on the instrumentation technique, selection of irrigants and irrigation technique [2, 8, 10, 12, 16, 18, 24].

In this study, conventional and continuous irrigation protocol with 2% NaOCl solution was used in all groups while the canal instrumentation in the first and second group was performed with iRaCe NiTi rotary instruments (3 instruments), and in the third and fourth group with XP endo SHAPER (1 instrument). Better cleaning of the apical part of the canal was observed after XPS was used but without significant difference. Both instrument systems offer the same apex preparation size (# 30/04 in iRaCe and # 30/04 with XP endo SHAPER), but specific design of XPS and its flexibility allowed it to contract and expand within the canal, and therefore reaches those zones that conventional instruments cannot reach [28].

It is interesting that more efficient removal of the smear layer in the apical third was achieved when the preparation was done with one instrument only and significantly smaller amount of irrigant. Although higher bacterial reduction in the canal system is expected after prolonged irrigation [13, 31], somewhat better cleaning could be explained by the instrumentation technique, and rotational speed (800 rpm), but also the specific design of XPS. Namely, the shape like snake and superelasticity of XP ENDO SHAPER allowed it to expand in the canal and reach inaccessible parts (canals, lateral canals, apex ramifications) [20, 26, 28, 33, 34].

Efficient cleaning of the apical third of the root canal instrumented with iRaCe iinstruments is the result of satisfactory diameter in apex (30/04) that provides irrigant access on smear layer in this area [25, 28, 30]. It has been confirmed that the preparation of the canal with RaCe instruments causes significantly less transportation of cut dentine into the apical part of the canal compared to other rotating NiTi instruments [20, 35]. The smaller amount of smear layer obtained with the same instruments is related to slightly higher speed of these instruments (600 rpm) than the most common speeds of other NiTi instruments (150-300 rpm) [20, 36].

Since the presence of bacteria in the root canal system causes poor prognosis of endodontic treatment, the main precondition for success is maximum elimination of bacteria by chemo-mechanical instrumentation [7, 30]. NaOCl is the most commonly used solution for irrigation of the root canal due to

its effective antibacterial and tissue dissolution effect as well as its availability [30]. Irrigation technique has also effect on smear layer removal [6]. The advantage of the intermittent irrigation procedure (in 3 steps) in relation to the continuous is that the increase in the irrigation cycle increases its cumulative effect and fresh irrigants improve the quality and speed of bacterial biofilm removal from the canal system [6, 37, 38].

CONCLUSION

New rotary NiTi instrument XP endo SHAPER (1 instrument) and iRaCe set (3 instruments) provided efficient cleaning of the apical third of the root canal. Following the application of XP endo FINISHER after completed instrumentation more efficient removal of smear layer in the apical third of the root canal was achieved.

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Received: 04.09.2017 • Accepted: 27.11.2017

XP-endo SHAPER (XPS): efikasnost u čišćenju apeksne trećine kanala

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KRATAK SADRŽAJ

Uvod Cilj ovog rada je bio da se SEM analizom proceni efikasnost čišćenja apeksne trećine kanala korena primenom novog rotirajućeg NiTi instrumenta XPS uz protokol konvencionalne irigacije.

Materijal i metode rada Istraživanje je realizovano u in vitro uslovima na 40 ekstrahovanih jednokorenih zuba podeljenih u četiri grupe. Instrumentacija kanala u prvoj grupi je izvedena setom iRa Ce NiTi rotirajućih instrumenata, a u drugoj je nakon instrumentacije ovim setom za uklanjanje razmaznog sloja korišćen XPF. U trećoj grupi je instrumentacija kanala realizovana novim instrumentom XPS, a u četvrtoj je posle završene instrumentacije takođe korišćen XPS. Irigacija kanala korena u svim grupama je sprovedena 2% rastvorom NaOCl primenom konvencionalnog protokola. SEM analiza kvaliteta čišćenja apeksne trećine kanala je realizovana na uzdužnim presecima korenova i standardizovanim mikrofotografijama na uveličanju od 2000 puta.

Rezultati Dobijeni rezultati su pokazali da je najviše razmaznog sloja u apeksnoj trećini zabeleženo u grupi gde je instrumentacija realizovana setom iRa Ce NiTi instrumenata (2,12), a nešto manje u grupi sa novim instrumentom XPS (1,95). Identična i nešto manja količina razmaznog sloja je registrovana u drugoj i četvrtoj grupi, gde je posle završene instrumentacije korišćen XPF (1,64) ($p < 0,001$).

Zaključak Primena samo jednog instrumenta (XPS) u instrumentaciji kanala obezbeđuje efikasno čišćenje vrlo kompleksne apeksne trećine. Ovo čišćenje je značajno efikasnije posle primene XPF nakon završene instrumentacije kanala.

Ključne reči: XP-endo SHAPER; XP-endo FINISHER; razmazni sloj; konvencionalna irigacija

UVOD

Kompleksna i složena anatomija kanalskog sistema zuba i nemogućnost adekvatnog čišćenja ovog prostora postojećim instrumentima i tehnikama još uvek su značajan i aktuelan problem endodontskog lečenja [1, 2]. Čak ni pažljivim izborom ručnih ili mašinskih turpija nije moguće dopreti do svih delova kanala, pa skoro 30–50% površine zidova ostaje netaknuto [3].

Poseban problem u čišćenju predstavlja apeksna trećina kanala korena, kako zbog anatomskih specifičnosti (istmusi, ramifikacije, dodatni kanali) [3] tako i zbog malog dijametra apeksne preparacije koja dodatno otežava debridman kanala [4]. Za efikasno čišćenje kanalskog sistema vrlo je značajna i količina irigansa, odnosno tehnika i protokol irigacije, s obzirom na to da je to jedini način da se dopre do netaknutih i nepristupačnih površina kanala [5, 6].

Hemomehaničke procedure obezbeđuju znatno smanjenje broja bakterija u glavnom kanalu, ali ne i potpunu dezinfekciju kompletnog kanalskog sistema [7]. Zato se smatra da je realni cilj endodontskog tretmana u stvari smanjenje broja bakterija u kanalskom sistemu na nivo koji će omogućiti efikasnu reparaciju oštećenih periapikalnih tkiva [8, 9]. Mehaničkom instrumentacijom uz obilnu irigaciju se uklanja najveći broj bakterija iz kanalskog sistema, ali je za optimalnu dezinfekciju kanala neophodan i irigans sa antibakterijskim svojstvima [10, 11, 12].

Najčešće korišćena sredstva za irigaciju kanala su sigurno NaOCl (zbog snažnog antibakterijskog efekta [13] i izuzetnog rastvaračkog efekta organskog dela dentina [14]), odnosno hlorheksidin (zbog izuzetnog i produženog antibakterijskog efekta na brojne bakterije u kanalu) [15, 16, 17]. Potvrđeno je takođe da se tehnikama irigacije koje se baziraju na nekoj vrsti aktivacije rastvora u kanalu (pasivna ultrazvučna irigacija [18, 19], agitacija novim instrumentima – XP-endo FINISHER [6, 20] ili laser [21] – obezbeđuje efikasnija penetracija irigansa, odnosno efikasnije čišćenje kompletnog kanalskog sistema.

Istraživanja su takođe potvrdila da sredstva za irigaciju svojim fizičkim i hemijskim svojstvima omogućavaju rastvaranje razmaznog sloja na zidovima kanala i značajno doprinose njegovom uklanjanju [22, 23]. Time se značajno povećava kvalitet veze sredstva za opturaciju za zidove kanala i značajno utiče na kvalitet i ishod samog endodontskog zahvata [24, 25].

Cilj ovog rada je bio da se SEM analizom proceni efikasnost čišćenja apeksne trećine kanala korena primenom novog rotirajućeg NiTi instrumenta XP-endo SHAPER (samo jedan instrument) uz protokol konvencionalne irigacije.

MATERIJAL I METODE

Istraživanje je obavljeno na 40 ekstrahovanih humanih zuba (gornjih sekutića) koji su do eksperimenata čuvani u 0,01% rastvoru NaOCl na temperaturi 4°C.

Kod svih zuba je posle formiranja pristupnog kaviteta i provere prohodnosti kanala instrumentom (ISO 15) određena radna dužina (1 mm kraće od dužine na kojoj se vrh ručne turpije pojavljuje na apeksu). Na vrhu korena svakog zuba je zatim postavljena kuglica roze voska kako bi se sprečilo isticanje rastvora za irigaciju tokom instrumentacije.

Metodom slučajnog izbora zubi su podeljeni u četiri grupe po 10 zuba. Kompletnu preparaciju kanala obavio je jedan istraživač. Za ispiranje su korišćeni plastični špricevi zapremine 2 ml i odgovarajuće igle veličine 27.

Grupa 1 – preparacija je realizovana primenom osnovnog seta NiTi rotirajućih instrumenata iRaCe (FKG, Dentaire, Swiss) [26] sa tri instrumenta (R_1 #15/06; R_2 #25/04; R_3 #30/04) uz kontinuiranu konvencionalnu irigaciju 2% rastvorom NaOCl (Chloraxid 2%, Cerkamed, Poland). Kanal je ispiran sa 2 ml rastvora NaOCl pre svakog i posle poslednjeg NiTi instrumenta (ukupno 8 ml po kanalu).

Grupa 2 – instrumentacija kanala je urađena identično kao i u prvoj grupi, ali je posle završene instrumentacije kanala korišćen XP-endo FINISHER (FKG, Dentaire, Swiss). XPF je korišćen u kanalu ispunjenim irigansom (1 ml NaOCl) primenom sporih i nežnih pokreta uvlačenja i izvlačenja tokom jednog minuta i pri brzini od 800 o/min. Posle izvlačenja instrumenta, kanal je ispran sa još 1 ml rastvora.

Grupa 3 – instrumentacija kanala je obavljena novim NiTi rotirajućim instrumentom XP-endo SHAPER (XPF) (FKG, Dentaire, Swiss) [26] (jedan instrument #30/04) uz konstantnu irigaciju 2% rastvorom NaOCl pre i posle instrumenta (ukupno 4 ml po kanalu). Instrument je ubačen u kanal ispunjen irigansom i nežnim pokretima uvlačenja i izvlačenja pri brzini od 800 o/min. kanal je preparisan do radne dužine.

Grupa 4 – instrumentacija kanala je realizovana identično kao i u trećoj grupi primenom XP-endo SHAPERA, a posle instrumentacije za efikasnije čišćenje je korišćen XP-endo FINISHER, identično kao i u drugoj grupi.

Krunice svih zuba su presečene u predelu gleđno-cementne granice, a potom korenovi dijamantskim diskom uzdužno zasečeni i uz pomoć oštrog nožića razdvojeni na dve polovine. Ovako dobijene polovine pripremljene su za SEM analizu (JOEL, JSM 6460LV, Japan). Analizirana je samo apeksna trećina kanala (region 3 mm od granice preparacije) tako što je za svaki uzorak (polovina zuba) napravljeno po pet standardizovanih mikrofotografija na uvećanju od 2000 puta. Za kvalitativnu procenu zaostalog razmaznog sloja na zidovima kanala u apeksnom segmentu korišćeni su kriterijumi Hilsmana i sar. [27]:

Ocena: 1 – nema razmaznog sloja, dentinski tubuli otvoreni;
2 – mala količina razmaznog sloja, nekoliko tubula otvoreno;
3 – nehomogeni razmazni sloj pokriva zid kanala, malo tubula otvoreno;
4 – ceo zid kanala pokriven razmaznim slojem, nema otvorenih tubula;
5 – nehomogeni razmazni sloj koji pokriva ceo zid kanala.

SEM fotografije uzoraka svih zuba (400 slika) procenjivala su dva nezavisna istraživača. Dobijeni rezultati su uređeni u SPSS programu i analizirani primenom parametara deskriptivne statistike i analize varijanse.

REZULTATI

Rezultati SEM analize apeksne trećine kanala korena zuba su prikazani u Tabeli 1 i slikama 1–4.

Najviše razmaznog sloja u apeksnoj trećini zabeleženo je u grupi gde je instrumentacija realizovana samo NiTi rotirajućim instrumentima iRaCe [2, 12] (Slika 1), potom u grupi gde je korišćen XP-endo SHAPER (1,95) (Slika 2), dok je u drugoj (iRaCe i XP-endo FINISHER) (Slika 3) i četvrtoj grupi (XP-endo SHAPER i XP-endo FINISHER) (Slika 4) uočena identična i nešto manja količina razmaznog sloja (1,64). Jednofaktorska analiza varijanse je ukazala na visoko statistički značajnu razliku u prosečnim ocenama između grupa ($p < 0,001$) (Tabela 1). Ova razlika je bila značajna između prve (iRaCe) i druge grupe (iRaCe i XP-endo FINISHER), odnosno između prve (iRaCe) i četvrte grupe (XP-endo SHAPER i XP-endo FINISHER) (Tabela 1).

DISKUSIJA

Hemomehanička preparacija kanala korena zuba je jedan od presudnih faktora u kontroli endodontske infekcije [3, 7, 22], a uklanjanje razmaznog sloja sa zidova kanala korena značajan klinički parametar za uspeh endodontskog lečenja [13, 15, 25].

Poseban problem u čišćenju kanala korena i uklanjanju razmaznog sloja je područje granice instrumentacije, odnosno apeksna trećina kanala korena [6, 12, 18, 21]. Osnovni razlog za to je nepristupačnost ovog segmenta kanala, odnosno neadekvatan dijametar apeksne preparacije, ali i volumen, koncentracija i vreme izlaganja ovog dela kanala rastvoru za irigaciju [7, 10, 13, 28, 29, 30].

Zato je u ovom istraživanju instrumentacija i irigacija kanala realizovana na jednostavnim kanalnim sistemima (jednokoreni zubi), prema istom protokolu (sve kanale je obradio isti praktičar) uz isti irigans (2% NaOCl) i istu tehniku irigacije (konvencionalna, kontinuirana), tako da se dobijeni rezultati mogu analizirati u funkciji korišćenih NiTi rotirajućih instrumenata i njihovoj efikasnosti u čišćenju apeksne trećine kanala.

Dobijeni rezultati su ukazali na značajno efikasnije čišćenje i uklanjanje razmaznog sloja u apeksnoj trećini kanala korena kada je poslen završene instrumentacije NiTi rotirajućim instrumentima (iRaCe, XP-endo SHAPER) korišćen XP-endo FINISHER. Primena ovog instrumenta obezbedila je efikasnije uklanjanje razmaznog sloja iz apikalnog segmenta kanala, jer zahavljujući specifičnom dizajnu i činjenici da menja svoj oblik tokom rotacije može da dopre i do nepristupačnih delova u apeksnom delu kanala [6, 18, 20, 26]. Primena ovog instrumenta obezbeđuje značajno veću redukciju bakterija u kanalnom sistemu jer eliminiše bakterije iz teško dostupnih područja, zahvaljujući efektu aktivacije irigansa pri brzini od 800 o/min. [6]. Potvrđeno je takođe da ključni deo čišćenja kanala korena zavisi od tehnike instrumentacije, odnosno izbora irigansa i tehnike irigacije [2, 8, 10, 12, 16, 18, 24].

U ovom istraživanju je kao irigans korišćen 2% rastvor NaOCl i konvencionalni i kontinuirani protokol irigacije, dok je instrumentacija kanala u prvoj i drugoj grupi realizovana setom iRaCe NiTi rotirajućih instrumenata (tri instrumenta), a u trećoj i četvrtoj grupi sa XP-endo SHAPEROM (jedan instrument). Nešto bolje čišćenje apeksnog dela kanala i efikasnija hemomehanička preparacija je uočena posle primene XP-endo SHAPERA, ali bez značajnih razlika. Ova mala razlika bi se mogla objasniti istim dijametrom apeksne preparacije (#30/04 kod iRaCe i #30/04 kod XP-endo SHAPERA), a nešto bolji rezultat kod XP-endo SHAPERA specifičnim dizajnom ovog instrumenta i njegovom ekstremnom fleksibilnošću koja mu omogućava da se kontrahuje i širi unutar kanala i time dosegne i do onih zona do kojih konvencionalni instrumenti ne mogu [28].

Ono što je zanimljivo u rezultatima ovog istraživanja je činjenica da je efikasnije uklanjanje razmaznog sloja u apeksnoj trećini ostvareno kod kanala gde je preparacija urađena samo jednim instrumentom i sa znatno manjom količinom irigansa, odnosno sa kraćim vremenom delovanja na zidove kanala usled kraćeg vremena instrumentacije. Iako se veća bakterijska redukcija u kanalskom sistemu očekuje posle produžene irigacije [13, 31], nešto bolje čišćenje bi se ovde moglo objasniti upravo tehnikom instrumentacije odnosno nešto većom brzinom rotacije (800 o/min.), ali i specifičnim dizajnom XP-endo SHAPERA. Naime, „zmijoliki" izgled i superelastičnost XP-endo

SHAPERA omogućavaju mu da se „širi" unutar kanala i tako dopre do nepristupačnih delova (istmusi, lateralni kanali, apeksne ramifikacije) kanala [20, 26, 28, 33, 34].

