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Contents / Sadržaj

Živimo u svetu gde su sahrane važnije
od pokojnika, gde su svadbe važnije od ljubavi,
gde je izgled važniji od pameti.
Mi živimo u kulturi ambalaže,
koja prezire sadržaj.
Eduardo Galeano

Ovaj urednički komentar pišem posle vanrednog stanja i posle mnogo vremena provedenog sa samim sobom tokom izolacije. Bez obzira na to što slobodnog vremena uvek nedostaje, prinudno slobodno vreme sigurno nikog nije usrećilo, jer se u takvoj realnosti teško može „uživati samujući". Nažalost, svi naši problemi vezani za društveni ambijent i našu stvarnost postali su ogoljeniji i još izraženiji.

Naš odgovor na virus bila je „paraliza života", a ne pokušaj da se život nastavi u novim uslovima koje je virus izazvao. Sumanuta želja za kontrolom svega trasirala je put u bezizlaz i neizvesnu sutrašnjicu, a život u uslovima „logike kasarne" je još jasnije razotkrio agoniju koja predugo traje.

Teror „nekompetentnih", koji nam oblikuju život, i dalje je svuda oko nas i jasnim bojama oslikava našu stvarnost i demotiviše svaku izvesnost.

Bezprizorni prostakluk, bezočne neistine, medijska hipnoza i primitivna patetika su najoštriji okvir naše realnosti. Sakrivanje istine, „šminkanje stvarnosti" i šikaniranje onih koji više veruju svojim očima nego medijskoj propagandi indukuju moralni i svekoliki sunovrat u svakom smislu. Izvitopereno vrednosno poimanje oslikavaju nedobronamerni, nekompetentni i nesposobni sa emocionalnim, intelektualnim i vrlo često zdravstvenim hendikepima.

Sve ovo ne zaobilazi ni nauku, ni kulturu, koje su postale bremenitije „intelektualnim lopovlucima" i neetičnim i amoralnim kodeksima. „Kaljuga nesposobnih" i u ovim oblastima postaje dominantna. Intelektualni i moralni principi pojedinaca na „važnim i odgovornim" funkcijama unižavaju kredibilitet institucija na čijem su čelu. Njihova poimanja sopstvenih vrednosti upravo su srazmerna poltronstvu i snishodljivosti prema nadređenima, odnosno bahatosti i osionosti prema podređenima. Unižavanje zarad „mrvica" koje „sluganski" odnos nudi je vrhunski domet njihovih sopstvenih vrednosti i kvaliteta. U takvoj pozorišnoj predstavi njihovo sopstveno „ja" je najveća vrednosna kategorija, bez obzira na to što nema uporišta ni u moralnim, ni etičkim, ni naučnim, ni profesionalnim, a ponajmanje u ljudskim vrednosnim okvirima.

Činjenica je da ljudi drugorazrednih sposobnosti realnost vide izvitopereno i nerealno. Oni su „besprekorni" jedino u produkciji mediokriteta koji „nedre" plagirane doktorate i bujice kupljenih diploma i doktorata.

Zato borba za istinu mora biti neprekidna nit i proces koji traje. Istina je kao voda koja uvek pronađe put i svojom čistotom „spere pandemiju neistina". Istina je najsvetiji zadatak slobodnih, čestitih i hrabrih. Istrajnost i neodustajanje od ovog cilja je jedini i najbolji lek za bolje sutra. Treba dobro analizirati „crnu kutiju" naših problema, uvideti uzroke i, naravno, u rešavanju izbeći stereotipe i ponavljanje grešaka.

Odlučnost i odgovornost, čestitost i kreativnost moralnih intelektualaca moraji biti iskorak iz „sumorne kaljuge" i „informativnog galimatijasa" aktuelnog trenutka.

Završiću citatom Robina Šarme i nasušnom potrebom da samo „delanje i hrabrost" svakog pojedinca može pronaći put iz bezizlaza trenutka koji živimo. „I najmanje delo bolje je od najplemenitije namere".

Prof. dr Slavoljub Živković

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Evaluation of bond strength of one step and two steps self-etch adhesive agents with two different pulp-capping materials

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SUMMARY

Primary purpose of restorative dentistry is to preserve pulp vitality. Besides calcium hydroxide, the application of calcium silicate cements as a material for direct pulp capping has become used recently.

The aim of our study was to investigate the influence of materials for direct and indirect pulp capping on the bond strength of composite restorations using two different self etch dentin adhesives.

The test was performed on 60 intact molars extracted for periodontal or orthodontic reasons. The prepared samples were divided into the two groups and three subgroups depending on the adhesive and pulp cupping material. Two different calcium silicate based materials were used for pulp cupping. One step and two steps self etch dentin adhesive was applied to prepared specimens depending on the group and with the help of a specially made metal mold set up a composite post. The share bond strength was assessed using a universal testing machine.

The results showed significant difference in the share bond strength between the samples treated with TheraCal LC and Biodentine with TheraCal LC being superior to Biodentine.

Keywords: TheraCal LC; Biodentine; share bond strength; dentin adhesives

INTRODUCTION

Calcium silicate based materials are bioactive materials capable of forming apatite using calcium silicate or calcium aluminates. These materials are also biointeractive and release ions needed to stimulate formation of a dentin bridge [1].

Biodentine is dentin substitute composed of powder of tricalcium silicate cement, zirconium oxide, calcium carbonate and liquid. Biodentine (BD) is a bioactive material, with mechanical properties similar to dentin and can be used as its replacement [2]. It has good mechanical properties, as well as excellent biocompatibility and bioactive behavior.

TheraCal LC is light-curing calcium silicate cement promoted by the manufacturer for direct pulp capping or as a liner under restorative materials. Studies show that TheraCal LC has calcium ions release properties in a concentration range that can stimulate activity of dental pulp and odontoblasts [3–7]. Bioavailability of calcium ions plays a key role in the proliferation caused by the material, differentiation of human dental pulp cells and new formation of mineralized hard tissues. Compared to other materials for direct and indirect pulp capping it has been proven that TheraCal LC releases higher concentration of calcium ions compared to Dycal, but has lower level of released ions than Biodentine [1]. In clinical practice, self-etch adhesives are currently widely used. They are based on the use of acidic functional monomers that can simultaneously demineralize and prime dentin. Self-etch adhesives eliminate the rinsing phase, significantly reducing clinical application time, technique sensitivity, and risk errors during application [8]. Self-etch adhesives can be classified into two- step self-etch adhesives that include the application of an additional layer of solvent-free hydrophobic resin creating stronger adhesive layers, and one step self-etch adhesives which contain hydrophilic monomers, water, and volatile solvents [9, 10]. Bond strength

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between dentin liners and composite depends on their physicochemical properties, nature of the bond between liner and RC, and the types of adhesive used.

The aim of our study was to investigate the influence of materials for direct and indirect pulp capping on the bond strength of composite restorations using two different self etch dentine adhesives.

MATERIAL AND METHOD

The study included 60 intact molars extracted for periodontal or orthodontic reasons. After removal of soft tissues, the teeth were stored in distilled water (ISO 3696 grade 3) at room temperature. The teeth were then molded in self-adhesive acrylate using 2.5 cm × 2.5 cm × 2.5 cm plastic molds and cut at the level of the occlusal surface with a high speed diamond disc with water cooling to obtain smooth dentinal surface. This way prepared samples were divided into the two groups (1 and 2), depending on the adhesive used (One Coat 7 Universal-Coltene and Clearfil SE Bond Kuraray Noritake).

Each group was further subdivided into the three subgroups of 10 teeth each, with A, B and E subgroups from the first group where adhesive One Coat 7 Universal was used and C, D, F subgroups from the second group where Clearfil SE Bond was used. The specimens from subgroups A, B, C and D received cavity preparation on the occlusal surface using high speed handpiece and diamond bur with water cooling in 6 mm diameter and 2 mm depth to provide liner retention. Biodentine (Septodont, Saint- Maur-des-Fosses, France) was applied in cavities from subgroups A and C while Theracal LC (Bisco Inc., Schaumburg, IL, USA) was applied in the subgroups B and D. The teeth from subgroups E and F, where adhesive were applied directly to dentin served as control samples.

Dentin adhesive was applied to prepared specimens using a metal mold made specifically for this purpose; we set up the composite post (3 mm diameter and 3 mm height). The materials used in our research are shown in Table 1.