Efikasno čišćenje apeksnog dela kanala korena setom rotirajućih instrumenata iRaCe posledica je zadovoljavajućeg dijametra u apeksu (30/04), što obezbeđuje bolji efekat aplikovanog rastvora za irigaciju i njegov efikasniji rastvarački odnosno bolji efekat uklanjanja razmaznog sloja [25, 28, 30]. Potvrđeno je takođe da preparacija kanala RaCe instrumentima dovodi do znatno manje transportacije sečenog dentina u apeksni deo kanala u odnosu na druge rotirajuće NiTi instrumente [20, 35]. Manja količina razmaznog sloja u apeksnom delu kanala posle preparacije iRaCe setom NiTi rotirajućih instrumenata može biti i posledica nešto veće brzine ovih instrumenata (600 o/min.) u odnosu na najčešće brzine drugih setova NiTi (150–300 o/min.) [20, 36].

S obzirom na to da prisustvo bakterija u kanalskom sistemu uzrokuje lošu prognozu ishoda endodontskog lečenja, osnovni preduslov za uspeh je njihova maksimalna eliminacija hemomehaničkom instrumentacijom [7, 30]. NaOCl je najčešće korišćen rastvor za irigaciju kanala korena zbog efikasnog antibakterijskog i rastvaračkog efekta, odnosno brzine delovanja i njegove cene [30]. Na efikasnost uklanjanja razmaznog sloja sa zidova kanala korena može uticati i sam protokol odnosno tehnika irigacije [6]. Prednost intermitentnog postupka irigacije (u tri koraka) u odnosu na kontinuiranu je u tome što se povećanjem ciklusa irigacije povećava i njegov kumulativni efekat, jer se svežim irigansom poboljšavaju kvalitet i brzina čišćenja, ali i efikasno uklanjanje biofilma bakterija iz kanalskog sistema [6, 37, 38].

ZAKLJUČAK

U okviru ograničenja ove studije može se zaključiti da se nakon instrumentacije kanala korena novim rotirajućim NiTi instrumentom – XP-endo SHAPER (jedan instrument) i seta iRaCe (tri instrumenta) obezbeđuje efikasno čišćenje apeksnog dela kanala korena. Primena XP-endo FINISHERA posle završene instrumentacije kanala instrumentom XP-endo SHAPER i setom iRaCe rotirajućih NiTi instrumenata dovodi do značajno efikasnijeg uklanjanja razmaznog sloja u apeksnom delu kanala korena.

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DOI: 10.1515/sdj-2017-0017
UDC: 616.31-006-085; 615.849

Effects of radiotherapy on oral cavity tissues

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SUMMARY

Radiotherapy in the treatment of head and neck tumors is most often used as an independent method or in combination with surgery and / or chemotherapy. These therapeutic methods in a multidisciplinary approach generally lead to favourable therapeutic response. During radiotherapy of this region, oral mucosa is inevitably covered within irradiated volume. Radical therapy is achieved with high doses of radiation, which usually results in development of undesired toxic effects, which, depending on the time of manifestation can be acute and late. Acute radiation toxicity occurs during or immediately after completion of performed therapy, and the late one several months or years after the completed treatment. The most common acute complications in the oral cavity are inflammation of oral mucosa, loss of taste, dry mouth and secondary infections. Late complications include radiation caries, trismus, and osteoradionecrosis. The aim of this paper was to present the effects and specificities of toxicity observed on oral cavity tissues after radiotherapy.

Keywords: toxicity; radiotherapy; oral cavity; prevention

INTRODUCTION

Ionizing radiation by its effect leads to the formation of free radicals, which interfere with biochemical processes and cell division, resulting in cell death. Radiation is usually carried out in high doses (ranging from 50 Gy to about 70 Gy) in individual daily fractions of 2 Gy during five days a week including breaks over the weekend, and for a total duration of several weeks [1].

Tissues, depending on radiobiological response to radiation, can be radio resistant, and this includes tissues with fewer cell divisions (e.g. bone, cartilage and muscle tissues). In contrast to them, more sensitive to ionizing radiation are tissues whose cells actively divide, such as bone marrow, reproductive organs, eye lens, and digestive and respiratory epithelium. This group also includes mucous membrane of the mouth, therefore it is necessary to prevent these radiation effects and treat them adequately. By applying advanced technologies and using modern radiotherapy techniques, significant precision, better dose distribution and maximum protection of healthy tissues during radiation are achieved thereby reducing possible late toxicity [2].

ACUTE TOXICITY

Radiation toxicity in the oral cavity occurs in almost all patients who undergo radiation of a tumour in maxillofacial region, all three floors of the throat, base of the tongue, floor of the mouth, parotid region, larynx and neck. The cause of complications is high mitotic activity of mucous membrane cells, disturbance of oral microflora balance with microtrauma produced during normal physiological function of the oral cavity [3]. Acute toxicity most commonly occurs as oral mucositis, loss of taste and dry mouth (xerostomia).

The most common acute complication of radiation is oral mucositis. Cell death of basal keratinocytes under the action of ionizing radiation causes the damage of mucous membrane in the oral cavity. Already during the first week of radiotherapy, early clinical signs of mucositis can be noticed in the form of unclearly localized pale zones or milky white discoloration. They are the most noticeable in the buccal region, especially in the area of mechanical irritation from teeth. These changes are accompanied by mucosal erythema and atrophy. Around this altered epithelium, further action of radiotherapy causes progression of these changes in the form of ulceration. In these spots of mucosal damage, pale yellowish-white fibrin deposits form pseudomembranes and they are suitable place for the formation of infection, usually candidiasis (*Candida albicans*). In addition to the buccal region, other parts of the oral cavity may also be affected, particularly sides and the upper surface of the tongue, lip mucosa, soft palate, floor of the mouth and throat. Pain is also an important symptom within the onset of first changes and it represents the most significant factor in impairing the quality of life of patients who undergo radiation of head and neck tumours. Due to the presence of pain and disturbed swallowing, patients cannot adequately eat. Particularly the problem is the intake of solid foods and sometimes liquids as well. The pain can vary in intensity depending on the degree of radiation toxicity. As supportive therapy, besides the systemic analgesic therapy based on opioid analgesics, a diet containing dietary supplements rich in proteins is recommended. The most serious form of acute toxicity is complete inability of

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oral food intake. In order to prevent greater than 10% loss of body mass and anorexia, parenteral nutrition is required and in some cases radiotherapy is discontinued as well [4, 5]. Oral mucositis, depending on the changes observed, is classified by the World Health Organization (WHO) into the four categories (Table 1).

Loss of the sense of taste occurs as a partial reduction (dysgeusia) or a complete loss (ageusia) of all four tastes: salty, sweet, sour and bitter. Partial reduction of the sense of taste often precedes the development of mucositis. This type of toxicity arises in the initial phase of radiotherapy as an acute mucosal reaction due to the damage of receptor cells in so-called gustatory buds on the surface of the tongue. The taste sensory receptor cells are capable of repopulation within four months after the completion of treatment, but also some permanent damage may occur caused by mucositis and dry mouth. The disorder of the sour and bitter sensation is more intense than the disorder of feeling the sweet and salty taste. During radiation it is advised to quit smoking and consuming alcoholic drinks and very spicy foods [6]. The clinical significance of this type of toxicity is the consequent loss of appetite, which significantly affects general condition of the patient. The severity of the loss of taste depends on the dosage of radiation and covered irradiated volume. Usually, the sense of taste returns within the period of up to one year after the completion of radiotherapy.

Dry mouth (xerostomy) occurs as a result of salivary glands damage under the action of ionizing radiation. Oedema of salivary glands happens in the first hours after the beginning of radiation [7], resulting in decreased salivation and increased viscosity of saliva, which becomes thick and sticky. The disorder of salivary gland vascularization is due to fibrotic changes in the blood vessel wall, leading to atrophy and necrosis of glandular cells. This process is irreversible so that dryness of mucous membranes of the irradiated region, although being an acute reaction to radiotherapy, may last for several months or permanently [8]. As the salivary glands are located in different regions of the mouth, xerostomy also depends on the volume of irradiated tissue. Due to decreased salivation, the act of swallowing and eating is disturbed, mostly affecting solid food intake.

LATE TOXICITY

The effects of late toxicity of radiotherapy can occur few months after the completion of radiation, or years after the treatment. They are chronic, often irreversible and significantly impair the quality of life. Late toxicity is manifested as radiation caries, trismus, and osteoradionecrosis.

Decalcification of the tooth enamel is caused by changes in the chemical composition of the saliva and increased number of cariogenic bacteria in the oral cavity [7], which, in addition to dry mouth and decrease in pH of the oral cavity, favours caries formation. A special feature of radiation caries is the absence of pain, despite rapid progression and extensive loss of solid substance due to demineralization process of affected teeth [8]. The final result of this process is tooth loss.

Table 1. WHO Oral Mucositis Grading Scale
Tabela 1. Stepen oralnog mukozitisa prema Svetskoj zdravstvenoj organizaciji

Grade 0 Stepen 0	No presence of oral mucositis Bez prisustva oralnog mukozitisa
Grade I Stepen I	Erythema, oral soreness Prisustvo eritema i bolne osetljivosti
Grade II Stepen II	Ulceration; swallowing solid foods possible Prisustvo ulceracija; očuvana mogućnost gutanja čvrste hrane
Grade III Stepen III	Ulceration; swallowing solid foods impossible; liquid diet only Prisustvo ulceracija; nemogućnost gutanja čvrste hrane; tečna ishrana
Grade IV Stepen IV	Ulceration; oral alimentation impossible Prisustvo ulceracija; potpuna nemogućnost oralnog unosa hrane

Trismus represent painful, reduced opening of the mouth caused by spasm of chewing muscles. During radiotherapy using high doses of radiation, development of fibrotic changes in chewing muscles (*m. masseter*) occurs as well as the reduction of flexibility and extension in the region of temporomandibular joint, with the presence of mandibular hypomobility. These changes usually occur within few months after completion of radiotherapy, and can be that severe that patient can open mouth less than 2 cm, which significantly affects speech and food intake [7]. Sometimes, complete stiffness or ankylosis of temporomandibular joint may occur.

Osteoradionecrosis is one of the most serious late radiation toxicities. It arises as a result of irreversible damage of osteocytes with progressive decrease in microvascularization, which leads to decrease in blood circulation with the consequent hypoxia and tissue hypocellularity. The final result of these changes is osteoradionecrosis with or without secondary infection, with possibility of pathological fracture as well. Mandible is more susceptible to necrosis caused by radiation because of poorer vascularization and bone density compared to maxilla. Symptoms of this process are pain, swelling, fetor, ulceration and orocutaneous fistulas. Osteoradionecrosis usually occurs in the period up to one year after the completion of radiation. Poor oral hygiene and continued alcohol consumption as well as smoking are additional risk factors [9].

PREVENTION

All patients undergoing radiation therapy must have complete dental examination of the oral cavity before the initiation of the treatment. This involves detailed examination of mucous membranes and teeth, with special focus on decayed teeth that need to be completely repaired. If extraction of the tooth with advanced caries is required, it is necessary to do it 2-3 weeks before starting radiotherapy. Extraction of healthy teeth does not reduce the risk of developing osteoradionecrosis. Radiation mucositis cannot be prevented, but maintaining good oral hygiene can reduce the risk of oral infections. It is recommended to use soft brushes and mild toothpastes during and after radiation [10]. In order to prevent and relieve trismus, it is necessary to introduce regular exercises of chewing muscles all the time during, and for longer time interval after the completion of radiation.

Of utmost importance for alleviating oral dryness and inflammatory processes is to maintain normal mucous membrane moisture during radiation, so it is advised to do an intensive daily washing of oral cavity with sodium bicarbonate solution and local antiseptics. In case of pain and difficult swallowing, it is necessary to introduce palliative therapy, which often requires introduction of opiates as well.

CONCLUSION

The prevention of radiation toxicity can be achieved in close cooperation between the radiation oncologist and dentist. It is necessary to visit dentist before the beginning of planned oncologic treatment so that active processes in the oral cavity can be treated, as well as during the implementation of radiotherapy due to the severity of possible complications. With an adequate oral hygiene and increased care of oral mucosa, expected toxicity of radiotherapy can be significantly reduced or prevented.

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Received: 23.08.2017 • Accepted: 28.11.2017

Uticaj radijacione terapije na tkiva usne duplje

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KRATAK SADRŽAJ

Radioterapija se u lečenju tumora glave i vrata najčešće primenjuje kao samostalna metoda ili u kombinaciji sa hirurgijom i/ili hemioterapijom. Ove terapijske metode u multidisciplinarnom pristupu uglavnom dovode do povoljnog terapijskog odgovora. Prilikom zračne terapije tumora ove regije, oralna sluznica se neizbežno nalazi u obuhvaćenom zračnom volumenu. Radikalnost terapije se postiže visokim dozama zračenja, što obično ima za posledicu pojavu neželjenih toksičnih efekata, koji u zavisnosti od vremena ispoljavanja mogu biti akutni i kasni. Akutna toksičnost zračenja se javlja tokom ili neposredno po završetku sprovedene terapije, a kasna više meseci ili godina od završenog lečenja. Najčešće akutne komplikacije u usnoj duplji su zapaljenje oralne sluznice, gubitak ukusa, suvoća usta i sekundarne infekcije. U kasne komplikacije spadaju radijacioni karijes, trizmus i osteoradionekroza. Cilj ovog rada je bio da se predstave efekti i specifičnosti ispoljene toksičnosti na tkiva usne duplje nakon radijacione terapije, koja značajno utiče na kvalitet života ovih pacijenata.

Ključne reči: toksičnost; radioterapija; usna duplja; prevencija

UVOD

Jonizujuće zračenje svojim dejstvom dovodi do stvaranja slobodnih radikala, koji remete biohemijske procese i ćelijsku deobu, što za posledicu ima smrt ćelije. Zračenje se obično sprovodi visokim dozama (u rasponu od 50 Gy do oko 70 Gy) u pojedinačnim dnevnim frakcijama od 2 Gy tokom pet dana u nedelji i sa pauzama tokom vikenda, a u ukupnom trajanju od nekoliko nedelja [1].

Tkiva, u zavisnosti od radiobiološkog odgovora na zračenje, mogu biti radiorezistentna, i tu se svrstavaju tkiva sa manjim brojem ćelijskih deoba (npr. koštano, hrskavičavo i mišićno). Nasuprot njima, na jonizujuće zračenje su osetljivija tkiva čije se ćelije aktivno dele, kao što su koštana srž, reproduktivni organi, očno sočivo, odnosno digestivni i respiratorni epitel. Ovoj grupi pripada i sluznica usne duplje pa je zato neophodno predupredити ove efekte zračenja i adekvatno je tretirati. Primenom naprednih tehnologija i korišćenjem savremenih tehnika radioterapije postiže se značajna preciznost, bolja distribucija doze i maksimalna zaštita zdravih tkiva tokom zračenja, čime se smanjuje i moguća kasna toksičnost [2].

AKUTNA TOKSIČNOST

Radijaciona toksičnost u usnoj duplji nastaje kod skoro svih pacijenata kod kojih se sprovodi zračenje tumora maksilofacijalne regije, sva tri sprata ždrela, baze jezika, poda usta, parotidne regije, larinksa i vrata. Uzrok komplikacija predstavlja visoka mitotska aktivnost ćelija sluznice, narušavanje ravnoteže oralne mikroflore uz mikrotraume nastale tokom normalne fiziološke funkcije usne duplje [3].

Akutna toksičnost se najčešće javlja kao oralni mukozitis, gubitak osećaja ukusa i suvoća usta (kserostomija).

Najčešća akutna komplikacija zračenja je oralni mukozitis. Ćelijska smrt bazalnih keratinocita pod dejstvom jonizujućeg zračenja dovodi do oštećenja sluznice usne šupljine. Već tokom prve nedelje radioterapije mogu se primetiti rani klinički znaci mukozitisa, u vidu pojave nejasno ograničenih bledih zona ili mlečno bele prebojenosti. Najuočljivije su u bukalnoj regiji, posebno u predelu mehaničkih nadražaja zuba. Ove promene su praćene eritemom i atrofijom sluzokože. Oko ovako izmenjenog epitela daljim dejstvom zračne terapije nastaje progresija ovih promena u vidu pojave ulceracija. Na ovim mestima oštećenja sluznice nakupljaju se bledo žućkasto-beličaste fibrinske naslage koje formiraju pseudomembrane i koje su pogodno mesto za nastanak infekcije, obično pojavu kandidijaze (*Candida albicans*). Osim bukalne regije mogu biti zahvaćeni i drugi delovi usne duplje, naročito bočne strane i gornja površina jezika, mukoza predela usana, mekog nepca, poda usta i ždrela.

Bol je takođe važan simptom pri pojavi prvih promena i predstavlja najznačajniji činilac u narušavanju kvaliteta života bolesnika kod kojih se sprovodi zračenje tumora glave i vrata. Zbog prisutnog bola i poremećenog akta gutanja pacijenti ne mogu da se adekvatno hrane. Posebno im predstavlja problem unošenje čvrste hrane, ali i tečnosti. Bol može biti različitog intenziteta u zavisnosti od stepena ispoljene radijacione toksičnosti. U suportivnoj terapiji se osim sistemske analgetske terapije zasnovane na opioidnim analgeticima preporučuje i ishrana dijetetskim suplementima bogatim proteinima. Najteži oblik akutne toksičnosti predstavlja potpuna nemogućnost oralne ishrane, zbog čega u cilju sprečavanja gubitka telesne mase većeg od 10% i anoreksije otpočinje parenteralna ishrana, a u nekim slučajevima se i prekida radioterapija [4, 5]. Oralni mukozitis se u zavisnosti od ispoljenih promena klasifikuje po Svetskoj zdravstvenoj organizaciji (WHO) u četiri kategorije (Tabela 1).

Gubitak osećaja ukusa se javlja kao delimično smanjenje (dysgeusia) ili potpuni gubitak (*ageusia*) sva četiri ukusa: slanog, slatkog, kiselog i gorkog. Delimično smanjenje osećaja ukusa često prethodi razvoju mukozitisa. Ovaj tip toksičnosti nastaje u početnoj fazi zračne terapije kao akutna reakcija mukoze, zbog oštećenja receptorskih ćelija u takozvanim gustativnim pupoljcima na površini jezika. Receptorske ćelije čula ukusa su sposobne za repopulacije unutar četiri meseca od završenog lečenja, ali može nastati i izvestan stepen trajnog oštećenja, čemu doprinose mukozitis i suvoća usta. Poremećaj osećaja za kiselo i gorko je intenzivniji u odnosu na poremećaj osećaja slatkog i slanog ukusa. U toku zračenja se savetuje prestanak pušenja i konzumiranja alkoholnih pića i jako začinjenih jela [6]. Klinički značaj ovog tipa toksičnosti je u posledičnom gubitku apetita, što značajno utiče na opšte stanje pacijenta. Izraženost gubitka ukusa zavisi od doze zračenja i obuhvaćenog zračenog volumena. Obično se čulo ukusa vraća u intervalu do godinu dana od završetka radioterapije.

Suvoća usta (kserostomija) nastaje kao posledica oštećenja pljuvačnih žlezda pod dejstvom jonizujućeg zračenja. Edem pljuvačnih žlezda počinje već u prvim satima nakon početka zračenja [7], zbog čega dolazi do smanjenja lučenja pljuvačke, koja postaje gusta i lepljiva, i povećanja njenog viskoziteta. Poremećaj vaskularizacije pljuvačnih žlezda nastaje usled fibroznih promena u zidu krvnih sudova, što dovodi do atrofije i nekroze žlezdanih ćelija. Taj proces je ireverzibilan, tako da suvoća sluznice zračene regije, iako akutna reakcija na radioterapiju, može trajati ili nekoliko meseci ili trajno [8]. Kako se pljuvačne žlezde nalaze u različitim regijama usta, tako i kserostomija zavisi od volumena zračenog tkiva. Zbog smanjenog lučenja pljuvačke poremećeni su akt gutanja i ishrana pacijenata, a poseban problem predstavlja unos čvrste hrane.

KASNA TOKSIČNOST

Efekti kasne toksičnosti radioterapije se mogu javiti najranije nekoliko meseci od završetka zračenja, odnosno godinama nakon lečenja. Hroničnog su toka, često ireverzibilni i značajno narušavaju kvalitet života.

Kasna toksičnost se manifestuje kao radijacioni karijes, trizmus i osteoradionekroza.

Dekalcifikacija zubne gleđi je uzrokovana promenama u hemijskom sastavu pljuvačke i povećanim brojem kariogenih bakterija u usnoj duplji [7], što uz suvoću usta i smanjenje vrednosti pH u usnoj duplji pogoduje nastajanju karijesa. Posebna odlika radijacionog karijesa je odsustvo bola, uprkos jako brzom napredovanju i obimnom gubitku čvrste materije usled procesa demineralizacije zahvaćenih zuba [8]. Krajnji rezultat ovog procesa je trajni gubitak zuba.

Trizmus predstavlja bolno, ograničeno otvaranje usta uzrokovano grčenjem mišića za žvakanje. U toku sprovođenja radioterapije primenom visokih doza zračenja dolazi do razvoja fibroznih promena mišića žvakača (*m. massetera*), kao i smanjenja fleksibilnosti i ekstenzije predela temporomandibularnog zgloba, uz prisutan hipomobilitet mandibule. Ove promene obično nastaju nekoliko meseci nakon završetka radioterapije, a mogu biti toliko izražene da je nemogućnost otvaranja usta svedena na manje od 2 cm, što značajno utiče na govor i unos hrane [7].

Nekada može nastati i potpuna ukočenost odnosno ankiloza temporomandibularnog zgloba.

Osteoradionekroza je jedna od najozbiljnijih kasnih toksičnosti zračne terapije. Nastaje kao posledica ireverzibilnog oštećenja osteocita sa progresivnim smanjenjem mikrovaskularizacije, što dovodi do smanjenja prokrvljenosti sa posledičnom hipoksijom uz hipocelularnost tkiva. Krajnji rezultat ovih promena predstavlja osteoradionekroza sa prisustvom sekundarne infekcije ili bez nje, uz mogućnost nastanka i patološke frakture. Mandibula je podložnija nekrozi usled zračenja zbog slabije vaskularizacije i gustine kosti u odnosu na maksilu. Simptomi ovog procesa su bol, otok, fetor, ulceracije i orokutane fistule. Osteoradionekroza nastaje obično u periodu do godinu dana od kraja zračenja. Loša oralna higijena, kontinuirana upotreba alkohola i pušenje predstavljaju dodatne faktore rizika [9].

PREVENCIJA

Kod svih pacijenata kod kojih se planira zračenje tumora glave i vrata neophodno je pre započinjanja terapije napraviti kompletan stomatološki pregled usne duplje. Ovo podrazumeva detaljan pregled sluznica i zuba sa posebnim osvrtom na kariozne zube, koje je neophodno u potpunosti sanirati. Ukoliko je neophodna ekstrakcija zuba sa uznapredovalim karijesom, istu je neophodno učiniti dve-tri nedelje pre početka radioterapije. Vađenje zdravih zuba ne smanjuje rizik za nastanak osteoradionekroze. Radijacioni mukozitis se ne može prevenirati, ali održavanjem dobre oralne higijene moguće je smanjiti rizik od nastanka oralnih infekcija. Preporučuje se upotreba mekih četkica i blagih pasti za zube tokom i nakon zračenja [10]. U cilju sprečavanja i ublažavanja trizmusa neophodno je uvesti redovne vežbe mišića žvakača, sve vreme tokom i u dužem periodu posle završenog zračenja.

Od izuzetnog značaja za ublažavanje suvoće usta i upalnih procesa je održavanje normalne vlažnosti sluznice tokom zračenja, pa se savetuje svakodnevno intenzivno ispiranje usne šupljine rastvorom sode bikarbone uz lokalne antiseptike. U slučaju pojave bola i otežanog gutanja neophodno je uvesti i antidoloroznu terapiju, koja često zahteva uvođenje i opijata.

ZAKLJUČAK

Prevencija radioterapijske toksičnosti usne duplje se mora razmatrati u uskoj saradnji radijacionog onkologa i stomatologa, s obzirom na predviđene visoke doze jonizujućeg zračenja, a radi postizanja očekivanog terapijskog odgovora. Neophodna je koordinacija sa stomatologom pre početka planiranog onkološkog lečenja radi saniranja aktivnih procesa u usnoj duplji, kao i tokom sprovođenja zračne terapije, imajući u vidu ozbiljnost mogućih komplikacija. Adekvatnom oralnom higijenom i pojačanom negom sluznice u značajnoj meri se može ublažiti ili sprečiti očekivana toksičnost radioterapije.

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Serbian Dental Journal, vol. 64, N° 4, 2017

REWIEV ARTICLE
PREGLED LITERATURE

DOI: 10.1515/sdj-2017-0018
UDC: 616.314-77(091)

The Evolution of Articulators – Part II

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SUMMARY

Articulators are instruments that aimed to reproduce the range of jaw movements. The first instrument designs were attempts to duplicate anatomic relations or reproduce functional movements of the anatomy. They were able to preserve centric position only. More sophisticated articulating instruments evolved as more was learned about the anatomy, mandibular movements, and mechanical principles. Over time, interest for articulators progressed. Articulators became adjustable, and they attempted to reproduce jaw movements of each patient by reproducing the anatomy of temporomandibular joints (TMJ's) and related structures. Part I of the article has discussed evolution of articulators beginning from the 18th century till 1940. A history of articulators from 1940 till today is discussed in the present article.
Keywords: articulators; instruments; cast; temporomandibular joints; hinge

In continuation on the history of articulators part I, where the evolution of articulators beginning from the 16th century was described, the current article discusses the historical aspect of articulators since 1940.

Articulators introduced since 1940 range from the type that maintains a prescribed position, to fully adjustable articulators [1]. By the turn of the 20th century, several investigators have examined the nature of mandibular movements. Therefore, development of articulators has reflected newly discovered or rediscovered principles [2]. Historically, some aspects of jaw movements have been easy to duplicate mechanically on an articulator (hinge movement, relation of the casts to the hinge and inclination of the condylar path). Consequently these features appeared first on the instruments. Other movements have been more difficult to reproduce mechanically, such as Bennett movement in three dimensions, the timing of the Bennett movement, the exact curvature of the condylar path and intercondylar distance. The problems involved in duplicating these movements have been solved by modern instrument design. Through the history, some articulators have been modified and some have not been accepted by the profession and disapeared.

The current article has aimed to describe articulators introduced into the dental practice since 1940 till the present.

An electronic search was performed across the three databases (Science Direct, PubMed and Google Scholar) for relevant citations. Keywords such as articulators, history, and early articulators were used alone or in combination for the search. The option of "related articles" was also utilized. Finally, a search of review articles was performed and the most relevant papers pertaining to the history of articulators were selected.

The Modified Stephen Articulator

The Stephen articulator (Figure 1), as modified in 1940, is a simple hinge joint articulator that has fixed condylar path of 30 degrees. It is similar in design to the 1921 model, except that the upper and lower mounting arms on this model are longer. An adjustable setscrew in the posterior region holds the upper and lower members in the fixed vertical position [1].

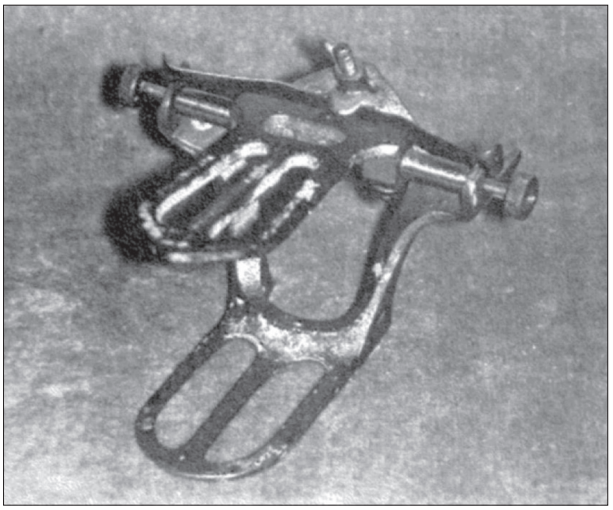

Figure 1. Modified Stephen Articulator [1]
Slika 1. Modifikovani artikulator Stephen [1]

The Stephen Articulator Model P

The additional features of the Stephen articulator Model P are incisal pin and vertical height adjustment. Another

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version of this articulator was manufactured to include a fixed 10 degree incisal guidance [1].

The Fournet Articulator

The Fournet articulator (Figure 2) was developed around 1940 and distributed by the Dentists' Supply Co. of New York. The Fournet articulator is one-dimension articulator that has no lateral movement. The maxillary cast is positioned horizontally by (1) the two maxillary central incisors, which are oriented aesthetically and rest on Spee curve template anteriorly, and (2) the Cook mounting jig, which fits into the depth of the hamular notch and orients the casts posteriorly [1].

The Johnson-Oglesby Articulators

The Johnson-Oglesby articulator was developed around 1950. It is small, nonadjustable, flexible articulator. The Johnson-Oglesby instrument had limited use, and restorations produced using it sometimes required major adjustments intraorally [1].

The Coble Articulator

The Coble articulator was developed around 1950. by Lucian G. Coble. The Coble articulator maintains centric relation and vertical dimension but does not allow functional movements. It is a hinge articulator in which the maxillary cast is mounted with a mounting jig that corresponds to the occlusal plane. The mandibular cast is positioned with an interocclusal record [1].

The Galetti Articulator

The Galetti articulator (Figure 3) was first manufactured about 1950. in Italy. It was advertised in this country in the early 1960's and distributed by John O. Luongo. In this articulator, each cast was held mechanically without plaster by two fixed posts anteriorly and one adjustable post posteriorly to each member. The upper member was adjustable by an extendable arm and a universal ball-and-socket joint to achieve the desired relationship of the maxillary to the mandibular cast, which permitted rapid cast mounting. This articulator had fixed condylar path and a vertical stop that was in the posterior region. It did not accept a face-bow [1].

The Pankey-Mann Articulator

The Pankey-Mann articulator (Figure 4) was developed in 1955. by Lindsey De Pankey and Arvin W. Mann. This articulator consists of a base that holds a platform for the mandibular cast and a vertical post containing two movable assemblies. The first assembly was made up of a horizontal rod that supports the face bow frame and also has centers of rotation for measuring and cutting calibres. A second movable assembly hold the mounted maxillary cast. By using the Pankey-Mann face bow to mount the mandibular cast, and cutting dividers to establish an occlusal plane in the mandibular teeth based on the spherical theory, the entire occlusal plane was engineered before tooth preparation is initiated [1].

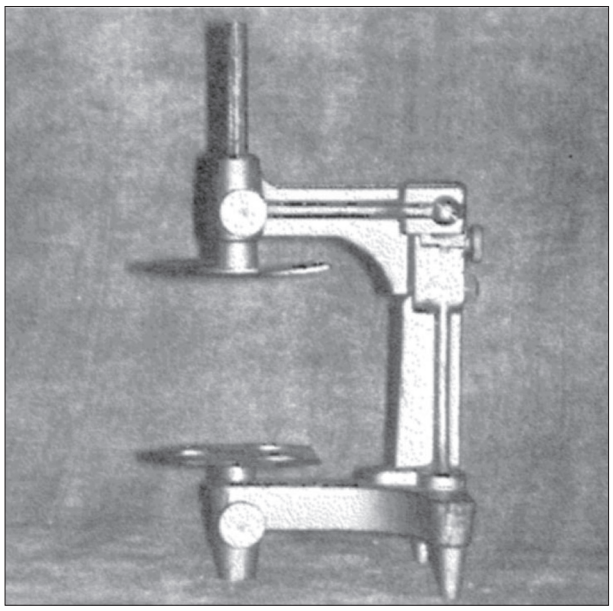

Figure 2. The Fournet Articulator [1]
Slika 2. Artikulator Fournet [1]

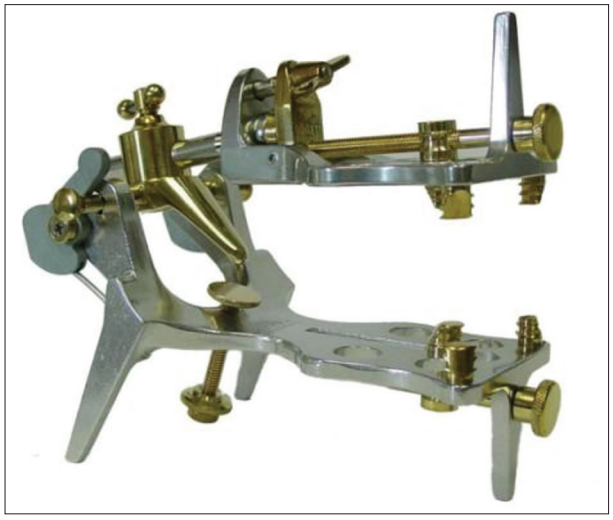

Figure 3. The Galetti Articulator [1]
Slika 3. Artikulator Galetti [1]

The Stuart Articulator

The Stuart articulator (Figure 5) was developed by Charles E. Stuart in 1955. It was a fully adjustable articulator. The upper member of the articulator had two sets of cams posteriorly on each side that guide truncated spheres located on the lower member. The movable outer cam and sphere on each side controlled all condylar movements except the angle and timing of the Bennett movement, which were controlled by the inner cam and sphere. The articulator settings were programmed using pantographic tracings from the patient [1].