Table 1. Materials used in this study
Tabela 1. Materijali korišćeni u studiji

Material **Materijal**	**Manufacturer** **Proizvođač**	**Composition** **Sastav**
Resin modified Calcium silikate cement Smolom modifikovani silikatni cement	Theracal LC (Bisco Inc., Schaumburg, IL, USA)	Polymerizable methacrylate monomers, Portland cement type III, polyethylene glycol dimethacrylate, and barium zirconate. Polimerizujući metakrilatni monomeri, Portland cement tip 3, politetilen glikol-dimetakrilat, barijum-cirkonat
Tricalcium silikate cement Trikalcijum silikatni cement	Biodentine (Septodont, Saint- Maur-des-Fosses, France)	Powder: tricalcium silicate, calcium carbonate, and zirconium oxide Liquid: water, calcium chloride (accelerator), and modified polycarboxylate Prah: trikalcijum-silikat, kalcijum-karbonat, cirkonijum-oksid Tečnost: voda, kalcijum-hlorid (akcelerator) i modifikovani polikarboksilat
Resin Composite Kompozitna smola	Brilliant EverGlow (Coltene)	Universal Submicron Hybrid Composite Univerzalni submikrohibridni kompozit
Universal Dental adhesive Univerzalni dentalni lepak	One Coat 7 Universal (Coltene)	(HEMA), hydroxypropylmethacrylate, methacrylate modified polyacrylic acid, urethanedimetha-crylate, glycerol dimethacrylate, amorph silicic acid, water (5%), initiators and stabi-lizers. (HEMA), hidroksipropilmetakrilat, metakrilatna modifikovana poliakrilna kiselina, uretanedimeta-krilat, glicerol-dimetakrilat, amorfna silicijumska kiselina, voda (5%), inicijatori i stabilizatori.
Universal Dental adhesive Univerzalni dentalni lepak	Clearfil SE Bond Kuraray Noritake	Primer: MDP, HEMA, dimethacrylate monomer, water, catalyst Bond: MDP, HEMA, dimethacrylate monomer, microfiller, catalyst Prajmer: MDP, HEMA, dimetakrilatni monomer, voda, katalizator Veza: MDP, HEMA, dimetakrilatni monomer, mikropunilo, katalizator

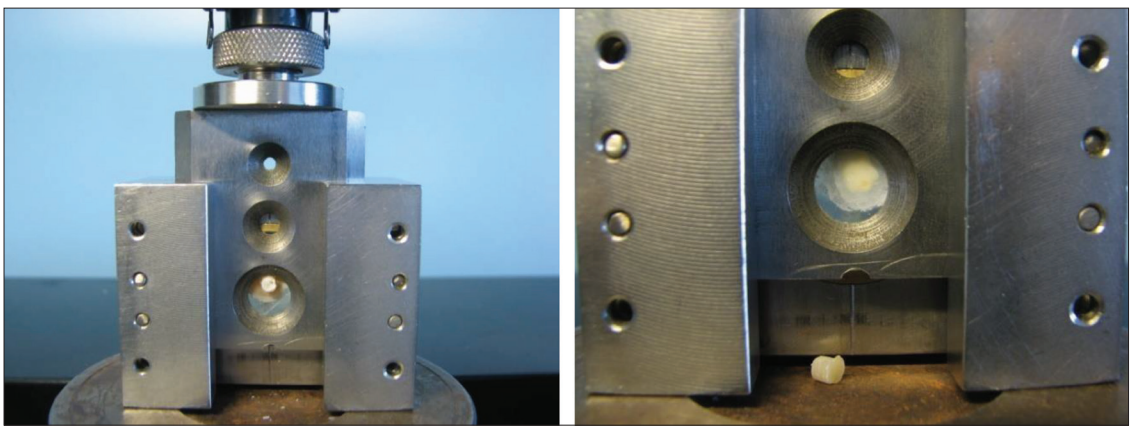

Figure 1. Instron 4301 Universal Testing machine
Slika 1. Univerzalna mašina za testiranje – Instron 43

Measurement of bond strength

The specimens were then mounted on a universal Instron 4301 bond strength-testing machine. A force of 1 mm/min was applied to each specimen by applying a notched edge blade with curved edge up to breaking of the bond between the composite and TLC/BD (Figure 1). Share bond strength values were measured in Newtons (N) and then converted to Mega pascals (MPa).

Fracture type analysis was performed using a stereomicroscope with magnification ×25, and fracture was classified as cohesive (fracture in the material itself), adhesive (fracture of the interface between the composite and the liner) and mixed (when both types of fracture are present at the same time).

RESULTS

Descriptive analysis of the results obtained for the first and second groups is shown in Tables 2 and 3. Analysis between groups A and B indicated that, for $p<0.05$, there was a significant difference between the two groups in relation to the average values of bond strength (Mann-Whitney U Test: Z=-2.8111; p=0.0049) in favor of a significantly greater bond strength in group B. Further analysis between groups A/E and B/E indicated that, for $p<0.05$, there was significant difference between the two groups in relation to the average values of bond strength (Mann- Whitney U Test: Z=-2.8419; p=0.0045/Z=-2.1923; p=0.0283) in favor of significantly greater bond strength in Group E.

Analysis between groups C and D indicated that, for $p<0.05$, there was a significant difference between the two groups in relation to the average values of the bond strength (Mann-Whitney U Test: Z=-2.3638; p=0.0181) in favor of a significantly greater bond strength in group D. Additional analysis between the C/F and D/S groups indicated that, for $p<0.05$, there was a significant difference between the groups with respect to the average values of the bond strength (Mann-Whitney U Test: Z=-2.6796; p=0.0074/Z=-1.7052; p=0.0882) in favor of a significantly greater bond strength in group F.

Analysis of the average bond strength between the A/C and B/D groups indicated that for $p>0.05$, there was no significant difference between the two groups with respect to the average bond strength values (Mann-Whitney U Test: Z=-0.8305; p=0.4062 and Z=0.0112; p=1.0000).

The observed modes of failure in the BD group were predominantly cohesive, whereas the TheraCal LC group had a mixed fracture besides the cohesive one.

DISCUSSION

Primary purpose of restorative dentistry is to preserve pulp vitality [11]. Calcium hydroxide has been the gold standard for a long time in direct pulp capping [12]. In addition to this material, the application of calcium silicate cements as a material for direct pulp capping has become more present recently. Calcium silicate based materials are bioactive materials capable of forming apatite using calcium silicate or calcium aluminates. These materials are also bio interactive and release ions needed to stimulate dentin bridge formation [13]. Biodentine is a bioactive material, with mechanical properties similar to dentin and can be used as its replacement to cause dentin bridge formation. It has good mechanical properties, as well as excellent biocompatibility and bioactive behavior. In ad-

Table 2. Descriptive analysis of the share bond strength in groups A, B, and E (One Coat 7 Universal-Coltene)
Tabela 2. Opisna analiza jačine adhezivne veze u grupama A, B i E (jednoslojni lepak 7 Universal Coltene)

Groups Grupe	Mean Srednja vrednost	N Broj	Std. Deviation St. devijacija	Min.	Max.	Percentiles Procenat		
						25th 25.	50th 50. Median Medijana	75th 75.
A (Biodentine)	11.24	7	3.06	6.86	16.58	9.70	10.80	13.40
B TheraCal LC	19.28	7	3.97	13.40	23.90	15.12	19.27	23.20
E	25.29	5	4.26	19.00	31.00	25.00	25.53	25.90

Table 3. Descriptive analysis of the share bond strength in groups C, D, and F (Clearfil SE Bond)
Tabela 3. Opisna analiza jačine adhezivne veze u grupama C, D i F (Clearfil SE Bond)

Groups Grupe	Mean Srednja vrednost	N Broj	Std. Deviation St. devijacija	Min.	Max.	Percentiles Procenat		
						25th 25.	50th 50. Median Medijana	75th 75.
C (Biodentine)	12.17	7	3.20	7.62	17.38	10.06	11.30	14.37
D TheraCal LC	19.24	7	4.46	13.40	25.26	13.53	19.70	22.70
F	23.88	5	5.15	15.70	28.28	22.00	26.40	27.02

dition, initial setting time of BD is about 12 minutes and it does not cause tooth changes [2, 14, 15].

A major drawback of Biodentine is its water-based chemistry that affects the bond with both dentin and composite, since the bond is mainly micromechanical. To overcome this limitation, tri calcuim silicate (TheraCal LC), modified with resin, was introduced as a material for direct pulp capping. Light-curable resin-modified products have the advantages of precise placement, command set, superior physical strength, less solubility, and reduced heavy metal release. These products with hydrophilic polymer matrix allowed the high release of calcium and hydroxide ions. They are promising materials for dental treatment of direct pulp capping [16].

TheraCal LC is a light-cured polymerizing hydraulic silicate material that sets by hydration. Bonding begins with the contact of material and water. Unlike Biodentine, TheraCal LC does not include water to hydrate the material, and the bonding process depends on the water captured by the environment and its diffusion into the material [17].

Bond strength between restorative materials and materials for direct and indirect pulp capping is also important for the success of restorations. It depends on their physicochemical characteristics, nature of the bond between the liner and the composite material and the type of adhesive system.

Presence of the resin component in TheraCal LC facilitates the placement of the final restoration in the same session. Various research have been done on the impact of these materials on bond strength. Deepa et al. compared and evaluated share bond strength of the composite with three different liners: TheraCal LC, Biodentine, and Fuji II LC after applying universal adhesive (Single Bond Universal). They found that bond strength of the composite with TheraCal LC and Fuji II LC was similar and significantly higher than that with Biodentine after application of universal adhesive [18]. Meraji and Camilleri's researches also show higher bond strengths of TheraCal LC than Biodentine, whether on composite material or Glass Ionomer Cements. The same authors concluded that bond strength between TheraCal LC and composite when applying total-etch adhesives was significantly better than bond strength when applying self-etch dentin adhesives [19].

The results of our study also showed that there was a significant difference in the share bond strength between the samples treated with TheraCal LC and Biodentine in the two tested dentin adhesives in favor of significantly greater bond strength in the TheraCal LC group. This may be due to the fact that the TheraCal LC exhibits early cohesive force upon photo-activation. In contrast, Biodentine shows low hardness of the material itself, at an early stage of application [20].

After initial setting, Biodentine is still a porous material that needs at least 2 weeks for complete polymerization of the hydrated calcium silicate gel and to form a solid mesh that will attain strength sufficient to withstand the stresses of polymerization [15, 18]. In our study, we applied the adhesive and composite material in the same session shortly after the initial setting of BD. This may be the reason for the low bond strength, as well as the cohesive type of material fracture.