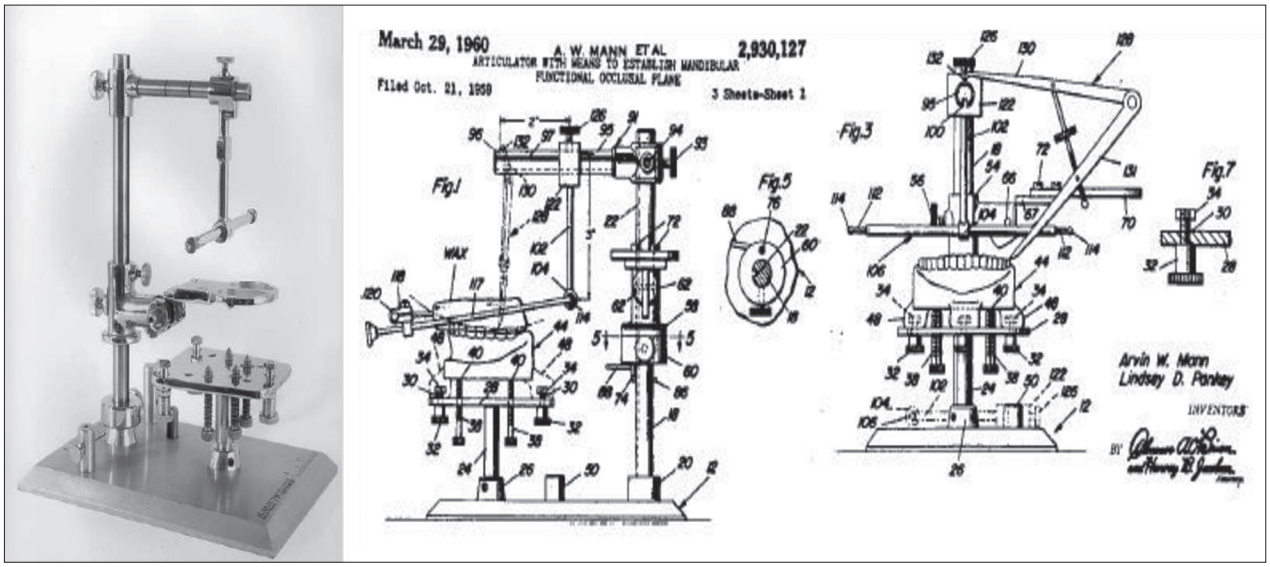

Figure 4. The Pankey-Mann Articulator [1]
Slika 4. Artikulator Pankey-Mann [1]

Figure 5. The Stuart Articulator [1]
Slika 5. Artikulator Stuart [1]

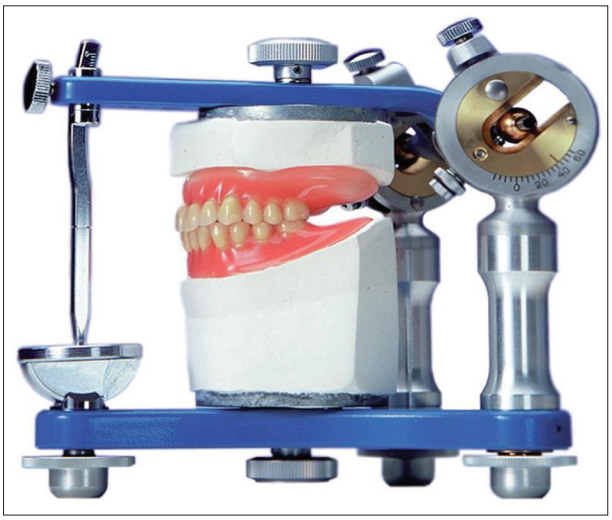

Figure 6. The Dentatus Articulator [1]
Slika 6. Artikulator Dentatus [1]

The Hanau Model H2 Series

The Hanau Model 96 H2 came out in 1958. The principal feature of this articulator was an increased distance between the upper and lower members from 95 mm to approximately 110 mm. In addition, the orbital indicator was added to the upper member. The H2-XPR, which is one of the models of the H2 series, was introduced in 1958. It had features identical to those of other models in this series, but in addition, it had extendable condylar shafts and retrusive-protrusive adjustment in the condylar element. Some other models of the H2 series are:

Model H2-O, with orbital indicator attachment;

Model H2-X, with extendable condylar shafts;

Model H2-PR, with calibrated adjustments to protrude or retrude condylar balls up to 3 mm.

An adaptation of the Hanau Model H110 articulator, which uses a 0.75 inch lucite shim to increase the condylar post height, was described by Elinchbaugh. He also described the fabrication of a 0.75 inch lucite orbital point guide plane that provided an anterior point of reference level with the condylar axis. This adaptation made the Model H is equivalent to some models of the H2 series [1].

The Dentatus ARL Articulator

The Dentatus ARL articulator (Figure 6) was first manufactured by A.B.Dentatus of Stockholm, Sweden in 1958. It was a semiadjustable, shaft type articulator with a straight condylar path and a fixed intercondylar distance. In mechanical principle and design it was similar to the Hanau H2 articulator. An adjustable positioning mechanism on the upper member allowed the use of a block that standardizes upper member to lower member, and transfer of casts from one to another articulator while the same relationship was maintained. The Dentatus ARL was a rigid, durable instrument with a curved incisal guide pin. Extendable condylar shafts enabled receiving a hinge axis face-bow. The Bennett movement was calculated from the Hanau's formula, and rotating the condylar post up to 40

degrees regulated it. As with the Hanau articulators, the size of Bennett movement was controlable, but not the timing or direction [1].

The Improved New Simplex Articulator

The Improved New Simplex Articulator (Figure 7) was distributed by the Dentists' Supply Co. of New York in 1960. This is an updated version of the Gysi Simplex articulator. It used average movements. The condylar inclination was 30 degrees, with a Bennett movement of 7.5 degrees. The incisal guide table was adjustable from 0 to 30 degrees to accommodate various amounts of vertical overlap of the teeth for each patient. It had model-locking pins to secure the maxillary and mandibular casts in place. A mounting jig, which doubles as an occlusal plane table, was used for arbitrarily mounting the maxillary cast [1].

The Verticulator

The Verticulator was developed by William Windish in 1960. The Verticulator consisted of two rigid members that separate and close only linearly in vertical dimension. It had a positive stop that locked in its closed position. Another model was introduced in 1962, which was able to accept full arch casts [1].

The Ney Articulator

The Ney articulator (Figure 8) was designed by Anthony J. De Pietro in 1962. It is an arcon instrument with no locking device between the upper and lower members for centric position. The condylar elements can be set to varying intercondylar distances. When the metal condylar elements do not follow or duplicate pantographic tracings, more precise duplication is possible with custom ground plastic inserts. A plastic incisal guide table, or a metal incisal guide table that has a provision for making a region of freedom centric position can be used [1].

The Hanau Model 130-21 Articulator

The Hanau University Series or Model 130-21 articulator was designed to be a split-axis instrument. It had a central locking device and a mechanism to keep upper and lower members together. It was adjustable in varying intercondylar distances. The condylar paths and Bennett guide paths were straight. The Bennett guide paths that are located near midline did not allow for immediate side shift. It would accept all positional records but could not duplicate pantographic tracings. The incisal guide pin was designed to compensate for changes in vertical dimension. It was self tripoding in an inverted position [1].

The Whip-Mix Articulator

The Whip–Mix articulator was developed by Charles E. Stuart in 1964. This was a semiadjustable arcon articulator that had three intercondylar adjustments: small, medium and large. These were selected by means of the accompanying Quick Mount face-bow that uses the external auditory meatus as a posterior landmark. This face-bow had a nasion anterior guide for establishing an anterior point of reference for maxillary cast positioning. The condylar element of the Whip-Mix articulator was adjustable about the vertical and horizontal axis but not the sagittal axis; hence it could not be set to all positional records. The condylar and Bennett guide paths were straight. There was no provision for timing in the Bennett movement. There was no centric position-locking device, and the upper and lower members could not be attached mechanically [1].

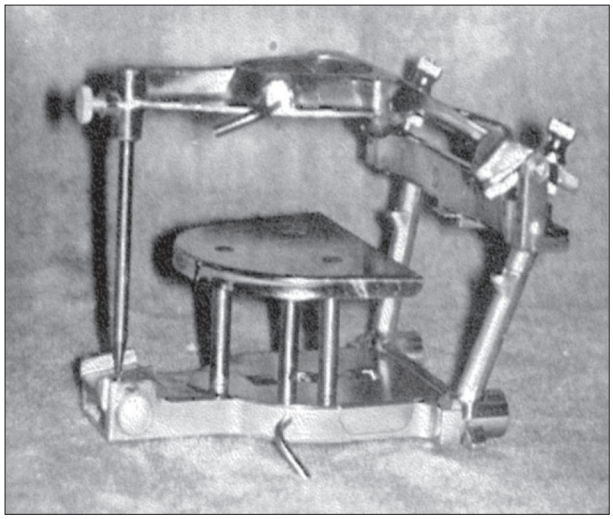

Figure 7. The Improved New Simplex Articulator [1]
Slika 7. Poboljšani novi prosti artikulator [1]

Figure 8. The Ney Articulator [1]
Slika 8. Artikulator Ney [1]

The Simulator

The Simulator (Figure 9) was developed by Ernest R. Granger in 1968. It was a fully adjustable articulator that could be set from pantographic tracings, positional records and other tracings. There were curved condylar paths, but the unique feature of this articulator was the condylar path that rotates inwardly, a broken axis and a mechanical timing element that combine to reproduce mechanically the Bennett movement and Fischer's angle. The Simulator had condylar path locks that could be re-

Figure 9. The Simulator [1]
Slika 9. Simulator [1]

Figure 10. The Protar Articulator [5]
Slika 10. Artikulator Protar [1]

leased so that the upper member could be separated from the lower member. The incisal guide pin was curved [1].

The Denar Model D4A Articulator

The Denar Model D4A articulator was developed by Niles Guichet in 1963. This articulator was programmed from tracings made with a pneumatically controlled pantograph of the same company, the Denar Corp of Anaheim, California. It was a fully adjustable instrument that used interchangeable condylar guidances that could be adjusted. It had a definite centric lock and had accommodations to hold the casts in an open position. The curved incisal pin assembly could rest on a mechanical or plastic incisal guide table [1].

The Dentatus ARO Articulator

The Dentatus ARO articulator was manufactured by A.B. Dentatus in 1971. It had all the features of Dentatus ARL plus the unique feature of a movable arm that holds the mandibular cast. The universal joint and the locking device that attaches the movable arm to the base allowed repositioning of the mandibular cast without remounting. The gauge block was used to center the lower member to the upper member, but once the mandibular cast has been repositioned, the articulator or casts could not be interchanged without the aid of centric relation records [1].

The Panadent Articulators

The Panadent System is the latest approach to dental instrumentation. The Panadent System was based on the premise that it was possible to classify individual condylar movements into groups based on the amount of precurrent side shift. A series of statistically selected three-dimensional analogs of condylar axis motion was developed. The Panadent articulator was introduced in 1978. The current models were introduced in 1983. The major modification in the latest models was the Dynalink Panalock mechanical latch. This mechanism keeps the upper and lower articular frames joined together, yet permits an opening movement of 180 degrees [1].

Recent Advances

SAM

The company was founded in 1971 by Heinz Mack, a practising dentist, in Munich, Germany. Their anatomically correct and skull related articulator system became known and identified as SAM (School Articulator Munich). These are basically arcon type of articulators. SAM developed a wide variety of articulator models, including SAM SE, SAM 2P, SAM 2PX and SAM 3. These articulators provide accurate functional simulation of mandibular movements [2, 3].

The Artex Articulator

This articulator was developed by *GIRRBACH DENTAL GMBH* Company and was listed in the FDA on 24th May, 1995. The ARTEX CN, which was the base model, is a non-arcon type average value articulator. The ARTEX CT is partially adjustable average-value articulator in non-Arcon design. Then came the ARTEX CP, which was partially adjustable average-value articulator with super smooth condyle track guide in Arcon design. The latest model was the ARTEX CR, which was fully adjustable average-value articulator in Arcon design. It provides comprehensive adjustment possibilities to reproduce the patient's clearance and movement dynamics [4].

The Protar Articulator

Developed by the KaVo Company during the begining of this century, the PROTAR articulators (Figure 10) offer good precision, they are cost effective and provide superior handling. Four models are available- the PROTAR, the PROTAR 3, the PROTAR 5, the PROTAR 7, and the latest model is the PROTAR 9. The PROTAR is 6.4" H x 6.6" W x 8" D and weighs 2.5 lbs. The Protar 3 has an upper member with curved sagittal and pre-set condylar guidance paths, a 45° horizontal condylar inclination, and a 15° fixed Bennett angle. The PROTAR 5 has an upper member identical to the one in the Protar 3 with the exception that it has an adjustable Bennett angle and an adjustable horizontal condylar inclination. The PROTAR

7 has an upper member with adjustable sagittal angle and horizontal condylar paths as well as immediate sideshift and retrusion with an adjustable shift angle. The PROTAR 9 has an upper member identical to that of the Protar 7 with adjustable protrusion, distraction, and retrusion [5].

The Virtual Articulators

The latest breakthrough in the world of articulators was the introduction of the VIRTUAL articulators in 2003. This system not only simulates the temporo-mandibular joint movements in the modelling software by viewing it on the computer screen, but is also the only system that allows the dental technician to take the measurements of his/her own articulator, to scan it and to add these data to the software database. The articulator dimensions are faithfully saved in the software so as to be able to virtually articulate the models.

CONCLUSION

The large number and great range in complexity of modern articulators can mislead the dentist into thinking that the choice of a suitable instrument is difficult. However, the choice is greatly simplified if one considers what records can be obtained accurately, what the instrument will be required to do, and the fact that articulator technology is not a substitute for a biological understanding of the masticatory system [6]. An emerging understanding of the neurophysiology of mandibular movements and the influence of several morphological and behavioural considerations led to the notion that each patient is his or her own best articulator. Also, the success or failure of the final restoration is more dependent on the operator of the articulator than on the articulator itself [7].

The Late *Carl O Boucher* summed up the articulator controversy by stating, *"It must be recognized that the person operating the instrument is more important than the instrument. If dentists understand articulators and their deficiencies, they can compensate for their inherent inadequacies".*

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Received: 26.05.2017 • Accepted: 08.08.2017

Istorija artikultora – drugi deo

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KRATAK SADRŽAJ

Artikulatori su instrumenti koji imaju za cilj da reprodukuju pokrete vilica. Prvi dizajni ovih instrumenta bili su pokušaji dupliranja anatomskih odnosa ili reprodukovanja funkcionalnih pokreta. Oni su jedino mogli da adekvatno reprodukuju centralnu poziciju. Kasnije su se pojavili sofisticiraniji artikulatori sa novim saznanjima o anatomiji, mandibularnim pokretima i mehaničkim principima. Tokom vremena raslo je interesovanje za artikulatore. Oni su postali podesivi i pokušali su da reprodukuju individualne pokrete vilica svakog pacijenta reprodukcijom anatomije temporomandibularnih zglobova (TMZ) i susednih struktura. Prvi deo našeg rada je razmatrao razvoj artikulatora od 18. veka do 1940. godine. Istorija artikulatora od 1940. do danas predstavljena je u ovom članku.

Ključne reči: artikulatori; instrumenti; liveni; temporomandibularni zglobovi; šarke

U ovom članku, u nastavku istorije artikulatora I, gde je opisana evolucija artikulatora počev od 16. veka, govori se o istorijskom aspektu artikulatora od 1940. godine do danas.

Artikulatori uvedeni od 1940. najpre su bili instrumenti koji samo reprodukuju propisani položaj, a onda je došlo do razvoja i nastanka potpuno podesivih artikulatora [1]. Početkom 20. veka nekoliko autora je ispitalo prirodu pokreta mandibule. Stoga, razvoj artikulatora tog vremena odražava novootkrivene ili potvrđene principe [2]. Istorijski gledano, neki aspekti kretanja vilice su se lako mehanički prenosili i reprodukovali u artikulatoru (pokret po osovini, odnos modela prema osovini, kao i kondilarni nagib). Shodno tome, ove karakteristike su se prve pojavile na instrumentima. Ostali pokreti kao što su Benetov pokret u tri dimenzije, vreme Benetovog pokreta, tačna krivina kondila i interkondilarna distanca bili su teži da se reprodukuju mehanički. Problemi u dupliciranju ovih pokreta su rešeni savremenim dizajnom instrumenta. Kroz istoriju, neki artikulatori su modifikovani, neki od njih uopšte nisu prihvaćeni od strane profesije pa su zato i nestali.

Cilj ovog rada bio je da opiše artikulatore uvedene u stomatološku praksu od 1940. do danas.

Elektronska pretraga je obavljena u okviru tri baze podataka (Science Direct, PubMed i Google Scholar) za relevantne citate. Ključne reči kao što su artikulatori, istorija i rani artikulatori korišćene su same ili u kombinaciji za pretraživanje. Korišćena je i opcija „povezanih članaka". Na kraju, izvršena je pretraga revijalnih radova i izabrani su najvažniji citati koji se odnose na istoriju artikulatora.

Modifikovani artikulator Stephen

Artikulator Stephen (Slika 1), modifikovan 1940, jednostavan je zglobni instrument koji je imao fiksni ugao kondilarne putanje od 30 stepeni. Sličan je u dizajnu modelu iz 1921. godine, osim što su gornja i donja grana na ovom modelu duži. Podesivi šrafovi u zadnjem delu drže gornji i donji deo u fiksnom vertikalnom položaju [1].

Artikulator Stephen, model P

Dodatne karakteristike artikulatora Stephen, model P su incizalni kočić i vertikalno podešavanje visine. Još jedna verzija ovog artikulatora je proizvedena tako da sadrži fiksni incizalni nagib od 10 stepeni [1].

Artikulator Fournet

Artikulator Fournet (Slika 2) razvijen je oko 1940. godine i distribuiran od strane Dentists' Supply Co., Njujork. To je bio jednodimenzionalni artikulator koji nije imao bočne pokrete. Model gornje vilice bio je orijentisan i postavljan horizontalno pomoću (1) dva maksilarna centralna sekutića, koja su bila estetski orijentisana i naslanjala se na Špeovu krivu napred i (2) držač za montiranje, koji se uklapa u dubinu žleba i usmerava modele posteriorno [1].

Artikulatori Johnson-Oglesby

Artikulator Johnson-Oglesby je razvijen oko 1950. godine. To je mali, nepodesivi, fleksibilni artikulator. Njegova upotreba je bila ograničena, a zubne nadoknade napravljene u njemu su ponekad zahtevale veliko podešavanje na pacijentu [1].

Artikulator Coble

Ovaj artikulator razvio je oko 1950. godine Lucian G. Coble. Artikulator Coble održava centralnu relaciju i vertikalnu dimenziju, ali ne dozvoljava funkcionalne kretnje. To je osovinski artikulator u kome se gornja vilica podešava pomoću montažnog šrafa koji odgovara okluzalnoj ravni. Model donje vilice se postavlja pomoću zapisa zagrižaja [1].

Artikulator Galetti

Artikulator Galetti (Slika 3) – prvi je proizveden oko 1950. godine u Italiji. On je reklamiran početkom 1960-ih i distribuirao ga je od John O. Luongo. U ovom artikulatoru svaki model je bio mehanički fiksiran bez gipsa pomoću dva fiksna kočića spreda i jednog podesivog kočića sa zadnje strane svakog modela. Gornji

model se mogao podešavati pomoću zglobova da bi se postigao željeni odnos gornje i donje vilice i tako ubrzalo postavljanje modela. Ovaj artikulator je imao fiksni ugao kondilarne putanje i vertikalni stoper u zadnjem delu. Nije prihvatio obrazni luk [1].

Artikulator Pankey-Mann

Artikulator Pankey-Mann (Slika 4) razvijen je 1955. godine od strane Lindsey De Pankey i Arvin W. Mann. Ovaj artikulator se sastojao od postolja koje drži platformu za model donje vilice i vertikalnog kočića koji drži dva pokretna dela. Prvi deo je bio sastavljen od horizontalnog štapa koji drži okvir obraznog luka, ima centre rotacije za merenje i presecanje na željenu veličinu. Drugi pokretni deo drži postavljeni model vilice. Korišćenjem njihovog obraznog luka za postavljanje modela donje vilice i uspostavljanje okluzalne ravni na zubima donje vilice prema sferičkoj teoriji, celokupna okluzalna ravan je uspostavljena pre bilo kakvog rada na zubima [1].

Artikulator Stuart

Artikulator Stuart (Slika 5) razvio je Charles E. Stuart 1955. godine. To je bio potpuno prilagodljiv artikulator. Gornji član artikulatora imao je dva ispupčenja sa zadnje strane koji vode dve zarubljene sfere koje se nalaze na donjem članu. Pokretno spoljno ispupčenje i sfera sa obe strane kontrolišu sve kondilarne kretnje osim Benetovog ugla i vremena pokreta, koji su kontrolisani unutrašnjim ispupčenjem i sferom. Podešavanja artikulatora su programirana pomoću pantografskih zapisa pacijenta [1].

Model Hanau, H2 serija

Model Hanau 96 H2 pojavio se 1958. godine. Glavna karakteristika ovog artikulatora bila je veće rastojanje između gornjeg i donjeg dela od 95 mm na približno 110 mm. Pored toga, gornji član je dobio orbitalni indikator. H2-XPR, koji je jedan od modela serije H2, uveden je 1958. godine. Imao je identične osobine kao i drugi modeli u ovoj seriji, ali pored toga je imao proširene kondilarne osovine i podešavanje kondilarnog elementa napred-nazad. Neki drugi modeli serije H2 su:

(1) Model H2-O, sa dodatkom za orbitalnu indikaciju;
(2) Model H2-X, sa proširenim kondilarnim vratilom;
(3) Model H2-PR, sa kalibriranim podešavanjima za pomeranje kondila napred-nazad do 3 mm.

Elinchbaugh je opisao adaptaciju Hanau modela H110 artikulatora, koji koristi plastični podmetač od 0,75 inča kako bi povećao visinu postolja kondila. Takođe je opisao izradu orbitalne ravni od 0,75 inča plastike koja je davala prednju referentnu tačku za nivo kondilarne ose. Ova adaptacija je učinila model H ekvivalentnim nekim modelima serije H2 [1].

Artikulator Dentatus ARL

Artikulator Dentatus ARL (Slika 6) prvi put je proizveden od strane A. B. Dentatusa iz Stokholma, Švedska, 1958. godine. To je bio polupodesivi artikulator tipa vratila sa ravnim kondilarnim nagibom i fiksnim interkondilarnim rastojanjem. U mehaničkom principu i dizajnu bio je sličan artikulatoru Hanau H2. Prilagodljivi mehanizam za pozicioniranje na gornjem delu omogućio je korištenje bloka koji standardizuje gornji član prema donjem članu i prenos modela sa jednog na drugi artikulator dok je isti odnos modela zadržan. Dentatus ARL je bio krut, izdržljiv instrument sa incizalnim kočićem. Produžeci kondilarne osovine omogućavali su prihvatanje obraznog luka. Benetov pokret je izračunavan iz Hanauove formule, a rotacija kondila do 40 stepeni je omogućavala njegovo podešavanje. Kao i kod artikulatora Hanau, veličinu Benetovog pokreta bilo je moguće kontrolisati, ali ne i njegovo vreme i pravac [1].

Poboljšani novi prosti artikulator

Ovaj artikulator (Slika 7) distribuiran je od strane Dentists 'Supply Co. u Njujorku 1960. godine. Ovo je poboljšana verzija artikulatora Gysi Simplex. On je koristio prosečne vrednosti pokreta. Kondilarni nagib je bio 30 stepeni, a Benetov pokret 7,5 stepeni. Incizalni tanjirić se podešavao od 0 do 30 stepeni kako bi se prilagodio različitim veličinama vertikalnog preklapanja zuba za svakog pacijenta. Imao je kočiće za zaključavanje modela kako bi osigurali maksilarne i mandibularne modele stabilne i na mestu. Montažna konzola, koja se udvostručuje kao okluzana ravan, korišćena je za proizvoljno montiranje maksilarnog modela [1].

Vertikulator

Vertikulator je razvio William Windish 1960. godine. Sastojao od dva kruta člana koja se odvajaju i zatvaraju samo linearno u vertikalnoj dimenziji. On je imao pozitivni stoper koji se zaključavao u zatvorenom položaju. Drugi model uveden je 1962. godine i bio u stanju da prihvati modele potpunih vilica [1].

Artikulator Ney

Artikulator Ney (Slika 8) dizajnirao je Anthony J. De Pietro 1962. godine. To je arkon instrument bez uređaja za zaključavanje između gornjeg i donjeg dela za centričnu poziciju. Kondilni elementi mogu se podesiti na različita interkondilarna rastojanja. Kada metalni kondilarni elementi ne prate ili dupliraju pantografske zapise, preciznije dupliranje je moguće sa prilagođenim plastičnim umecima. Tanjirić po kome se kreće incizalni kočić može biti plastični ili metalni [1].

Artikulator Hanau, model 130-21

Hanau univerzitetska serija ili model 130-21 dizajniran je da bude instrument sa podeljenim osovinama. On je imao centralno zaključavanje i mehanizam za držanje gornjeg i donjeg člana zajedno. Takođe je bio podesiv na različitim interkondilarnim rastojanjima. Kondilarni nagib i Benetove kretnje su bile ravne. Vodiči Benetove kretnje koji se bili blizu srednje linije nisu dozvoljavali trenutni pomak bočne strane. Prihvatio bi sve položaje, ali nije mogao duplirati pantografske tragove. Inicizalni kočić je bio dizajniran da nadoknađuje promene u vertikalnoj dimenziji. Bio je samoadaptivni i u obrnutom položaju [1].

Artikulator Whip-Mix

Ovaj artikulator je razvio Charles E. Stuart 1964. godine. Ovo je bio polupodesivi arkon artikulator koji je imao tri interkondi-

larna podešavanja: mala, srednja i velika. Oni su birani pomoću obraznog luka koji koristi spoljni ušni kanal signal kao zadnji orijentir. Ovaj obrazni luk je imao je prednji vodič (nasion) za uspostavljanje prednje referentne tačke za pozicioniranje maksilarnog modela. Kondilni nagib na artikulatoru Whip-Mix je bio podesiv u odnosu na vertikalnu i horizontalnu, ali ne i na sagitalnu osu, tako da se nije mogao postaviti na sve pozicije. Kondilni nagib i Benetova kretnja su bili ravni. Vreme Benetove kretnje nije bilo određeno. Nije bilo uređaja za zaključavanje položaja, a gornji i donji delovi nisu mogli biti mehanički pričvršćeni [1].

Simulator

Simulator (Slika 9) razvio je Ernest R. Granger 1968. To je bio potpuno podesiv artikulator koji se mogao podesiti koristeći pantografske tragove, pozicijske i druge zapise. On je imao zakrivljene kondilarne putanje, ali jedinstvene karakteristike ovog artikulatora bile su kondilarna staza koja se okreće unutra, slomljena osa i mehanički element koji se sastojao od mehaničkog reprodukovanja Benetovog pokreta i Fišerovog ugla. Simulator je imao šrafove koji su omogućavali da se gornji član odvoji od donjeg člana. Incizalni kočić je bio zakrivljen [1].

Artikulator Denar, model D4A

Ovaj artikulator razvio je Niles Guichet 1963. godine. On se podešavao pomoću zapisa dobijenih pneumatski kontrolisanim pantografom iste kompanije, Denar Corp, Anaheim, Kalifornija. To je bio potpuno prilagodljiv instrument koji je koristio promenljive kondilarne nagibe koji su se mogli podešavati. Imao je određenu centralnu bravicu, ali se mogao držati i u otvorenom položaju. Zakrivljeni incizalni kočić se naslanjao na mehanički ili plastični stočić [1].

Artikulator Dentatus ARO

Artikulator Dentatus ARO je proizveo A.B. Dentatus 1971. godine. Imao je sve karakteristike Dentatus ARL plus jedinstvenu osobinu pokretne ručice koja drži model donje vilice. Univerzalni zglob i uređaj za zaključavanje koji pričvršćuju pokretnu ručicu na bazu omogućavali su pozicioniranje modela donje vilice glave bez ponovnog podešavanja. Donji član se mogao centrirati prema gornjem članu, ali kad je jednom postavljen model donje vilice u određeni položaj, artikulator ili modeli se nisu mogli menjati bez pomoći zapisa centralnog odnosa vilica [1].

Artikulatori Panadent

Panadent sistem je pokazao najnoviji pristup stomatološkim instrumentima. On je bio zasnovan na pretpostavci da je moguće klasifikovati pojedine kondilarne kretnje u grupe na osnovu bočnog pomaka. Razvijena je serija statistički odabranih trodimenzionalnih analoga pokreta kondilne ose. Artikulator Panadent je predstavljen 1978. godine. Aktuelni modeli uvedeni su 1983. godine. Glavna modifikacija u najnovijim modelima bila je mehanička brava Dynalink Panalock. Ovaj mehanizam održava gornji i donji okvir artikulatora zajedno, ali ipak omogućava njegovo otvaranje od 180 stepeni [1].

Nedavni napredak

SAM

Kompaniju je osnovao 1971. godine Heinz Mack, stomatolog praktičar iz Minhena, Nemačka. Njegov anatomski ispravan instrument postao je poznat i identifikovan kao SAM (School Articulator Munich). Svi modeli su bili arkon tipovi artikulatora. SAM je razvio širok spektar modela artikulatora, uključujući SAM SE, SAM 2P, SAM 2PX i SAM 3. Ovi artikulatori pružaju tačnu funkcionalnu simulaciju pokreta donje vilice [2, 3].

Artikulator Artex

Ovaj artikulator je razvila kompanija GIRRBACH DENTAL GMBH i bio je naveden u FDA listi 24. maja 1995. ARTEX CN, koji je bio osnovni model, artikulator je srednjih vrednosti koji nije arkon tip. ARTEX CT je delimično podesivi artikulator srednje vrednosti u non-arkon dizajnu. Zatim je dolazio ARTEX CP, koji je bio delimično podesiv artikulator srednjih vrednosti sa super-glatkim kondilnim vodičem u arkon dizajnu. Najnoviji model bio je ARTEX CR, koji je bio potpuno prilagodljiv artikulator srednjih vrednosti u arkon dizajnu. On je omogućavao sveobuhvatna podešavanja za reprodukciju pacijentovog razmaka gornjih i donjih zuba i dinamike kretanja [4].

Artikulator Protar

Razvijen od strane kompanije KaVo početkom ovog veka. Artikulatori PROTAR (Slika 10) nudili su dobru preciznost, bili su ekonomični i laki za rukovanje. Na raspolaganju su četiri modela – PROTAR, PROTAR 3, PROTAR 5, PROTAR 7, a najnoviji model je PROTAR 9. Dimenzije PROTAR-a su 6,4" V × 6,6" Š × 8" D, a težina 2,5 lb. PROTAR 3 ima gornji član sa zakrivljenim sagitalnim i unapred zadanim kondilnim stazama, 45° horizontalnim nagibom kondilne putanje i fiksnim Benetovim uglom od 15°. PROTAR 5 ima gornji član identičan onom kao kod artikulatora PROTAR 3 sa izuzetkom da on ima podesivi Benetov ugao i horizontalni kondilni nagib. PROTAR 7 ima gornji deo sa podesivim sagitalnim uglom i horizontalnim kondilnim nagibom, kao i neposrednim pomicanjem u stranu i podesivim uglom pomaka. PROTAR 9 ima gornji član identičan PROTAR 7 sa podesivom protruzivnom kretnjom, distrakcijom i retruzivnom kretnjom [5].

Virtuelni artikulatori

Najnoviji napredak u svetu artikulatora bilo je uvođenje artikulatora VIRTUAL 2003. godine. Ovaj sistem ne samo da simulira temporo-mandibularne pokrete u softveru za modelovanje tako što ga pregledava na ekranu računara već je to i jedini sistem koji dozvoljava zubnom tehničaru da uzme merenja sa svog artikulatora, skenira ih i doda ove podatke u softver. Dimenzije artikulatora su verno prenesene u softver kako bi mogli virtuelno postaviti modele.

ZAKLJUČAK

Veliki broj i složenost modernih artikulatora mogu dovesti u zabludu praktičare da misle da je izbor odgovarajućeg instrumen-

ta težak. Međutim, izbor je u velikoj meri pojednostavljen, ako se uzme u obzir koje podatke je moguće dobiti tačno, šta se očekuje od artikulatora, kao i činjenica da tehnologija artikulatora nije zamena za biološko razumevanje mastikalnog sistema [6]. Rastuće razumevanje neurofiziologije pokreta donje vilice i uticaj nekoliko morfoloških i bihevioralnih karakteristika doveli su do ideje da je svaki pacijent njegov ili njen najbolji artikulator. Takođe, uspeh ili neuspeh finalne zubne nadoknade više zavisi od onog ko koristi artikulator nego od samog artikulatora [7].

Carl O. Boucher sumirao je kontroverzu artikulatora navodeći: „Mora se priznati da je osoba koja upravlja instrumentom važnija od instrumenta. Ako stomatolozi razumeju artikulatore i njihove nedostatke, oni mogu nadoknaditi njihove inherentne neadekvatnosti".

DE GRUYTER OPEN

Serbian Dental Journal, vol. 64, N° 4, 2017

CASE REPORT
PRIKAZ IZ PRAKSE

DOI: 10.1515/sdj-2017-0019
UDC: 616.314-089; 615:46:616.314

Decoronation as an option for ridge preservation prior to implant placement

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SUMMARY

Decoronation is a surgical procedure based on idea of sectioning tooth crown and maintaining the root in situ with intention to preclude occurrence of severe deformities of bone and soft tissue which may aggravate later rehabilitation of patient.

The aim of this report is to present the use of decoronation in a young adult patient as a solution in order to preserve sufficient amount of bone for delayed implant placement and decrease volume of grafting material to a minimum.

Obtained results showed this procedure may greatly improve anatomical conditions for implant placement while reducing invasiveness and required financial means.