The effectiveness of bonding of current commercial dentin adhesives is variable. Karadas et al. investigated bond strength of different dentin adhesives with TheraCal LC. They reported that etch and rinse adhesives provided better bond strength restoration than self-etch adhesives [21]. The study also showed that two-step self-etch adhesives had higher bond strength values than one-step self-etch adhesives, with the exception of Clearfil S3, probably due to the fact that it contains 10-Methacryloyloxydecyl dihydrogen phosphate (MDP), which is known to bond chemically to the tooth calcium [21, 22]. In contrast, our study showed that there was no significant difference in the bond strength between one-step and two-step self-etch adhesives in the two examined liners. The application of one-step dentin adhesives provides optimal bonding efficiency with a simplified application protocol.

It has been proven that in order to resist the material's contraction forces and provide good enamel and dentin retention, bond strength of the composite material should be minimum 17-20 MPa [23]. This bond strength was achieved in both tested dentin adhesives only in the samples where we used TheraCal LC as the liner. Cantekin showed in his research that light-cured MTA showed clinically acceptable and higher shear bond scores compared to MTA when used with Methacrylate-based composite, as composite material used in our research. According to the same authors, Methacrylate-based composites achieved greater bond strength than silorane-based composites and GI Cement [24].

Despite the high bond strength values of the TheraCal LC samples, the results of our study showed that this bond strength was significantly lower than that of the control group in the two tested dentin adhesives, indicating that despite the presence of the resin component, TheraCal LC as well as Biodentine have an effect on the bond strength of the composite material with dentin.

CONCLUSION

TLC has achieved bond strength sufficient to resist material's contraction forces and provide good enamel and dentin retention at an early stage after application. However, the application of TheraCal LC has an impact on the bond strength of the composite material to the dentin.

BD showed significantly lower bond strength in the early stage after the initial bonding of the material, as well as cohesive fracture confirming the fact that, prior to placement of definitive restoration, this material should be allowed to mature long enough to achieve the required hardness to withstand the forces of the contraction of the restorative material and to provide good retention. The type of dentin adhesive (one-step and two-step self-etch adhesives) had no effect on the bond strength of the two examined liners.

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Procena čvrstoće veze jednokomponentnih i dvokomponentnih adhezivnih sredstava sa dva različita materijala za direktno prekrivanje pulpe

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KRATAK SADRŽAJ

Primarna svrha restorativne stomatologije je očuvanje vitalnosti pulpe. Pored kalcijumovog hidroksida, primena kalcijum-silikatnih cementa kao materijala za direktno zatvaranje pulpe u poslednje vreme je sve prisutnija.

Cilj naše studije bio je istražiti uticaj materijala za direktno i indirektno zatvaranje pulpe na čvrstoću vezivanja kompozitnih restauracija korišćenjem dva različita samonagrizajuća dentinska lepka.

Ispitivanje je izvršeno na 60 intaktnih kutnjaka izvađenih iz parodontskih ili ortodontskih razloga. Pripremljeni uzorci su podeljeni u dve grupe i tri podgrupe, u zavisnosti od lepka i materijala za prekrivanje pulpe.

Dva materijala na bazi kalcijumovog silikata korišćena su kao materijali za prekrivanje pulpe.

Jednokomponentni i dvokomponentni dentinski lepkovi naneseni su na pripremljene uzorke u zavisnosti od grupe, a uz pomoć posebno izrađenog metalnog kalupa postavljen je kompozitni post. Jačina veze je procenjena korišćenjem univerzalne mašine za testiranje.

Rezultati su pokazali da postoji značajna razlika u jačini veze između uzoraka tretiranih sa TheraCal LC i biodentinom u dva testirana dentinska lepka u korist značajno veće čvrstoće vezivanja kod TheraCal LC grupe.

Ključne reči: TheraCal LC; biodentin; jačina veze; dentinski lepak

UVOD

Materijali na bazi kalcijum-silikata su bioaktivni materijali koji mogu formirati apatit koristeći kalcijum-silikat ili kalcijum-aluminat. Ovi materijali su takođe biointeraktivni i oslobađaju jone potrebne za podsticanje formiranja dentinskog mosta [1].

Biodentin (BD) jeste zamena za dentin koji se sastoji od praška trikalcijum-silikatnog cementa, cirkonijum-oksida i kalcijum-karbonata i tečnosti. BD je bioaktivni materijal, mehaničkih svojstava sličnih dentinu i može se koristiti kao njegova zamena [2]. Ima dobra mehanička svojstva, kao i odličnu biokompatibilnost i bioaktivno ponašanje.

TheraCal LC (TLC) svetlosno je vezujući kalcijum-silikatni cement koji promoviše proizvođač za direktno zatvaranje pulpe ili kao oblogu ispod restorativnih materijala. Studije pokazuju da TheraCal LC ima svojstva oslobađanja jona kalcijuma u rasponu koncentracija koje mogu podstaći aktivnost zubne pulpe i odontoblasta [3–7]. Bioraspoloživost kalcijumovih jona igra ključnu ulogu u proliferaciji koju prouzrokuje materijal i diferencijaciji ćelija zubne pulpe kod ljudi i novom stvaranju mineralizovanog tvrdog tkiva. U poređenju sa drugim materijalima za direktno i indirektno zatvaranje pulpe, dokazano je da TheraCal LC oslobađa veću koncentraciju kalcijumovih jona u poređenju s Dicalom, ali ima niži nivo oslobođenih jona od BD [1]. U kliničkoj praksi trenutno se široko koriste samonagrizajući lepkovi. Zasnivaju se na upotrebi kiselih funkcionalnih monomera, koji mogu istovremeno demineralizovati i pripremiti dentin. Samonagrizajući dentinski lepkovi uklanjaju fazu ispiranja, značajno smanjujući vreme kliničke primene, osetljivost tehnike i greške rizika tokom nanošenja [8]. Lepkovi za samonagrizanje mogu se klasifikovati u dvokomponentne samonagrizajuće lepkove, koji uključuju nanošenje dodatnog sloja hidrofobne smole bez rastvarača koji stvaraju jače lepljive slojeve, i jednokomponentne lepkove, koji sadrže hidrofilne monomere, vodu i isparljive rastvarače [9, 10].

Čvrstoća veze između dentinskih slojeva i kompozita zavisi od njihovih fizičko-hemijskih svojstava, prirode veze između lajnera i kompozita i vrste korišćenog lepka.

Cilj naše studije bio je istražiti uticaj materijala za direktno i indirektno prekrivanje pulpe na čvrstoću vezivanja kompozitnih restauracija korišćenjem dva različita samonagrizajuća dentinska lepka.

MATERIJAL I METODA

Ispitivanje smo obavili pomoću 60 netaknutih kutnjaka izvađenih iz parodontskih ili ortodontskih razloga. Posle uklanjanja mekih tkiva zubi su čuvani u destilovanoj vodi (ISO 3696, kvalitet 3) na sobnoj temperaturi. Zubi su ukalupljeni u samovezujući akrilat pomoću plastičnih kalupa veličine 2,5 cm × 2,5 cm × 2,5 cm i isečeni na nivou okluzalne površine dijamantskim diskom velike brzine vodenim hlađenjem da bi se dobila glatka dentinalna površina. Uzorci pripremljeni na ovaj način su podeljeni u dve grupe (1 i 2), zavisno od lepka koji smo koristili (One Coat 7 Universal-Coltene i Clearfil SE Bond Kuraray Noritake).

Svaka grupa je dalje podeljena u tri podgrupe od po 10 zuba, A, B i E podgrupe iz prve grupe, gde smo kao lepak koristili One Coat 7 Universal-Coltene, i C, D, F podgrupe iz druge grupe, gde smo koristili Clearfil SE Bond. Na uzorcima podgrupa A, B, C i D na okluzalnoj površini sa turbinom i dijamantnom opeklinom

vodenim hlađenjem pripremljene su šupljine prečnika 6 mm i dubine 2 mm da bi se obezbedilo zadržavanje obloge. Za uzorke podgrupa A i C kao podlogu smo primenili BD (Septodont, Saint-Maur-des-Fosses, France), a za podgrupe B i D Theracal LC (Bisco Inc., Schaumburg, IL, USA). Zubi iz podgrupa E i F, gde smo lepak nanosili direktno na dentin, služili su kao kontrolni uzorci.

Dentinski lepak nanesen je na prethodno pripremljene uzorke i pomoću metalnog kalupa napravljenog posebno za ovu svrhu postavili smo kompozitni stub (promera 3 mm i visine 3 mm). Materijali korišćeni u našem istraživanju prikazani su u Tabeli 1.

Merenje čvrstoće veze

Uzorci su zatim montirani na univerzalnu mašinu za ispitivanje jačine veze Instron 4301. Snaga od 1 mm / min. primenjena je na svaki uzorak do prekida veze između kompozita i TLC / BD (Slika 1). Vrednosti čvrstoće veze su izmerene u njutnima (N) i zatim su pretvorene u megapaskale (MPa).

Analiza tipa preloma izvedena je stereomikroskopom sa uvećanjem H25, a fraktura je klasifikovana kao kohezivna (lom u samom materijalu), adhezivna (lom interfejsa između kompozita i košuljice) i mešana (kada postoje obe vrste preloma istovremeno).

REZULTATI

Analiza rezultata dobijenih za prvu i drugu grupu prikazana je u tabelama 2 i 3.

Analiza između grupa A i B pokazala je da postoji značajna razlika između dve grupe u odnosu na prosečne vrednosti čvrstoće veze, $p < 0,05$ (Man-Vitnijev U test: $Z = -2,8111$; $p = 0,0049$) u korist značajno veće čvrstoće veze u grupi B. Dalja analiza između grupa A / E i B / E pokazala je da postoji značajna razlika između dve grupe u odnosu na prosečne vrednosti čvrstoće veze, $p < 0,05$ (Man-Vitnijev U test: $Z = -2,8419$; $p = 0,0045$ / $Z = -2,1923$; $p = 0,0283$) u korist značajno veće čvrstoće veze u grupi E.

Analiza između grupa C i D pokazala je da je za $p < 0,05$ postojala značajna razlika između dve grupe u odnosu na prosečne vrednosti čvrstoće veze (Man-Vitnijev U test: $Z = -2,3638$; $p = 0,0181$) u korist značajno veće čvrstoće veze u grupi D. Dodatna analiza između grupa C / F i D / S je pokazala da je za $p < 0,05$ postojala značajna razlika između grupa u odnosu na prosečne vrednosti čvrstoće veze (Man-Vitnijev U test: $Z = -2,6796$; $p = 0,0074$ / $Z = -1,7052$; $p = 0,0882$) u korist značajno veće čvrstoće veze u grupi F.

Analiza prosečne vrednosti čvrstoće veze između grupa A / C i B / D pokazala je da nije bilo značajne razlike između dve grupe u odnosu na prosečne vrednosti čvrstoće veze, $p > 0,05$ (Man-Vitnijev U test: $Z = -0,8305$; $p = 0,4062$ i $Z = 0,0112$; $p = 1,0000$).

Kod grupe BD zapažen je pretežno kohezivni tip preloma, dok je kod Theracal LC grupe bio prisutan i kohezivni i mešoviti prelom.

DISKUSIJA

Primarna svrha restorativne stomatologije je očuvanje vitalnosti pulpe [11]. Kalcijum-hidroksid je već duže vreme zlatni standard kod direktnog pokrivanja pulpe [12]. Pored ovog materijala, primena kalcijum-silikatnih cementa kod direktnog pokrivanja pulpe u poslednje vreme je sve prisutnija. Materijali na bazi kalcijum-silikata su bioaktivni materijali koji mogu formirati apatit koristeći kalcijum-silikate ili kalcijum-aluminate. Ovi materijali su takođe biointeraktivni i oslobađaju jone potrebne za podsticanje formiranja dentinskih mostova [13]. BD je bioaktivni materijal, mehaničkih svojstava sličnih dentinu i može se koristiti kao njegova zamena koja stimuliše stvaranje dentinskih mostova. Ima dobra mehanička svojstva, kao i odličnu biokompatibilnost i bioaktivno ponašanje. Pored toga, početno vreme vezivanja BD je oko 12 minuta i ne izaziva promene zuba [2, 14, 15].

Glavni nedostatak BD je njegova hemija na bazi vode, koja utiče na vezu i sa dentinom i sa kompozitom, pošto je veza uglavnom mikromehanička.

Da bi se prevazišlo ovo ograničenje, uveden je trikalcium-silikat (Theracal LC), modifikovan smolom, kao materijal za direktno zatvaranje kaše.

Proizvodi modifikovani smolom imaju prednosti preciznog postavljanja, brzog vezivanja, vrhunske fizičke snage, manje rastvorljivosti i smanjenog oslobađanja teških metala. Ovi proizvodi sa hidrofilnom polimernom matricom omogućavaju visoko oslobađanje kalcijuma i hidroksidnih jona. Oni su perspektivni materijali za direktno prekrivanje pulpe [16].

Theracal LC je svetlosno polimerizacioni hidraulični silikatni materijal koji se veže hidratacijom. Vezivanje započinje dodirom materijala i vode. Za razliku od BD, Theracal LC ne uključuje vodu za hidrataciju materijala, a proces vezivanja zavisi od vode koju zarobi iz okoline i njene difuzije u materijal [17].

Snaga veze između restorativnih materijala i materijala za direktno i indirektno zatvaranje pulpe takođe je važna za uspeh restauracija. To zavisi od njihovih fizičko-hemijskih karakteristika, prirode veze između lajnera i kompozitnog materijala i vrste adhezivnog sistema.

Prisutnost komponente smole u Theracal LC olakšava postavljanje konačne restauracije u istu sesiju. Učinjeno je mnogo istraživanja o uticaju ovih materijala na čvrstoću veze.

Deepa i saradnici uporedili su i procenili čvrstoću veze kompozita s tri različita lajnera: Theracal LC, BD i Fuji II LC pri nanošenju univerzalnog lepka (Single Bond Universal). Otkrili su da je čvrstoća vezivanja kompozita sa Theracal LC i Fuji II LC slična i značajno veća od one sa BD posle nanošenja univerzalnog lepka [18].

Meraji i Camilleri u svojim istraživanjima takođe pokazuju veću čvrstoću vezivanja Theracal LC u odnosu na BD, bilo da se radi o kompozitnom materijalu ili staklenom jonomernom cementu. Isti autori su zaključili da je čvrstoća veze između Theracal LC i kompozita pri nanošenju dentinskog lepka sa kiselinskim nagrizanjem značajno bolja od čvrstoće veze kod nanošenja samonagrizajućih dentinskih lepkova [19].

Rezultati naše studije takođe su pokazali da postoji značajna razlika u jačini veze između uzoraka tretiranih sa Theracal LC i BD kod dva ispitivana dentinska lepka u korist značajno veće čvrstoće vezivanja u Theracal LC grupi. To može biti posledica činjenice da Theracal LC pokazuje ranu kohezivnu silu tokom fotoaktivacije. Suprotno tome, BD pokazuje nisku tvrdoću samog materijala u ranim fazama posle nanošenja [20].

Posle početnog vezivanja, BD je i dalje porozan material, kome treba najmanje dve nedelje za potpunu polimerizaciju hidriranog kalcijum-silikatnog gela i za formiranje čvrste mreže koja će dobiti snagu dovoljnu da izdrži napore polimerizacije [15, 18].

U našoj studiji lepak i kompozitni materijal smo naneli u istoj sesiji nedugo posle početnog postavljanja BD. To može biti razlog slabe čvrstoće vezivanja, kao i kohezivni tip loma materijala.

Efikasnost adhezije trenutnih komercijalnih dentinskih lepkova je promenljiva. Karadas i saradnici ispitivali su čvrstoću adhezije različitih dentinskih lepkova sa Theracal LC. Izveštavali su da su lepkovi za nagrizanje i ispiranje omogućili bolje obnavljanje čvrstoće vezivanja od samoljepljivih lepkova [21]. Studija je takođe pokazala da dvokomponentni samonagrizajući dentinski lepkovi imaju veće vrednosti čvrstoće vezivanja u odnosu na jednokomponentne samonagrizajuće lepkove, sa izuzetkom Clearfil S3, verovatno zbog činjenice da sadrže 10-metakriloloksidecil dihidrogen-fosfat, za koji se zna da se hemijski veže sa kalcijumom zuba [21, 22]. Suprotno tome, naša studija je pokazala da nije bilo značajne razlike u jačini veze između jednokomponentnih i dvokomponentnih samonagrizajućih dentinskih lepkova kod dva ispitivana lajnera. Primena jednokomponentnih samonagrizajućih dentinskih lepkova pruža optimalnu efikasnost adhezije uz pojednostavljeni protokol primene.

Da bi se suprotstavio silama kontrakcije materijala i obezbedio dobru retenciju za cakline i dentine, dokazano je da čvrstoća vezivanja kompozitnog materijala treba da bude najmanje 17–20 MPa [23]. Ova čvrstoća vezivanja postignuta je u oba testirana dentinska lepka samo u uzorcima gde smo koristili Theracal LC kao podlogu. Cantekin K. je u svom istraživanju pokazao da svetlosno polimerizaciona MTA pokazuje klinički prihvatljive i veće rezultate jačine veza u poređenju sa MTA kada se koristi u kombinaciji sa kompozitom na bazi metakrilata, kao što je to kompozitni materijal korišćen u našem istraživanju. Prema istim autorima, kompoziti na bazi metakrilata postižu veću čvrstoću veze od kompozita na bazi silorana i glas-jonomernog cementa [24].

Uprkos visokim vrednostima čvrstoće vezivanja za Theracal LC uzorke, rezultati našeg istraživanja pokazali su da je ta čvrstoća veze bila značajno niža od snage kontrolne grupe kod dva testirana lepka za dentin, što ukazuje da uprkos prisustvu komponente smole, TheraCal LC kao i BD utiču na čvrstoću vezivanja kompozitnog materijala sa dentinom.

ZAKLJUČAK

Theracal LC je postigao čvrstoću vezivanja dovoljnu da se odupire silama kontrakcije materijala i obezbedi dobru retenciju u ranoj fazi posle nanošenja.

Međutim, primena Theracal LC ima uticaj na čvrstoću vezivanja kompozitnog materijala na dentin.

BD je pokazao značajno nižu čvrstoću vezivanja u ranoj fazi posle inicijalnog vezivanja materijala, kao i kohezivni, koji je potvrdio činjenicu da pre postavljanja konačne restauracije BD treba ostaviti dovoljno dugo da bi se postigla potrebna tvrdoća i otpornost silama kontrakcije kod postavljanja restaurativnog materijala i obezbedila dobra retencija restauracije.

Tip dentinskog lepka (jednokomponentni i dvokomponentni samonagrizajući dentinski lepak) nije imao uticaja na čvrstoću veze dvaju ispitivanih lajnera.