Keywords: decoronation; implant placement; ridge preservation

INTRODUCTION

Decoronation was firstly introduced by Malmgren et al. more than 30 years ago [1]. However, up to date there is scarce literature data concerning this concept. Basic idea of this method is removing the crown and maintaining the root of a tooth [2]. Originally proposed as a treatment protocol for ankylosed incisors in children after traumatic avulsion, this method revolutionized therapeutic approach to ankylosed teeth and improved conditions for an implant therapy after skeletal growth is finished.

Although this method often leads to root resorption and its replacement with bone, the width of alveolar ridge maintains unaffected [3, 4]. Further, due to alveolar ridge preservation implant surgery may be minimized to a great extent [5]. This impact is explained by the following two mechanisms. Initially, after removing crown 1 – 2 mm below cervical bone clot organization is inevitable and consequently bone forming cells and growth factors lead to biologic bone development. Secondly, by sectioning tooth below the level of the osseous crest interdental and circumferential periodontal fibers are detached allowing for adjacent teeth to erupt. As this eruption of the adjacent teeth progresses bone apposition on the top of interdental septum occurs [2].

On the other hand, alveolar socket and ridge preservation using various grafting materials is well known method used to compensate for bone resorption and provide adequate bone volume for an implant placement [6]. Nevertheless, economic aspects or willingness to avoid additional surgical trauma required for earning autologous bone are sometimes the main reasons that motivate patient to opt for a low - budget prosthodontic solution after tooth failure.

The aim of this report was to present tooth decoronation in a young adult patient as a solution for preserving sufficient amount of bone for delayed implant placement and decrease volume of grafting material to a minimum. The second objective was to increase the volume of (keratinized) soft tissue thus minimizing surgical trauma.

CASE REPORT

A 20 years old female patient was clinically and radiologically examined at the Department of Oral Surgery, School of Dental Medicine University of Belgrade. Having found non-salvageable maxillary left first premolar indicated for extraction patient was advised to undergo implant therapy due to intact canine and good condition of the second premolar (Figure 1). However, due to financial reasons, patient was not able to do either immediate extraction and implant placement or alveolar socket preservation. Besides, patient was not psychologically prepared for surgical procedure. Therefore, decoronation was proposed as a temporary socket preservation method in order to help patient by avoiding usage of bone substitute and collagen membrane during this phase and lowering the costs. Decoronation was done using diamond bur under copious saline irrigation in accordance with recommendation from the literature [1]. Technique was modified by omitting horizontal incision and flap rising (Figure 2).

After a period of five months patient decided to proceed with implant therapy. Owing to excellent healing of soft tissue (Figure 3A) crestal incision was made including mesial and distal papilla and flap was raised without releasing incisions. What was surprising is an outstanding amount of bone that had to be removed to access submerged roots (Figure 3B). Minimally traumatic extraction of roots was done using periotomes (Figure 4A-C). In line with standard drilling protocol standard diameter bone

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Figure 1. Clinical finding of tooth indicated for extraction
Slika 1. Klinički prikaz zuba indikovanog za ekstrakciju

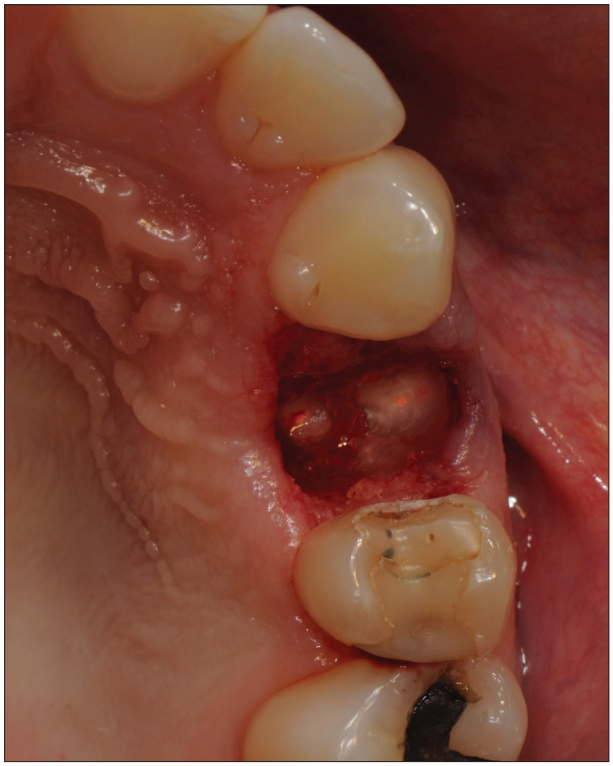

Figure 2. Decoronation without flap elevation
Slika 2. Dekoronizacija (uklanjanje krunice zuba) bez podizanja flapa

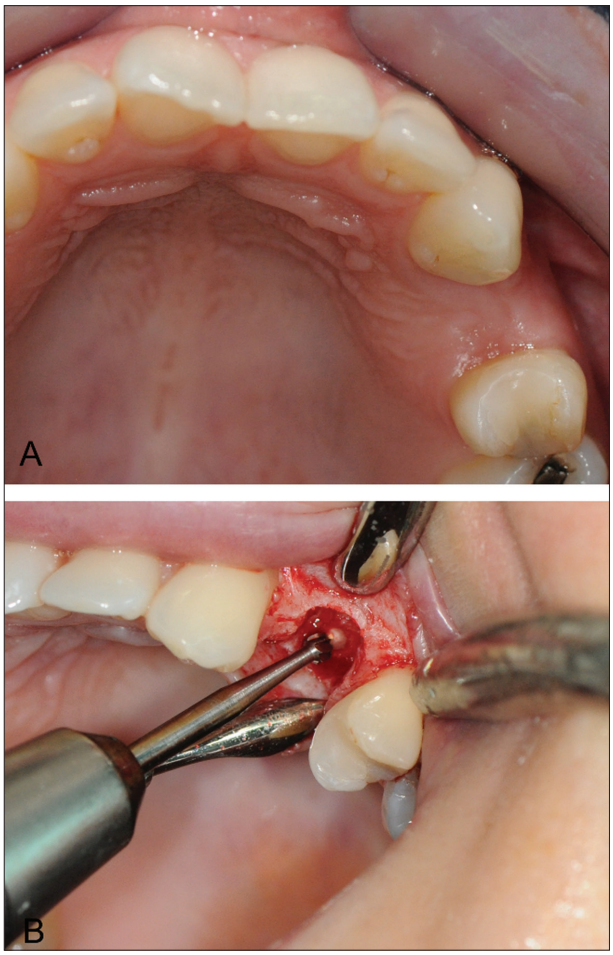

Figure 3. Healing after 5 months (A); bone removal in order to extract roots (B)
Slika 3. Zarastanje posle pet meseci (A); uklanjanje kosti radi vađenja korenova (B)

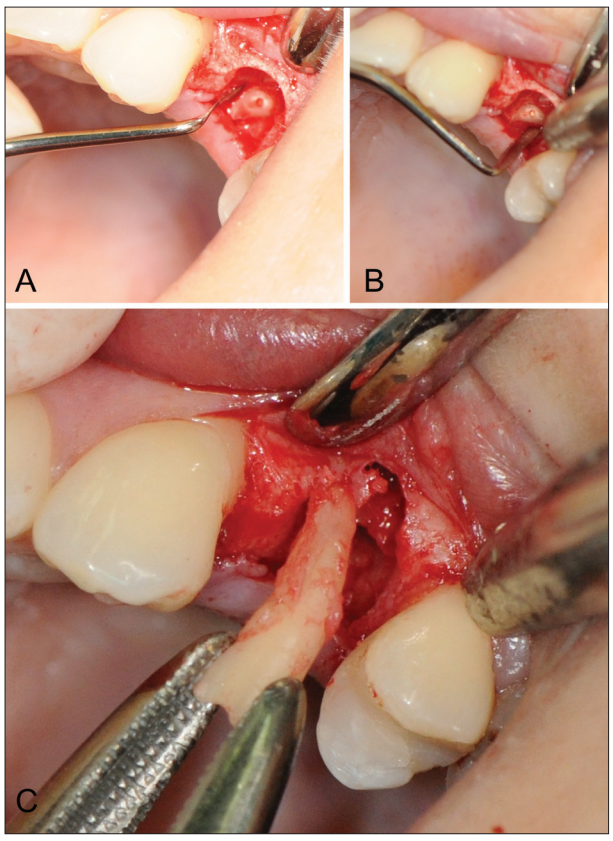

Figure 4. Minimally traumatic extraction of roots using periotomes (A, B); buccal root extracted (C)
Slika 4. Minimalno invazivno vađenje korenova upotrebom periotoma (A, B); bukalni koren izvađen (C)

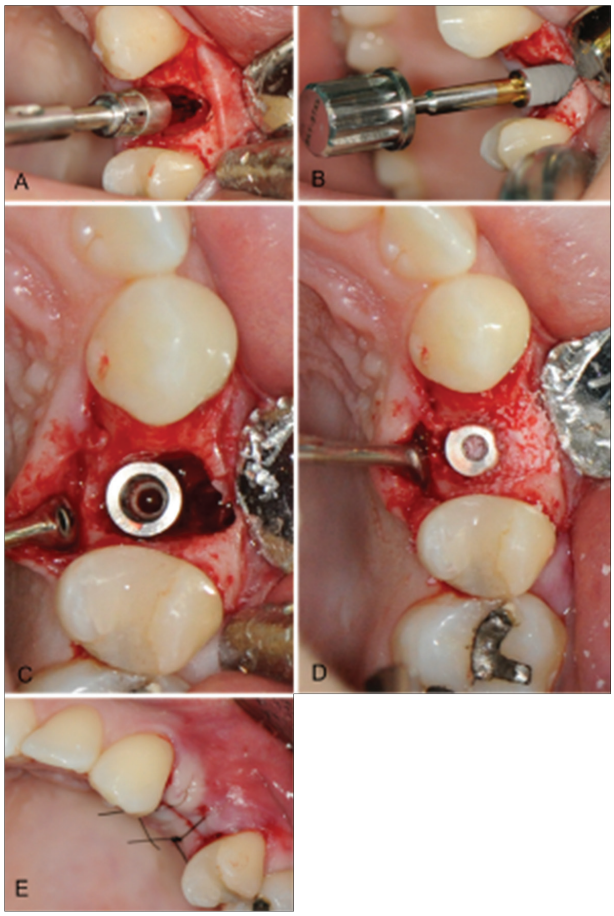

Figure 5. Site preparation (A); implant placement (B); adequate buccolingval position of implant (C); buccal gap filled with bone substitute (D); flap repositioned and sutured (E)
Slika 5. Preperacija ležišta implantata (A); ugradnja implantata (B); odgovarajuća bukolingvalna pozicija implantata (C); bukalni defekt popunjen koštanim zamenikom (D); repozicioniran i ušiven režanj (E)

level implant (Bredent® 4.0 x 12mm) was inserted into the palatal socket (Figure 5A-E). With the intention of providing long term stability of bone and soft tissue support buccal alveolar socket was filled with bone substitute of low resorption rate and covered with absorbable membrane. Flap was repositioned and sutured with 5-0 nylon sutures. After six months implant was uncovered and definite prosthetic crown was delivered (Figure 6A-C).

DISCUSSION

Regardless of obvious clinical advantages decoronation is not widely accepted amongst practitioners even 3 decades after its introduction. Presumably, the main reason may be a limited number of evidence based research data addressing success rate of this procedure as well as constant pressure induced by medical companies in favor of use varied materials.

When it comes to bone preservation a variety of different grafting materials have been used for decades. More recently enamel matrix derivate (EMD) has been found to promote complete periodontal tissue regeneration and therefore it is recommended for the treatment of avulsed teeth [7]. However, more artificial materials is used, it is

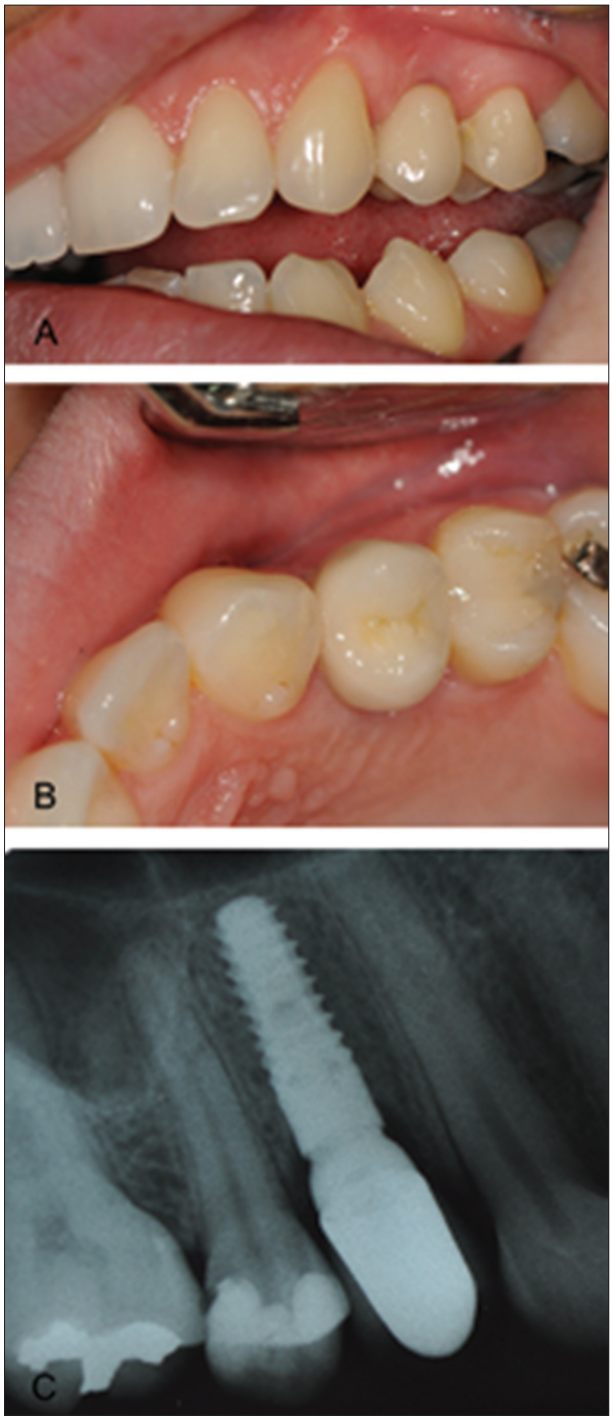

Figure 6. Definitive prosthetic solution: clinical (A, B) and radiological aspect (C)
Slika 6. Definitivno protetsko rešenje: klinički (A, B) i radiološki aspekt (C)

higher the cost. On the other hand, it has been shown that not only bone preservation but also bone gain is to be expected after decoronation [1, 3, 8, 9, 10]. It is essential to highlight that effects on bone preservation and formation are time dependent. Namely, during pubertal growth spurt this procedure can greatly contribute to normal alveolar ridge development and after the growth peak is reached (by the age of 16) limited amounts of bone may be gained. Additionally, if decoronation was done before the occurrence of severe alveolar ridge deformation, tilting of the adjacent teeth could be reduced and accept-

able soft tissue appearance could be established before implant placement. Our finding is consistent with those confirming bone and soft tissue gain. Moreover, when favorable gingival phenotype and bony socket walls are present acceptable healing by secondary intention will occur as a rule. By this approach mobilizing flap was avoided and mucogingival junction was left undisturbed which was crucial as its position may play an important role in long term implant stability regarding both function and aesthetics. Besides, it has been known for long time that every elevation of mucoperiosteal flap leads to the loss of crestal alveolar bone height irrespective of using partial or full thickness flap [11]. Hence, in those cases where anatomical conditions are encouraging more conservative approach is recommended.

On the contrary, Lin et al. showed that preservation of ridge width after decoronation was not 100% successful [4]. In this study a mean of 1.67 mm decrease in width was found with tendency to further decrease during time. Likewise, Tsukiboshi et al. concluded that decoronation procedure showed lack of bone preservation efficiency and related it to the loss of tooth dependent bone volume (TDBV) which is not genetically determined but based on vitality of periodontal fibers [12]. Nonetheless, based on existing literature data it can be emphasized that bone alterations after decoronation are similar to those found after using other preservation methods [13, 14, 15].

While grafting procedure at the time of implant placement cannot be excluded by decoronation it can help to preserve sufficient bone volume for implant insertion and additional grafting is only used for long term implant stability [16]. Correspondingly, Filippi et al. reported slight decrease in width after two weeks following decoronation procedure that remained constant after 9 months follow up [17].

CONCLUSION

Along with literature evidences it can be concluded that decoronation might be a beneficial alternative regarding bone preservation prior to implant placement. This surgical procedure is a simple and conservative technique to avoid bone loss, aesthetic disturbances and excessively invasive treatments. In order to achieve best results careful diagnosis and right indication assessment are mandatory.