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Edentulism in the elderly in Montenegro

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SUMMARY
Introduction For the first time in Montenegro, a survey was conducted to examine the oral health status of the elderly.
Materials and methods The study included 170 subjects of both genders, average age 72.32 ± 6.85 years. The research methodology was in line with the WHO methodological guidelines for epidemiological studies of national oral pathology. For statistical analysis of data IBM STATISTICS 20 was used. Descriptive and inferential statistical methods, Tamhane T2 post hoc tests, χ^2 test were applied. The homogeneity of the dispersions was checked by the Leven test. The significance level was set to 0.05.
Results The DMFT value was 29.417 ± 3.81 (MT: 26.25 ± 6.95; FT: 2.68 ± 3.98; DT: 0.63 ± 1.56) and it was significantly higher in women, smokers and people who did not visit the dentist regularly. The percentage of edentulous persons was 46.47%. The index of dental rehabilitation - IRD was 73.86%. The average age of dentures was 11 years.
Conclusion The state of oral health of the elderly in Montenegro is not at satisfactory level, which is reflected in the high percentage of edentulous people and unfavorable structure of DMFT.
Keywords: edentulous; elderly; dental rehabilitaton; Montenegro

INTRODUCTION

Improving oral health is a basic prerequisite for improving general health [1]. This is especially important for the elderly whose general health is impaired and burdened by chronic diseases. Research in the region [2], Europe [3, 4, 5] and other continents [6–9] has influenced the launch of research on the oral health status of the elderly in Montenegro. Studies of the impact of oral health on the quality of life have been conducted worldwide for more than five decades and a high degree of interdependence between quality of life and oral health has been proven [10–14]. These findings have been implemented in a new definition of oral health [15, 16]. About 30% of Europeans, aged between 65 and 74, no longer have their natural teeth [17]. There is a recommendation for the implementation of oral health in general health prevention programs, which should result in people up to the age of 65 preserving at least 20 natural teeth [18]. Numerous authors have investigated the influence of oral health habits, socio-economic status and other characteristics on the occurrence of oral diseases and consequent edentulousness [5, 6, 7, 17–23]. Demographic data indicate a decades-long trend of population aging [24]. In order to prepare the health system for the increased number of elderly patients in the future, it is necessary to collect data on the state of oral health.

The aim of the research was to examine the state of oral health of the elderly in the central region of Montenegro.

MATERIAL AND METHOD

Prior to the implementation of the research, obligatory measures were taken, such as obtaining approval from the Ethics Committee of the Medical Faculty of the University of Montenegro in Podgorica. A research plan was made, respondents were informed and their consent to participate in the research was obtained.

All clinical examinations were performed by one dentist (a specialist in dental prosthetics, who was trained to analyze oral health data using relevant indices) according to the principles of good clinical practice. Kappa statistics were used to test the reliability of the researcher. The Kappa value estimated after retesting for intra-consistency of the investigator was 0.94.

Sample research

The study included 170 people with an average age of 72.32 ± 6.85. The method of including respondents in the research was based on the following characteristics:

1. Persons aged 65 and over who applied for an examination at the Faculty of Medicine in Podgorica - Study program of dentistry on certain days (Mondays and Wednesdays) in the period from September to December 2016 were included.

2. All users of the services of homes for the elderly "Nana" and "Ljubav spaja" in Spuž and Danilovgrad were included, whose state of general and mental health allowed them to be examined.

All respondents voluntarily agreed to participate in the research after they were explained the purpose of the research, the method of distribution of the obtained data and the anonymity of participation.

The sample was 5% according to the number of inhabitants aged 65 and over in the central part of Montenegro and it was statistically allocated so that the expected coefficient of variation falls between 8 and 11%.

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The first research instrument used was a clinical examination of oral health, according to the WHO methodology, using the methodological guidelines for epidemiological studies of national oral pathology [25].

Data related to the number of carious, extracted and filled teeth, data on present dental restorations (fixed and mobile) and the age of dental restorations were analyzed.

The state of oral health was assessed on the basis of relevant indices, showing the following:

1. Caries status was registered using Klein Palmer's DMF system (D – Decaued, M – Missing, F – Filled) [26]. Caries was diagnosed by inspection with the help of a dental probe and a flat dental mirror, in daylight. Dental caries (K) was characterized by lesions with a clearly formed cavity on the tooth surface. Changes in transparency and initial demineralization of enamel with an intact surface that did not lead to disruption of dental tissue continuity were not registered. The term filling (P) included all permanent and temporary fillings of teeth. Extracted (E) teeth were all extractions caused by caries or periodontal disease. This indicator was presented in total for all respondents, in relation to certain characteristics of the respondents.

2. DMFT index – average caries index (DT – average number of carious teeth, MT – average number of extracted teeth, FT – average number of filled teeth).

3. IRZ index – The dental rehabilitation index was used to express (in percentage) how many lost teeth were replaced by making dental prosthetic restorations (fixed and mobile). It was calculated: number of restored teeth / number of extracted teeth + number of restored teeth x 100.

4. The presence of dental prosthetic restorations (fixed and mobile) and their age were recorded.

The second research instrument was a closed-ended questionnaire with 4 questions:

Q1 – When was the last time you went to the dentist?

Q2 – What are the reasons for your last visit to the dentist?

Q3 – Are you a user of tobacco products?

Q4 – What do you recognize as the main reason for the loss of your teeth?

During the examination, the respondents were given advice on how to properly maintain oral tissue, teeth and dental restorations. Dental restorations were reviewed and advice was given on how to maintain them.

In statistical processing, the collected data were processed using the statistical program IBM STATISTICS 20. Methods of descriptive and inferential statistics were used. Of the descriptive methods, the arithmetic mean and standard deviation were used. As part of inferential statistics, the t test for two independent samples, the χ^2 test, the Tamhane T2 percent hoc test, and the ANOVA were used. The homogeneity of the dispersions was checked by the Leven test. The significance level was set to 0.05.

RESULTS

Sample structure

A total of 170 people were examined. The structure of respondents by gender showed that there were 89 (52.35%) females and 81 (47.64%) males. The average age of the subjects was 72.32 ± 6.85. Of which 104 (61.17%) were respondents aged 65–74, 53 (31.17%) aged 75–84 and 13 (7.6%) aged 85 and older. According to the place of residence in the cities of the central region of Montenegro: there were 114 (67.05%) from Podgorica, 20 (11.76%) from Danilovgrad, 22 (12.94%) from Nikšić, and 14 from Cetinje (8.23%). The structure of respondents by level of education showed that most respondents had secondary education – 64 (37.64%), 39 (22.94%) had an academic education, 27 (15.88%) had a college degree, 32 (18.82) %) were with primary education while 8 (4.70%) were without education.

Analysis of the oral health status of the respondents

Out of 170 examined persons, 79 (46.47%) were edentulous. DMFT was 29.417 ± 3.81 (min 15; max 32). The structure of DMFT showed that the subjects had an average of 26.25 ± 6.95 extracted teeth – MT, 2.68 ± 3.98 filled teeth – FT, while the number of carious teeth per subject was on average 0.63 ± 1.56 (damaged teeth DT). Subjects had an average of 2.39 ± 3.66 healthy teeth and 7.14 ± 9.19 prosthetically unrehabilitated teeth.

The presence of remaining natural teeth expressed according to the segments of dentition (which was important for the planning of prosthetic therapy) showed that the subjects had on average a higher number of teeth in lower dental arch (1.14) compared to the upper dental arch (0.73). In the anterior segments of dental arches, the number of preserved natural teeth was higher than in the posteror. In the lower anterior segments, the average number of natural teeth was the largest and it was 2.22, while in the upper anterior segment it was 1.29. The presence of the first permanent molars was on average 0.41 per subject (25.88% of persons had between 1 and 3 first permanent molars).

DMFT analysis according to the characteristics of the respondents

The study showed that females had statistically higher value of DMFT compared to males ($t = -2.593$; $p = 0.011$) (Table 1).

Persons who were users of tobacco products had significantly higher value of DMFT compared to persons who did not use tobacco products ($t = 2.279$; $p = 0.024$) (Table 1).

The data showed statistically significant difference in the value of DMFT according to the time elapsed since the last visit to the dentist. People who have visited dentist in the last 12 months had significantly lower DMFT value compared to subjects who have not seen dentist longer (between 1 and 5 years; more than 5 years) (ANOVA; $F = 4.805$; $p = 0.009$). Leven's test indicated heterogeneity of dispersions ($p < 0.001$) (Tamhane test, $p = 0.009$) (Table 2).

There was no statistically significant difference in the values of DMFT in the subjects in relation to age ($t = -1.147$; $p = 0.253$).

Table 1. Existence of a statistical difference in the value of DMFT according to the sex of respondents and according to the use of tobacco products
Tabela 1. Postojanje statističke razlike u vrednosti KEP-a prema polu ispitanika i prema korišćenju duvanskih proizvoda

Respondent characteristics Karakteristike ispitanika	n	Value DMFT Vrednost KEP-a	Statistical difference of average values Statistička značajnost srednjih vrednosti	Statistic test and significance Statistički test i značajnost
Gender of respondents Pol ispitanika				
Male Muški	81	28.21 ± 4.42	0.1683 ± 0.03	χ^2 test
Female Ženski	89	30.16 ± 3.14	0.1774 ± 0.02	t = -2.593; p = 0.011*
Use of tobacco products Upotreba duvanskih proizvoda				
Yes Da	54	29.33 ± 3.76	0.1784 ± 0.02	χ^2 test
No Ne	116	28.80 ± 4.24	0.1708 ± 0.03	T = 2.279; p = 0.024*

Explanation of labels in the table: *existence of statistically significant difference
Objašnjenje oznaka u tabeli: *postojanje statistički značajne razlike

Table 2. Existence of a statistical difference in the value of DMFT according to the time elapsed since the last visit to the dentist
Tabela 2. KEP prema vremenu proteklom od poslednje posete stomatologu

Time since last dental visit (I) Vreme proteklo od poslednje posete stomatologu (I)	n	Value DMFT Vrednost KEP-a	Time since last dental visit (J) Vreme proteklo od poslednje posete stomatologu (J)	Statistical difference of average values (I i J) Statistička razlika prosečnih vrednosti (I i J)	p
up to 12 months do 12 meseci	45	28.17 ± 4.45	from 1 to 5 years od 1 do 5 godina	-.00659	0.459
			5 years and more 5 godina i više	-.01376*	0.009
from 1 to 5 years od 1 do 5 godina	67	29.10 ± 3.73	up to 12 months do 12 meseci	.00659	0.459
			5 years and more 5 godina i više	-.00717	0.145
5 years and more 5 godina i više	58	30.56 ± 2.70	up to 12 months do 12 meseci	.01376*	0.009
			from 1 to 5 years od 1 do 5 godina	.00717	0.145

Explanation of labels in the table: *existence of statistically significant difference
Objašnjenje oznaka u tabeli: *postojanje statistički značajne razlike

Table 3. Presence of dental restorations
Tabela 3. Prisustvo stomatoprotetskih nadoknada

Type of dental restoration Prisutne stomatoprotetske nadoknade	n (%)	Male – n Muškarci – n	Female – n Žene – n
Fixed prostheses Fiksne nadoknade	16 (9.41%)	11	9
Mobile prosthesis in one jaw and a fixed prosthesis in the other U jednoj vilici mobilna, u drugoj fiksna nadoknada	10 (5.88%)	5	5
Mobile dental restorations in both jaws U obe vilice mobilna zubna nadoknada	83 (48.82%)	29	54
Mobile prostheses in one jaw and no prosteses in the other jaw U jednoj vilici mobilna nadoknada, u drugoj nenadoknađeni ekstahovani zubi	34 (20.00%)	14	19

Presence of dentures

The dental rehabilitation index – IRD was 73.86%. It was found that in 83 (48.82%) persons there were mobile dental restorations in both jaws. Thirty-four (20.00%) subjects had dentures in one jaw and no dental restorations in the other jaw. There were 16 (9.41) persons with fixed prostheses. The number of persons who had dentures in one jaw and a fixed prosthesis in the other jaw was 10 (5.88%) (Table 3).

The average age of dental prostheses was 11 years: 59 were between 0–5 years old (41%), 36 were 6–10 years old (25%), 19 were 11–19 years old (13%), 18 19–20 years old (12.5%) and 12 were 30+ years old (8%).

Analysis of the answers to the questions from the questionnaire

Reasons for teeth loss: 108 (63.52%) reported caries, while 61 (35.88%) reported periodontitis. One respondent (0.58%) cited trauma as the cause (Table 4). It was noticeable that women had decay more often (63, 71.59%) compared to periodontitis 25 (28.40%). For males, approximately the same number of subjects had decay 45 (54.87%) or periodontal disease 37 (45.12%) as a reason for teeth loss.

The last visit to the dentist in 58 (34.11%) was more than 5 years ago. In 37 (21.76%) subjects 2–5 years have passed since the last visit. In 30 (17.64%) subjects the visit

to the dentist was 1-2 years ago. It has been 6–12 months since the last visit for 16 (9.41%) subjects, and less than 6 months for 29 (17.05%) persons (Table 4).

Table 4. Analysis of questionnaire results
Tabela 4. Analiza rezultata upitnika

Questions and offered answers **Pitanja i ponuđeni odgovori**	**n**	**%**
Causes of tooth loss **Uzroci gubitka zuba**		
Caries Karijes	108	63.52
Periodontal disease Parodontopatija	61	35.88
Last visit to the dentist **Poslednja poseta stomatologu**		
< 6 months < 6 meseci	29	17.05
6–12 months 6–12 meseci	16	9.41
1–2 years 1–2 godine	30	17.64
2–5 years 2–5 godina	37	21.76
> 5 years > 5 godina	58	34.11
Reasons for last visit to the dentist **Razlozi poslednje posete stomatologu**		
Pain/problem with mouth teeth and dentures Bol/problem sa ustima zubima i zubnim nadoknadama	101	59.41
Need for treatment Stomatološki tretman	22	12.94
Regular control Redovni pregled	21	12.35
Consultation/advice Konsultacija/savet	26	15.29
Use of tobacco products **Korišćenje duvanskih proizvoda**		
Yes Da	54	31.76
No Ne	116	68.23

As the reason for the last visit to the dentist, the majority of respondents 101 (59.41%) reported pain or a problem with teeth, gums or dental prosthesis. The need for consultations as the reason for the last visit to the dentist was stated by 26 (15.29%) respondents. Treatment was the reason for 22 (12.94%) subjects and regular checkup for 21 (12.35%) subjects (Table 4).

The use of tobacco products was confirmed by 54 (31.76%) respondents, while 116 (68.23%) denied their use (Table 4). Among males, there were 33 (40.74%) smokers, while among women, tobacco use was confirmed by 21 (32.59%).

DISCUSSION

Research by Petersen PE et al. [8, 27] showed that number of edentulous people age 65 and over in the world is high. Also, WHO data from 2016 [9] showed that about 30% of Europeans (prevalence varies from 5% to 51%) between the ages of 65 and 74 do not have natural teeth. If this is compared with data from Montenegro (46.47%), it can be seen that the situation in Montenegro is worse than the European average. According to Peterson et al. [8], the situation in Europe in 2010 was as follows: in Poland, the prevalence of edentulousness in elderly was 43.9%, in Slovakia 43%, in United Kingdom 37.5%, in Hungary and Denmark 27%, in Austria 15% while in Lithuania it was lower than 13%. On other continents, the percentage of edentulousness among elderly was: in the USA 26%, in India and Indonesia 19%, in Lebanon 20%, while in China the situation was significantly better (11%).

Numerous factors influence the values of DMFT such as demographic and other characteristics of the population, behavior related to oral health, development of health systems [22] and others. In Europe, periodontal disease is the number one problem when it comes to oral health, while the caries rate has decreased significantly compared to previous decades [1, 3]. The reduction in the incidence of caries in these countries is largely the result of decades of continuous use of oral health programs. In Montenegro, caries is the dominant cause of teeth loss. The analysis of the structure of DMFT supports the fact that dental services are available to the population. However, they are much more curative than preventive, and extracted teeth predominate in structure. The existing dental service should be further improved and directed towards preventive and prophylactic methods. Continuity in the promotion of oral health should be insisted on and directed towards all population groups. Emphasis must be placed on health literacy, information and education.

Prosthetic rehabilitation expressed by the rehabilitation coefficient in this study (73.86%) indicated similarity with the results of research in the elderly in Republika Srpska [2] where 31% had an upper complete and 18% had a lower complete dentures. There were 4.6% of persons who had removable denture in one jaw and a fixed one in the other, while a fixed prosthesis was present in 10% of the subjects. In a study by Haikol et al. in Finland [28], fixed prostheses were present in 23.7% of sixty-year-olds and 38.6% of eighty-year-olds (60% of the elderly had mobile dental restorations). Thus, in Montenegro and RepublikaSrpska, the presence of dentures was higher compared to fixed dental restorations, while in Finland the presence of fixed dental restorations was higher.

The value of DMFT observed in relation to the gender of the subjects in this study was consistent with the results in the study of Baumgartner et al. [4] and Pan et al. [5] and was significantly higher in women than men.

Numerous studies [20, 21, 23] have proven the negative impact of using tobacco products on the increasing incidence of oral diseases, which is in line with the results in Montenegro. A statistical association between the frequency of dental visits and the value of DMFT present in examined subjects was also demonstrated in the study of Nguyen at al. [6], Popović at al. [7], as well as in numerous other studies [17, 20, 22]. DMFT values were lower in individuals who have responsible oral health behaviors.

The significance of this research is that for the first time the state of oral health of the elderly in Montenegro was examined. The obtained results can be considered

representative for the elderly living not only in the central part of Montenegro, but in the whole territory, because close to two thirds of the country's population is concentrated in the central part. In search of a specialist dental service, patients from the other two regions are gravitating towards dental practices, most of which are concentrated in Podgorica and Nikšić.

CONCLUSION

The state of oral health of the elderly in the central region of Montenegro is not at a satisfactory level. The loss of natural teeth and its consequences may become a significant public health problem in the future given the increase in the number of older people. Oral health care needs to become an integral part of state general health care and treatment programs. The promotion of healthy lifestyles and the concept of active aging should also contribute to improving oral health status of the entire population, especially the elderly.

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Bezubost kod starih osoba u Crnoj Gori

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KRATAK SADRŽAJ

Uvod Prvi put u Crnoj Gori rađeno je istraživanje koje je imalo za cilj da ispita stanje oralnog zdravlja starih osoba.

Metode Obuhvaćeno je 170 ispitanika oba pola, prosečne starosti 72,32 ± 6,85. Instrument istraživanja je usklađen sa metodološkim uputstvom SZO za epidemiološka ispitivanja nacionalne oralne patologije. U statističkoj obradi podataka korišćeni su program IBM Statistics 20, metode deskriptivne i inferencijalne statistike, Tamhane T2 post hoc testovi, χ^2 test. Homogenost disperzija proveravana je Levenovim testom. Nivo značajnosti je 0,05.