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Received: 02.06.2017 • Accepted: 03.08.2017

Dekoronizacija kao metod prezervacije alveolarnog grebena u cilju ugradnje implantata

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KRATAK SADRŽAJ

Dekoronizacija je hirurška procedura koja ima za cilj uklanjanje krunice zuba i zadržavanja korena u alveoli radi sprečavanja nastanka značajnijih promena i poremećaja u koštanom i mekotkivnom kompleksu, koje mogu otežati kasniju protetsku rehabilitaciju pacijenta.

U ovom radu je prikazana dekoronizacija kod odrasle mlade pacijentkinje radi prezervacije (alveolarnog grebena) i stvaranja mekog tkiva za postavljanje implantata uz upotrebu minimalnih količina veštačkih materijala.

Ostvareni rezultati pokazali su da ova procedura može doprineti poboljšanju anatomskih uslova za ugradnju implantata uz značajnu redukciju invazivnosti, kao i finansijskih sredstava neophodnih za sprovođenje tehnike.

Ključne reči: dekoronizacija; ugradnja implantata; prezervacija alveole

UVOD

Dekoronizacija je prvi put opisana od strane Malmgrena i sar. pre više od 30 godina [1]. Ipak, sve do danas podaci iz literature koji obrađuju ovu temu su oskudni. Kao što se može zaključiti iz imena, ova procedura se bazira na ideji uklanjanja krunice zuba i zadržavanja korena u alveoli [2]. Originalno predložen kao terapijski protokol za tretiranje ankilotičnih sekutića u dečjem uzrastu posle traumatske avulzije, ovaj metod je doneo preokret u terapijskom pristupu problemu ankilotičnih zuba i omogućio stvaranje boljih uslova za postavljanje implantata posle završetka skeletnog razvoja. Iako primenom ovog metoda često dolazi do zamene zubnog tkiva koštanim, širina alveolarnog grebena ostaje očuvana [3, 4]. Štaviše, zahvaljujući potencijalnom stvaranju novog koštanog tkiva, ugradnja implantata može biti minimalno invazivna [5]. Dva principa leže u osnovi stvaranja nove kosti. Inicijalno, posle uklanjanja krunice do nivoa 1–2 mm ispod krestalnog dela alveolarnog grebena dolazi do stvaranja krvnog ugruška koji predstavlja izvor faktora rasta koji utiču na osteoblaste da stvaraju novu kost. Osim toga, odsecanjem krunice ispod nivoa cervikalnog dela zuba interdentalna i cirkumferencijalna periodontalna vlakna ostaju bez uporišta omogućavajući nicanje susednih zuba. Napredovanje erupcije susednih zuba dovodi do stvaranja nove kosti na vrhu interdentalnog septuma putem apozicije [2].

S druge strane, prezervacija alveole i alveolarnog grebena korišćenjem različitih materijala je dobro poznat način da se spreči gubitak kosti i obezbedi odgovarajući volumen koštanog tkiva za ugradnju implantata [6]. Međutim, ekonomski aspekt ili želja da se izbegne dodatna hirurška trauma prilikom uzimanja autolognog koštanog grafta su ponekad glavni razlozi zbog kojih se pacijenti odluče za neko jeftinije i manje invazivno rešenje za nadoknadu zuba.

Cilj ovog rada je prikaz upotrebe dekoronizacije kod mladog odraslog pacijenta u cilju prezervacije dovoljne količine kosti i stvaranja mekog tkiva za postavljanje implantata uz smanjenje potrebe za veštačkim materijalima.

PRIKAZ PACIJENTA

Dvadesetogodišnja pacijentkinja pregledana je klinički i radiološki na Klinici za oralnu hirurgiju Stomatološkog fakulteta Univerziteta u Beogradu. Budući da je prvi premolar u gornjoj vilici bio indikovan za vađenje, a da je očnjak intaktan, kao najbolje rešenje predložena je ugradnja implantata (Slika 1). Kako pacijentkinja nije bila u mogućnosti da se podvrgne ugradnji implantata u datom momentu, što zbog nedostatka finansijskih sredstava, što zbog psihološke nespremnosti za sprovođenje hirurške intervencije, u skladu sa podacima iz literature predložena je dokoronizacija kao privremno rešenje za očuvanje koštanog tkiva radi finansijskog olakšanja jer se time izbegava upotreba koštanih zamenika i membrane u ovoj fazi pripreme za ugradnju implantata. Uz saglasnost pacijentkinje, procedura je izvedena korišćenjem dijamantskog borera uz obilnu irigaciju u skladu sa preporukama iz literature [1]. Tehnika je izmenjena izostavljanjem horizontalne i vertikalne incizije (Slika 2).

Posle pet meseci pacijentkinja je odlučila da nastavi sa implantološkom terapijom. Uočeno je odlično mekotkivno zarastanje (Slika 3A). Urađena je krestalna incizija uključujući mezijalnu i distalnu papilu, posle čega je podignut mukoperiostalni režanj bez relaksacionih incizija. S obzirom na izvanredno koštano zarastanje, jedan deo stvorene kosti morao je biti uklonjen radi pristupanja potopljenim korenovima (Slika 3B). Korišćenjem periotoma, korenovi su izvađeni minimalno traumatski (Slika 4A–C). Prateći uobičajni hirurški protokol, postavljen je implantat standardnog dijametra (Bredent® 4.0 × 12 mm) u palatinalnu alveolu (Slika 5A–E). S namerom da se obezbedi dugotrajna stabilnost koštanog i mekotkivnog profila oko implantata, bukalna alveola je popunjena spororesorptivnim veštačkim zamenikom za kost, preko čega je postavljena kolagena membrana. Mukoperiostalni režanj je repozicioniran i ušiven najlonskim koncem 5-0. Posle šest meseci izrađen je definitivni protetski rad (Slika 6A–C).

DISKUSIJA

Bez obzira na očigledne kliničke prednosti, dekoronizacija nije široko prihvaćen metod među kolegama ni posle tri decenije

od prvog predstavljanja. Razlog za to može biti ograničen broj naučnih radova koji pokazuju stopu uspeha ove procedure, kao i konstantni pritisak od strane farmaceutskih kompanija u korist upotrebe različitih materijala za nadogradnju i očuvanje koštanog i mekog tkiva.

Dramatično veliki broj različitih materijala se koristi za prezervaciju kosti već godinama. Takođe, nešto skorije otkriveno je da gleđni proteini indukuju kompletnu regeneraciju parodontalnog kompleksa i preporučena je upotreba ovih preparata kod replantacije izbijenih zuba [7]. Međutim, tačno je i da veća količina upotrebljenih veštačkih materijala nosi sa sobom značajno veće finansijsko opterećenje za pacijente. S druge strane, pokazano je da se dekoronizacijom može ostvariti ne samo očuvanje koštanog tkiva već i njegov dobitak [1, 3, 8, 9, 10]. Važno je istaći da efekat na očuvanje i stvaranje kosti zavisi od vremenskog okvira u kome se dekoronizacija izvodi. Naime, tokom pubertetskog naglog razvoja svih tkiva ova procedura može veoma mnogo doprineti normalnom razvoju alveolarnog grebena, dok po dostizanju vrhunca rasta i razvoja (oko 16. godine života) uticaj dekoronizacije na stvaranje nove kosti bitno opada. Isto tako, ukoliko se dekoronizacija uradi pre nastanka ozbiljnije deformacije alveolarnog grebena, inklinacija susednih zuba može se sprečiti i prihvatljiv izgled mekih tkiva može biti ostvaren, što je jedan od ključnih preduslova za uspeh kasnije implantološke terapije. Uz sva ograničenja, naš nalaz u prikazanom slučaju je u skladu sa istraživanjima koja potvrđuju uvećanje koštanog i mekotkivnog volumena. Štaviše, sa stanovišta autora ovog rada, zadovoljavajuće zarastanje čak i putem sekundarne intencije može se očekivati u slučajevima kad su očuvani koštani zidovi alveole i kad je prisutan povoljan gingivalni fenotip.

Ovakvim pristupom izbegava se odizanje mukoperiostalnog režnja i samim tim koronarno pomeranje mukogingivalne linije, što značajno doprinosi dugotrajnoj funkcionalnoj i estetskoj stabilnosti ugrađenog implantata. Osim toga, već dugo je poznato da svako odizanje mukoperiostalnog režnja, nezavisno od toga da li je u pitanju režanj pune debljine ili poludebljine, dovodi do gubitka kosti u krestalnom delu alveolarnog grebena [11]. Stoga, u onim slučajevima kad su ispunjeni anatomski preduslovi u smislu kvaliteta koštanog i mekog tkiva, preporučuje se konzervativniji pristup u svetlu moderne stomatološke filozofije „manje je više".

Nasuprot istraživanjima koja govore u prilog dekoronizaciji, Lin i sar., su pokazali da prezervacija alveolarnog grebena posle dekoronizacije nije 100% uspešna [4]. U ovoj studiji pronađeno je da srednja vrednost smanjenja širine alveolarnog grebena iznosi 1,67 mm sa tendencijom daljeg smanjenja kako vreme prolazi. Takođe, Tsukiboshi i sar., su zaključili da metod dekoronizacije nije efikasan u pogledu prezervacije alveolarnog grebana i to pripisali činjenici da postoji određena količina kosti koja nije genetski određena već da je zavisna od vitaliteta periodontalnih vlakana [12]. Bilo kako bilo, bazirano na postojećim dokazima iz literature, može se reći da su promene koštanog kompleksa posle dekoronizacije slične promenama koje se dešavaju posle primene nekih drugih metoda prezervacije [13, 14, 15].

I dok se simultana nadogradnja koštanog tkiva u trenutku postavljanja implantata ne može sa sigurnošću isključiti dekoronizacijom, količina potrebnog materijala je značajno manja i služi samo kao osiguranje za dugotrajnu stabilnost implantata [16]. S tim u vezi, Filippi i sar. su našli neznatno smanjenje širine alveolarnog grebena posle dve nedelje od dekoronizacije, ali je tokom sledećih devet meseci širina ostala nepromenjena [17].

U skladu sa nalazima iz literature, može se zaključiti da dekoronizacija predstavlja validnu alternativu za očuvanje kosti radi kasnije uspešne insercije implantata. Ova hirurška procedura predstavlja jednostavnu i konzervativnu tehniku kojom se mogu izbeći gubitak kosti, estetske nepravilnosti, kao i preterano invazivni terapijski protokoli. Radi ostvarenja najboljih rezultata upotrebom ove tehnike obavezni su pažljiva dijagnostika i pravilno postavljanje indikacije.

CASE REPORT
PRIKAZ IZ PRAKSE
DOI: 10.1515/sdj-2017-0020
UDC: 616.314-77-089.843:111.852

Integration of function, aesthetics and patients' personal preferences in the prosthetic treatment planning

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SUMMARY
Introduction Optimal aesthetic results require suitable smile design that fulfils patient's expectations. Psychological importance of teeth appearance is clear and often discussed in relation to the success of prosthetic treatment.
The objective of this article was to present methodology for creating customized smile design using the Visagismile concept and evaluate aesthetic satisfaction with prosthetic treatment.
Case report A 52-year-old female patient required complete esthetical dental mouth reconstruction. Digital planning software (Visagismile) provided dentists and technicians a 2D preview of the final design that relates facial perception and personality of the patient. The latest innovation of used software in addition to documents that dentists send for the Visagismile application is that they need to send an intraoral 3D scan of the patients mouth (with any scanner) and define the length and position of incisal edges of the central incisors. This information as a STL file is sent to new Visagismile/REBEL center that is actually a digital lab, that converts 2D designs created by the Visagismile concept into 3D and create a digital wax up immediately.
Conclusions Visagismile concept supports both dentist and patient in deciding the aesthetics of the prosthetic restoration. The total coefficient of the assessment of patients for the final aesthetic result was highly satisfactory. Using the proposed methodology, a smile design corresponding to individual facial features, temperament and personal preferences of the patient can be reproduced.
Keywords: personalized digital design; esthetic treatment; prosthetic treatment

INTRODUCTION

Optimal aesthetic results require suitable smile design that satisfies patient's expectations largely influenced by psychological peculiarities of character, social status and education [1, 2, 3]. Psychological importance of good appearance of teeth is clear and often discussed in relation to the success of prosthetic treatment [4]. Detailed functional analysis of dentition using provisional restorations to change or adapt the smile design is also needed [5, 6]. To build the design of future prosthetic work, contemporary dental medicine uses digital technology in order to meet maximum requirements [7, 8]. Papasotiriou et al. studied the effectiveness of computer visualization and applicability in clinical practice. They examined two groups. Patients from the first group consulted by computer visualization showed higher satisfaction with the treatment (93.75%) compared to conventionally consulted (83.3%) [9].

The objective of this article was to present the methodology for creating customized smiles designs using the Visagismile concept and evaluates aesthetic satisfaction after prosthetic treatment.

CASE REPORT

A woman of age 52 required esthetic prosthetic reconstruction of her teeth. After the full-face picture of the patient with half smile was taken it was revealed that her smile doesn't show any teeth (very short teeth). However, a stretched smile showed incisal edges of the upper incisors. A digital planning software Visagismile provided dentists and technicians a 2D preview of the final design that related facial perception and personality of the patient to the smile design, using thousands of algorithms for the combination of incisal silhouette, tooth axis, dominance of the centrals and combination of individual tooth shapes [10, 11]. The latest innovation of the software is, in addition to documents that dentists used to send for the Visagismile application, they only need to send intraoral 3D scan of patients mouth (with any scanner), define the length and position of incisal edges of central incisors and send this information as a STL file to new Visagismile/REBEL center. The new REBEL system is actually a digital lab, that converts 2D designs created by the Visagismile concept in to 3D, and creates digital wax up immediately. Current esthetic software programs can be powerful tools in assessing and modifying the design of deficient smiles [12, 13]. In this case, impressions from the upper and lower jaw with standard metal trays and impression material were taken. Plaster-working models were made. They were placed in the articulator and a wax modeling of the upper front teeth was produced in accordance with the parameters set by the Visagismile design. Silicone keys with high hardness were made on wax prototypes. In the silicon index a Bis-acril self-cured composite was placed

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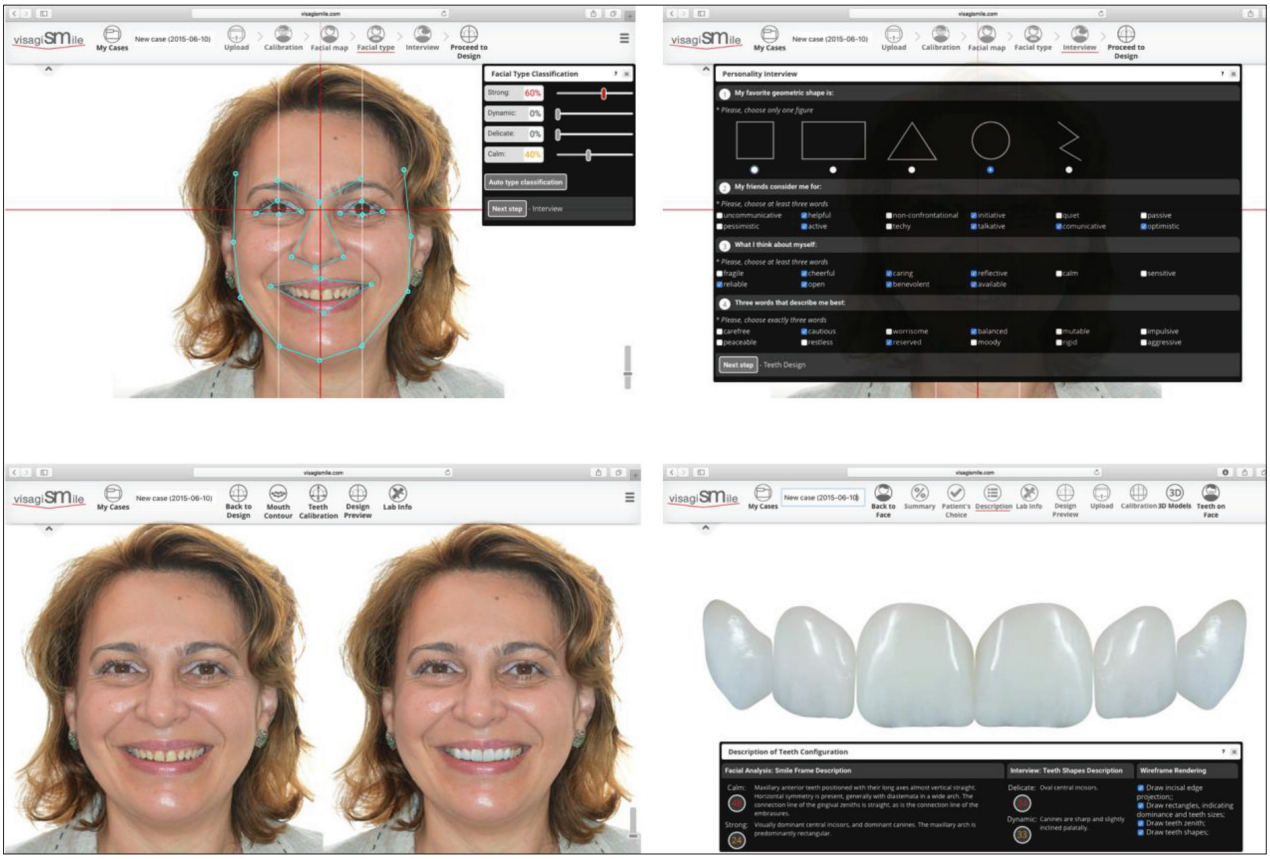