Rezultati Vrednost DMFT iznosi 29,417 ± 3,81 (MT: 26,25 ± 6,95; FT: 2,68 ± 3,98; DT: 0,63 ± 1,56) i statistički je značajno veća kod žena, kod korisnika duvanskih proizvoda i kod osoba koje neredovno posećuju stomatologa. Bezubih osoba je 46,47%. Indeks rehabilitacije zuba je 73,86%. Prosečna starost zubnih nadoknada je 11 godina.

Zaključak Stanje oralnog zdravlja starih osoba u Crnoj Gori nije na zadovoljavajućem nivou, što se ogleda u visokom procentu bezubih osoba i nepovoljnoj strukturi DMFT-a.

Ključne reči: bezubost; stare osobe; Crna Gora

UVOD

Unapređenje oralnog zdravlja osnovni je preduslov za unapređenje zdravlja u celini [1]. Ovo je posebno važno za stare osobe kod kojih je opšte zdravlje narušeno i opterećeno hroničnim oboljenjima. Istraživanja u regionu [2], u Evropi [3, 4, 5] i na drugim kontinentima [6–9] uticala su na pokretanje istraživanja stanja oralnog zdravlja starih u Crnoj Gori. Ispitivanja uticaja koje oralno zdravlje ima na kvalitet života sprovode se u svetu već više od pet decenija i dokazan je visok stepen međuzavisnosti kvaliteta života i oralnog zdravlja [10–14]. Ova saznanja implementirana su u novu definiciju oralnog zdravlja [15, 16]. Oko 30% Evropljana, starosti između 65 i 74 godine, nema više svoje prirodne zube [17]. Postoji preporuka za implementiranje oranozdravstvenih u opštezdravstvene preventivne programe, što uz kontinuitet njihovog sprovođenja treba da rezultira time da ljudi do 65. godine sačuvaju najmanje 20 prirodnih zuba [18]. Brojni autori su istraživali uticaj oralnozdravstvenih navika, socioekonomskog statusa i drugih karakteristika na pojavu oralnih oboljenja i posledičnu bezubost [5, 6, 7, 17–23].

Demografski podaci ukazuju na višedecenijski trend starenja stanovništva [24]. Da bi se zdavstveni sistem pripremio za povećan broj starih pacijenata u budućnosti, potrebno je prikupiti podatke o stanju oralnog zdravlja.

Cilj istraživanja je da ispita stanje oralnog zdravlja starih osoba u središnjem regionu Crne Gore.

METODOLOGIJA

Pre realizacije istraživanja urađene su obavezne mere koje prethode, kao što je dobijanje saglasnosti od Etičkog komiteta Medicinskog fakulteta Univerziteta Crne Gore u Podgorici. Urađen je plan istraživanja, informisani su ispitanici i dobijena je njihova saglasnost za učešće u istraživanju.

Sve kliničke preglede obavio je jedan stomatolog (specijalista stomatološke protetike, koji je obučen da analizira podatke oralnog zdravlja pomoću relevantnih indeksa) po principima dobre kliničke prakse. U testiranju pouzdanosti istraživača primenjivana je statistika *kappa. Kappa* vrednosti procenjene posle ponovnog pregleda za intrakonzistenciju istraživača iznosile su 0,94.

Istaraživanje je rađeno po metodu analitičke studije preseka, u periodu od septembra do decembra 2016. u središnjem delu Crne Gore. Pregledi su obavljeni na Medicinskom fakultetu u Podgorici i domovima za stara lica „Ljubav spaja“ i „Nana“ u Spužu i Danilovgradu.

Uzorak istraživanja

Istraživanjem je obuhvaćeno 170 osoba prosečne starosti 72,32 (stand. devij. 6,85). Metoda uključivanja ispitanika u istraživanje je bila zasnovana na sledećim karakteristikama:

1. Uključene su osobe starosti od 65 i više godina koje su se javile na pregled na Medicinski fakultet u Podgorici – Studijski program stomatologije određenim danima (ponedeljkom i sredom) u periodu od septembra do decembra 2016.

2. Uključeni su svi korisnici usluga domova za stara lica „Nana“ i „Ljubav spaja“ u Spužu i Danilovgradu čije je stanje opšteg i mentalnog zdravlja dozvoljavalo da budu pregledani.

Svi ispitanici su dobrovoljno pristali da učestvuju u istraživanju nakon što su im objašnjeni svrha istraživanja, način distribucije dobijenih podataka i anonimnost učešća. O dobrovoljnosti su se izjasnili potpisivanjem informisanog pristanka. Za ispitanike koji su korisnici usluga domova za stara lica prethodno je dobijena saglasnost od uprave domova.

Uzorak je 5% prema broju stanovnika starosti 65 i više godina u središnjem delu Crne Gore i statistički je alociran tako da je očekivani koeficijent varijacije između 8 i 11%.

Prvi instrument istraživanja koji je korišćen je klinički pregled oralnog zdravlja, po metodologiji SZO, primenom metodološkog uputstva za epidemiološka ispitivanja nacionalne oralne patologije [25].

Analizirani su podaci vezani za broj karijesnih, ekstrahovanih i plombiranih zuba, podaci o prisutnim zubnim nadoknadama (fiksnim i mobilnim) i o starosti zubnih nadoknada.

Stanje oralnog zdravlja procenjivano je na osnovu relevantnih indeksa, pri čemu su prikazani sledeći:

1. Karijesni status registrovan je pomoću Klajn-Palmerovog sistema DMF (D – decaued, M –missing, F – filled) [26].

Karijes je dijagnostikovan inspekcijom uz pomoć stomatološke sonde i ravnog stomatološkog ogledala, pri dnevnoj svetlosti. Dentalnim karijesom (K) obeležene su lezije sa jasno formiranim

kavitetom na površini zuba. Promene u transparenciji i početne demineralizacije gleđi sa intaktnom površinom koje nisu dovele do prekida kontinuiteta zubnog tkiva nisu registrovane. Pojam plombe (P) uključuje sve stalne i privremene ispune. Pod ekstahovanim (E) zubima podrazumevaju se sve ekstrakcije nastale kao posledica karijesa ili oboljenja parodoncijuma. Ovaj indikator predstavljen je ukupno za sve ispitanike, u odnosu na određene karakteristike ispitanika.

2. DMFT indeks – indeks karijesa prosečan (DT – prosečan broj karijesnih zuba, MT – prosečan broj ekstrahovanih zuba, FT – prosečan broj plombiranih zuba).

3. IRZ indeks – indeks rehabilitacije zuba korišćen je da se izrazi (u procentima) koliko je izgubljenih zuba nadomešteno izradom stomatoprotetskih nadoknada (fiksnih i mobilnih). Izračunava se: broj nadoknađenih zuba / broj izvađenih zuba + broj nadoknađenih zuba ×100.

4. Evidentirano je prisustvo stomatoprotetskih nadoknada (fiksnih i mobilnih) i njihova starost.

Drugi instrument istraživanja je upitnik zatvorenog tipa sa četiri pitanja:

P1 – Kada ste poslednji put bili kod stomatologa?

P2 – Koji su razlozi Vaše poslednje posete stomatologu?

P3 – Da li ste korisnik duvanskih proizvoda?

P4 – Šta prepoznajete kao glavni razlog gubitka svojih zuba?

Tokom pregleda isptanicima su pruženi saveti kako da pravilno održavaju higijenu usta, zuba i zubnih nadoknada. Pregledane su zubne nadoknade i dati su saveti za njihovo održavanje.

U statističkoj obradi prikupljeni podaci obrađivani su statističkim programom IBM Statistics 20. Korišćene su metode deskriptivne i inferencijalne statistike. Od deskriptivnih metoda upotrebljene su aritmetička sredina i standardna devijacija. U sklopu inferencijalne statistike korišćen je t-test za dva nezavisna uzorka, χ^2 test, Tamhane T2 post hoc test i ANOVA. Homogenost disperzija proveravana je Levenovim testom. Nivo značajnosti je 0,05.

REZULTATI

Demografski podaci

Ukupno je pregledano 170 osoba. Struktura ispitanika prema polu pokazala je da je bilo 89 (52,35%) ispitanika ženskog i 81 (47,64%) ispitanik muškog pola. Prosečna starost ispitanika je 72,32 ± 6,85. Bilo je 104 (61,17%) ispitanika starosti 65–74 godine, 53 (31,17%) starosti 75–84 godine i 13 (7,6%) od 85 godina i starijih. Prema mestu stanovanja u gradovima središnjeg regiona Crne Gore: iz Podgorice je bilo 114 (67,05%) ispitanika, iz Danilovgrada 20 (11,76%), iz Nikšića 22 (12,94%), i sa Cetinja 14 (8,23%) ispitanika. Struktura ispitanika prema stepenu obrazovanja pokazala je da je najviše ispitanika – 64 (37,64%) sa srednjim stepenom obrazovanja, 39 (22,94%) ispitanika ima visoko obrazovanje, 27 (15,88%) ima više obrazovanje, 32 (18,82%) ima osnovno obrazovanje, dok je 8 (4,70%) ispitanika bez obrazovanja.

Analiza stanja oralnog zdravlja ispitanika

Od 170 pregledanih osoba 79 (46,47%) osoba je bezubo. DMFT iznosi 29,417 ± 3,81 (min. 15; max. 32). Struktura DMFT-a pokazuje da ispitanici u proseku imaju 26,25 ± 6,95 ekstrahovanih zuba, 2,68 ± 3,98 plombiranih zuba, dok je broj karioznih zuba po ispitaniku u proseku 0,63 ± 1,56. Ispitanici su u proseku imali 2,39 ± 3,66 zdravih zuba i 7,14 ± 9,19 protetski nenadoknađenih zuba.