Figure 1. Workflow of Visagismile software, face reading, interview, design preview
Slika 1. Vorkflov softver Visagismile, čitanje lica, intervju, pregled dizajna

Figure 2. Initial situation of upper and lower teeth: central occlusion, protrusion, right and left laterotrusion
Slika 2. Inicijalna situacija gornjih i donjih zuba: centralna okluzija, protruzioni položaj, desni i levi laterotruzioni položaj

Figure 3. Wax-up of upper and lower teeth: central occlusion, protrusion, right and left laterotrusion
Slika 3. Voštani model gornjeg i donjeg zubnog niza: centralna okluzija, protruzioni položaj, desni i levi laterotruzioni položaj

Figure 4. Mock up of upper and lower teeth: central occlusion, protrusion, right and left laterotrusion
Slika 4. Proba gornjih i donjih zuba: centralna okluzija, protruzioni položaj, desni i levi laterotruzioni položaj

Figure 5. Final restorations of upper and lower teeth: central occlusion, protrusion, right and left laterotrusion.
Slika 5. Završna restauracija gornjih i donjih zuba: centralna okluzija, protruzioni položaj, desni i levi laterotruzioni položaj

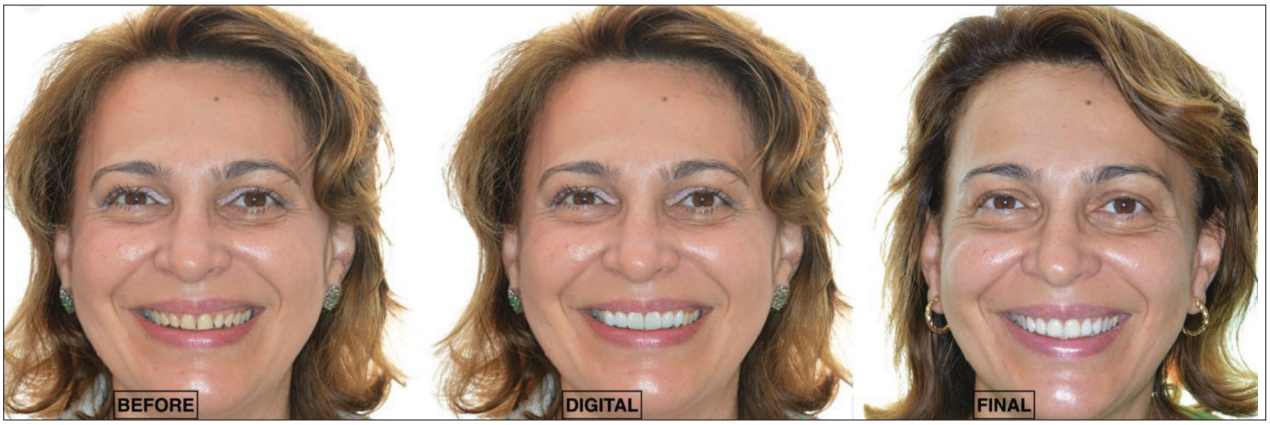

Figure 6. Final restorations of upper and lower teeth: before,digital planing, final restorations.
Slika 6. Završne restauracije gornjeg i donjeg zuba: ranije, digitalno planiranje, završne restauracije

and the design was recreated in the mouth in the form of a composite mask over the patient's natural teeth. After the person's consent, the treatment was completed with definitive prosthetic work [5]. The main advantage of the presented clinical case was minimally invasive treatment. The old composite restorations needed to be replaced because of existing microleakage. The canting of the occlusal plane and the abrasion of incisal edges were consistent with functional problems. There was also a diastema and spacing between the front teeth. At the lower jaw, there was one missing premolar with space that distributed among other teeth. By adding volume on the buccal surface and incisal edge of the teeth on the upper and lower jaw, positioning them more vestibularly, we could expand the arch and be minimally invasive and totally additive in this particular case. By achieving optimal teeth proportions, we restored normal occlusion in protrusion and laterotrusion, and removed functional disorders. The treatment plan for restoring upper teeth included six lithium-disilicate veneers on the front six teeth, partial veneers on first premolars, and lithium-disilicate overlays on molars. Follow-up of the case lasted three years and the patient had no complications. There were no ceramic chippings or debonding. Function and aesthetics were as preserved as on the day one.

The patient was asked to complete a questionnaire (orofacial aesthetic scale of Larsson [12]), which evaluates the aesthetic result of individual applications design. Results showed high degree of satisfaction regarding the teeth shade, gum appearance and changes in overall appearance of her smile and teeth.

CONCLUSION

Visagismile concept supports dentists and patients in deciding about aesthetics of prosthetic restoration. The total coefficient representing the final aesthetic result of the prosthetic treatment was satisfactory. Using the proposed methodology, smile design corresponding to individual facial features, the temperament, and personal preferences of the patient can be achieved.

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Received: 04.09.2017 • Accepted: 28.11.2017

Integracija funkcije, estetike i pacijentovih ličnih želja u planiranju protetskog tretmana

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KRATAK SADRŽAJ

Uvod Optimalni estetski rezultati zahtevaju odgovarajući dizajn osmeha koji ispunjava očekivanja pacijenta. Psihološki značaj dobrog izgleda zuba je jasan i često u vezi sa uspehom protetskog tretmana.

Cilj ovog rada je bio da se predstavi metodologija za kreiranje prilagođenog dizajna osmeha koristeći koncept Visagismile i da se proceni zadovoljstvo pacijenta posle protetske terapije.

Prikaz slučaja Žena od 52 godine je zahtevala estetsku terapiju zuba. Korišćen je program digitalnog planiranja Visagismile, koji stomatolozima i zubnim tehničarima pruža 2D pregled finalnog dizajna osmeha, a u vezi sa percepcijom lica i ličnosti pacijenta. Najnovija inovacija ovog softvera je u tome što treba poslati samo intraoralni 3D snimak osmeha pacijenata (sa bilo kojim skenerom) uz definisanje dužine i pozicije incizalnih ivica centralnih sekutića kao STL datoteku novom Visagismile / REBEL centru, gde ova digitalna laboratorija odmah formira digitalni vosak. Postojeći estetski softverski programi su moćni alati u proceni i modifikaciji dizajna neadekvatnih osmeha.

Zaključak Visagismile koncept olakšava i pomaže stomatologu i pacijentu u planiranju estetike protetske nadoknade. Ukupan koeficijent procene pacijenata o konačnom estetskom rezultatu protetskog rada bio je veoma zadovoljavajući. Predloženi protetski metod protetike može reprodukovati dizajn osmeha koji odgovara pojedinačnim osobinama lica, temperamentu i ličnim željama pacijenta.

Ključne reči: personalizovani digitalni dizajn; estetski tretman; protetski tretman

UVOD

Optimalni estetski rezultati podrazumevaju odgovarajući dizajn osmeha koji ispunjava očekivanja pacijenta [1, 2], na koja u velikoj meri utiču psihološke osobenosti nekog karaktera, društveni status i obrazovanje [3]. Psihološki značaj dobrog izgleda zuba je jasan, i često zavisi od uspeha protetskog tretmana [4].

Često je potrebna i detaljna funkcionalna analiza denticije, kojom se uspostavljaju privremene promene ili prilagođava sam dizajn osmeha [5, 6]. Za dizajniranje budućeg protetskog rada savremena stomatologija koristi digitalne tehnologije u pokušaju da ispuni maksimalne zahteve pacijenata [7, 8, 9].

Papasotiriou, Nathanson i Goldstein [10] proučavali su efikasnost računarske vizualizacije i primenljivosti u kliničkoj praksi. Ispitivane su dve grupe. Pacijenti iz prve grupe su ispitivani pomoću računarske vizualizacije i bili su zadovoljniji – 93,75%, u poređenju sa pacijentima sa konvencionalnim konsultacijama – 83,3%.

Cilj ovog rada je bio da se predstavi metodologija za kreiranje prilagođenog dizajna osmeha koristeći koncept Visagismile i da se proceni zadovoljstvo pacijenta estetskim rešenjem posle protetske terapije.

PRIKAZ SLUČAJA

Žena od 52 godine je zahtevala estetski tretman zuba. Pripremljena je fotografija lica pacijenta sa blagim osmehom. Ukoliko se na fotografiji ne vide zubi (pacijenti sa vrlo kratkim zubima), pacijent se slika sa širokim osmehom koji omogućava prikazivanje incizalnih ivica gornjih sekutića. Program digitalnog planiranja koji je korišćen u vreme tretmana bio je Visagismile [11], koji stomatolozima i zubnim tehničarima pruža 2D pregled finalnog dizajna osmeha, a u vezi je sa percepcijom lica i ličnosti pacijenta, jer omogućava rad sa hiljadama algoritama za kombinaciju incizalne siluete, ose zuba, dominacije centralnih inciziva i kombinacije pojedinačnih oblika zuba. Najnovija inovacija ovog softvera je u tome da je, pored dokumenata koje su stomatolozi koristili za slanje Visagismile, neophodno samo poslati intraoralni 3D snimak usta pacijenata (sa bilo kojim skenerom) i definisati dužinu i poziciju incizalnih ivica centralnih sekutića. Ovu informaciju treba poslalati kao STL datoteku novom Visagismile / REBEL centru. Novi REBEL sistem je digitalna laboratorija koja odmah formira digitalni vosak. Može zvučati komplikovano, ali je to najjednostavniji način da se postigne jedan od najboljih 3D digitalnih voskova. Postojeći estetski softverski programi mogu biti moćni alati u proceni i modifikaciji dizajna osmeha [12, 13, 14].

Za konkretni slučaj su uzeti otisci gornje i donje vilice sa standardnim metalnim kašikama i materijalom za otiske. Izrađeni su gipsani modeli i fiksirani u artikulatoru, a modelovanje u vosku gornjeg fronta zuba izrađeno je u skladu sa parametrima postavljenim Visagismile dizajnom. Silikonski trejevi visoke tvrdoće napravljeni su na voštanim prototipovima. U silikonski trej je postavljen bis-akrilni samovezujući kompozit, a nakon toga je trej postavljen u usta pacijenta preko prirodnh zuba i na taj način formirana kompozitna maska u vidu novodizajniranog osmeha. Posle saglasnosti pacijenta terapija je završena definitivnim protetskim radom [15]. Glavna prednost u predstavljenom kliničkom slučaju je u tome što je ovde predstavljena minimalno invazivna procedura za zubne strukture. Stare kompozitne restauracije je bilo neophodno zameniti zbog postojećih mikropukotina. Zaravnjene okluzalne površine zuba i abrazija incizalnih ivica su takođe predstavljale postojeće funkcionalne probleme. Postojali su dijasteme i razmaci između prednjih zuba. U donjoj vilici nedostajao je jedan premolar, te je taj prostor morao biti „podeljen“ među drugim zubima. Dodavanjem materijala na bukalnoj površini i incizalnoj ivici zuba gornje i donje vilice i pozicioniranjem vestibularno proširen je luk i obezbeđen minimalno invazivni tretman i potpuno odgovarajući u ovom konkretnom slučaju. Postizanjem optimalnih proporcija zuba normalna okluzija se može vraćati u protruzioni i laterotruzioni smer i time ukloniti funkcionalne poremećaje. Plan terapije za restauraciju gornjih

zuba obuhvatao je šest litijum-disilikatnih venira na prednjih šest zuba, poluvenire na prvim premolama i litijum-silikatne overleje na molarima. Praćenje slučaja je trajalo tri godine, a pacijent nije imao komplikacija. Nije bilo odlamanja keramike niti rascementiranja. Funkcija i estetika su bili očuvani kao i prvog dana.

Od pacijenta je zatraženo da popuni upitnik (orofacijalnu estetsku skalu Larsson [13], koja procenjuje estetski rezultat dizajna pojedinačnih slučajeva. Sumirani rezultati iz odgovora pacijenta na pitanja pokazuju koeficijent koji ukazuje na zadovoljstvo pacijenta u pogledu boje zuba, vidljivosti desni i ukupnog izgleda osobe u odnosu na promene koje se javljaju u pogledu osmeha i zuba.

ZAKLJUČAK

Visagismile koncept pomaže stomatologu i pacijentu u planiranju estetike protetske nadoknade. Ukupan koeficijent procene pacijenata o konačnom estetskom rezultatu protetskog rada bio je veoma zadovoljavajući. Predloženi protetski metod protetike može reprodukovati dizajn osmeha koji odgovara pojedinačnim osobinama lica, temperamentu i ličnim željama pacijenta.

Da li ste pažljivo čitali radove?

1. Dekoronizacija je hirurški postupak:
   a) uklanjanja krunice zuba
   b) uklanjanja korena zuba
   c) zadržavanje krunice zuba u alveoli

2. Primenom zračne terapije tumora glave i vrata oralna sluznica je:
   a) obavezno zahvaćena
   b) retko zahvaćena
   c) nepristupačna za zračenje

3. Dekoronizacija kao metod prezervacije alveolarnog grebena je rađena u cilju:
   a) ugradnje implanta
   b) pripreme za dodatak veštačkih materijala
   c) konzervativnog zbrinjavanja

4. Kserostomija nastaje kao posledica:
   a) oštećenja oralne sluznice
   b) oštećenja pljuvačnih žlezda
   c) oštećenja čula ukusa

5. Implantološka terapija kod pacijentkinje sa dekoronizacijom je realizovana:
   a) posle tri meseca
   b) posle pet meseci
   c) posle devet meseci

6. XP-endo SHAPER je:
   a) rotirajući instrument za preparaciju kanala
   b) rotirajući instrument za uklanjanje razmaznog sloja
   c) ultrazvučni instrument

7. Neželjeni toksični akutni efekti radioterapije nastaju:
   a) tokom zračenja
   b) po završetku zračenja
   c) tokom i neposredno po završetku zračenja

8. Postupak dekoronizacije je realizovan kod:
   a) mlade osobe
   b) deteta
   c) starije osobe

9. Dekalcifikacija gleđi nastaje kao posledica:
   a) oštećenja koštanog tkiva
   b) promena u hemijskom sastavu pljuvačke
   c) ankiloze TM zgloba

10. Prezervacija alveole i alveolarnog grebena je način da se spreči:
    a) gubitak krunice zuba
    b) gubitak korena zuba
    c) gubitak kosti

11. Jonizujuće zračenje se obično izvodi visokim dozama od:
    a) 20–30 GY
    b) 30–40 GY
    c) 50–70 GY

12. XP-endo FINISHER je:
    a) rotirajući instrument koji se koristi za preparaciju kanala
    b) instrument koji se koristi posle završene preparacije kanala
    c) instrument sa recipročnim pokretima

13. Akutne komplikacije zračne terapije su:
    a) gubitak ukusa
    b) osteoradionekroza
    c) trizmus

14. Integracija funkcije, estetike i pacijentovih želja je realizovana u sklopu:
    a) protetske terapije
    b) restaurativne terapije
    c) parodontološke terapije

15. XP-endo SHAPER se koristi za preparaciju kanala korena pri brzini od:
    a) 150–300 obrtaja
    b) 600 obrtaja
    c) 800 obrtaja

16. Kasne komplikacije radioterapije su:
    a) suvoća usta
    b) zapaljenje oralne sluznice
    c) karijes

17. Estetski softverski program Visagismile obezbeđuje:
    a) dobre mogućnosti u modifikaciji dizajna osmeha
    b) neznatne mogućnosti u modifikaciji dizajna osmeha
    c) komplikovane mogućnosti u modifikaciji dizajna osmeha

18. Posledice ispoljene toksičnosti zračne terapije:
    a) utiču na kvalitet života pacijenta
    b) ne utiču na kvalitet života pacijenta
    c) ne remete kvalitet života pacijenta

19. U dizajniranju estetske protetske nadoknade kod pacijentkinje starosti 52 godine korišćena je:
    a) fotografija
    b) fotografija i želja pacijenta
    c) digitalna tehnologija

20. Program digitalnog planiranja izgleda pacijenta sa osmehom je:
    a) STL program
    b) Visagismile
    c) Rebel laboratorija

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CIP - Каталогизација у публикацији
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616.31

STOMATOLOŠKI glasnik Srbije = Serbian
Dental Journal / glavni i odgovorni urednik
Slavoljub Živković. - God. 1, br. 1 (1955)-
. - Beograd (Džordža Vašingtona 19) :
Srpsko lekarsko društvo, 1955- (Beograd :
Službeni glasnik). - 29,5 cm

Dostupno i na: http://www.stomglas.org.rs - Tromesečno

ISSN 0039-1743 = Stomatološki glasnik Srbije
(Štampano izd.)
COBISS.SR-ID 8417026