Prisutnost preostalih prirodnih zuba izražena prema segmentima zubnih nizova (što je od značaja za planiranje protetske terapije) pokazuje da ispitanici u proseku imaju veći broj prisutnih zuba u donjem zubnom nizu – 1,14 u odnosu na gornji zubni niz – 0,73. U frontalnim segmentina zubnih lukova je broj sačuvanih prirodnih zuba veći nego u bočnim. U donjem frontalnom segmentu prosečan broj prirodnih zuba je najveći i iznosi 2,22 zuba, dok je u gornjem frontalnom segmentu 1,29. Prisutnost prvih stalnih molara je prosečno po ispitaniku 0,41 (25,88% osoba ima između jednog i tri prva stalna molara).

Analiza DMFT-a prema karakteristikama ispitanika

U istraživanju se pokazalo da osobe ženskog pola imaju statistički značajno veću vrednost DMFT-a u odnosu na osobe muškog pola ($t = -2,593$; $p = 0,011$) (Tabela 1).

Osobe koje su korisnici duvanskih proizvoda imaju statistički značajno veću vrednost DMFT-a u odnosu na osobe koje ne koriste duvanske proizvode ($t = 2,279$; $p = 0,024$) (Tabela 1).

Podaci pokazuju statistički značajnu razliku u vrednosti DMFT-a prema vremenu proteklom od poslednje posete stomatologu. Osobe kod kojih je poseta stomatologu bila u poslednjih 12 meseci imaju statistički značajno nižu vrednost DMFT-a u odnosu na ispitanike kod kojih je proteklo više vremena od poslednje posete (između jedne i pet godina; više od pet godina). (ANOVA; $F = 4,805$; $p = 0,009$). Levenov test ukazuje na heterogenost disperzija ($p < 0,001$). (Tamhane test, $p = 0,009$) (Tabela 2).

Ne postoji statistički značajna razlika u vrednostima DMFT-a kod ispitanika u odnosu na godine starosti ($t = -1,147$; $p = 0,253$).

Prisustvo stomatoprotetskih nadoknada

Indeks rehabilitacije zuba je 73,86%. Utvrđeno je da kod 83 (48,82%) osobe postoje mobilne zubne nadoknade u obe vilice. Mobilnu nadoknadu u jednoj vilici i nenadoknađen zubni niz u drugoj vilici imaju 34 (20,00%) ispitanika. Zubne nizove nadomeštene fiksnim nadoknadama ima 16 (9,41) osoba. Osoba koje u jednoj vilici imaju mobilnu a drugoj fiksnu nadoknadu bilo je 10 (5,88%) (Tabela 3).

Prosečna starost zubnih nadoknada iznosi 11 godina. Nadoknada starosti između 0 i 5 godina ima 59 (41%), 6–10 godina 36 (25%), 11–19 godina 19 (13%), 20–19 godina 18 (12,5%) i 30+ godina 12 (8%) ispitanika.

Analiza odgovora na pitanja iz upitnika

Kao razlog gubitka zuba 108 (63,52%) ispitanika navelo je karijes, dok je 61 (35,88%) ispitanik naveo parodontopatiju. Jedan ispitanik (0,58%) naveo je traumu kao uzrok (Tabela 4). Primetno je da žene češće navode karijes – 63 (71,59%) kao razlog gubitka zuba u odnosu na parodontopatiju – 25 (28,40%). Kod muških ispitanika približno jednak broj ispitanika navodi karijes – 45 (54,87%) kao razlog u odnosu na parodotopatiju – 37 (45,12%).

Poslednja poseta stomatologu kod 58 (34,11%) ispitanika bila je pre više od pet godina. Kod 37 (21,76%) ispitanika od po-

slednje posete prošlo je 2–5 godina. Kod 30 (17,64%) ispitanika odlazak kod stomatologa bio je pre 1-2 godine. Od poslednje posete kod 16 (9,41%) ispitanika proteklo je 6–12 meseci, a kod 29 (17,05%) ispitanika proteklo je manje od šest meseci (Tabela 4).

Kao razlog poslednje posete stomatologu najviše ispitanika – 101 (59,41%) navelo je bol ili problem sa zubima, desnima ili zubnim nadoknadama. Potrebu za konsultacijom ili savetom kao razlog poslednje posete stomatologu navelo je 26 (15,29%) ispitanika. Lečenje kao razlog navela su 22 (12,94%) ispitanika i redovnu kontrolu 21 (12,35%) ispitanik (Tabela 4).

Korišćenje duvanskih proizvoda potvrdilo je 54 (31,76%) ispitanika, dok je 116 (68,23%) negiralo njihovu upotrebu (Tabela 4). Među osobama muškog pola je 33 (40,74%) pušača. Žena korisnika duvanskih proizvoda je 21 (32,59%).

DISKUSIJA

Petersen i saradnici [8, 27] u svojim istraživanjima pokazuju da je broj bezubih osoba starosti 65 i više godina u svetu visok. Takođe, podaci SZO iz 2016. [9] pokazuju da oko 30% Evropljana (prevalenca varira od 5% do 51%) u dobi od 65 do 74 godine nema prirodne zube. Ako se ovo uporedi sa crnogorskim podatkom (46,47%), vidi se da je stanje u Crnoj Gori lošije od evropskog proseka. Prema podacima Petersena i saradnika [8], u Evropi je 2010. stanje bilo sledeće: u Poljskoj je zastupljenost bezubosti kod starih osoba bila 43,9%, u Slovačkoj 43%, u Velikoj Britaniji 37,5%, u Mađarskoj i Danskoj 27%, u Austriji 15% dok je u Litvaniji niža od 13%. Na drugim kontinentima procenat bezubih među starim osobama je sledeći: u SAD 26%, u Indiji i Indoneziji 19%, u Libanu 20%, dok je u Kini stanje značajno bolje – 11%.

Brojni faktori utiču na vrednosti DMFT-a: demografske i druge karakteristike stanovništva, ponašanje u vezi sa oralnim zdravljem, razvijenost zdravstvenih sistema [22] i drugo. U Evropi su oboljenja parodoncijuma problem broj jedan kada je stanje oralnog zdravlja u pitanju, dok je stopa karijesa značajno smanjena u odnosu na prethodne decenije [1, 3]. Redukcija stope karijesa u ovim državama je velikim delom rezultat višedecenijskog kontinuiranog sprovođenja oralnozdravstvenih programa. U Crnoj Gori je karijes dominantni razlog gubitka zuba. Analiza strukture DMFT-a govori u prilog činjenici da su stomatološke usluge dostupne stanovništvu. Međutim, mnogo više kurativne nego preventivne, te u strukturi prednjače ektrahovani zubi. Postojeću stomatološku službu treba dalje unapređivati i usmeravati ka preventivnim i profilaktičkim metodama. Treba insistirati na kontinuitetu u promociji oralnog zdravlja i usmeriti je prema svim populacionim grupama. Akcenat se mora staviti na zdravstveno opismenjavanje, informisanost i edukaciju.

Protetska rehabilitacija izražena kroz koeficijent rehabilitacije u ovoj studiji (73,86%) ukazuje na sličnost sa rezultatima istraživanja kod starih osoba u Republici Srpskoj [2], gde je 31% osoba imalo gornju totalnu, a 18% donju totalnu protezu. Osoba koje u jednoj vilici imaju mobilnu, a u drugoj fiksnu nadoknadu bilo je 4,6%, dok je zubne nizove nadomeštene fiksnim nadoknadama imalo 10% osoba. Haikola B. i saradnici u svom istraživanju u Finskoj [28] pokazuju da su fiksne nadoknade zastupljene kod 23,7% šezdestogodišnjaka i kod 38,6% osamdesetogodišnjaka (60% starih su imali mobilne zubne nadoknade). Dakle, u Crnoj Gori i Republici Srpskoj veća je prisutnost mobilnih u odnosu na fiksne zubne nadoknade, dok je u Finskoj veća zastupljenost fiksnih zubnih nadoknada.

Vrednost DMFT-a posmatrano u odnosu na pol ispitanika u ovom istaživanju saglasna je sa rezultatima istraživanja koje su sproveli Baumgartner W. i saradnici [4] i Pan S. i saradnici [5] i statistički je značajno veća kod žena nego kod muškaraca.

Brojna istraživanja [20, 21, 23] dokazala su negativan uticaj koji korišćenje duvanskih proizvoda kao loša navika ima na porast učestalosti oralnih oboljenja, što je u saglasnosti sa rezultatima u Crnoj Gori.

Statistička povezanost između učestalosti poseta stomatologu i vrednosti DMFT-a prisutna kod crnogorskih ispitanika dokazana je i u istraživanju koje su sproveli Nguyen i saradnici [6], u radu Popović Z. i saradnika [7], kao i u brojnim drugim radovima [17, 20, 22]. Vrednosti DMFT-a su niže kod osoba koje imaju odgovorno oralnozdravstveno ponašanje.

Značaj ovog istraživanja je u tome što je prvi put ispitivano stanje oralnog zdravlja starih osoba u Crnoj Gori. Dobijeni rezultati mogu se smatrati reprezentativnim za stare osobe koje žive ne samo u središnjem regionu Crne Gore već na celoj teritoriji jer je u središnjem delu koncentrisano blizu dve trećine stanovništva. U potrazi za specijalističkom uslugom pacijenti iz druga dva regiona gravitiraju prema stomatološkim ordinacijama čiji je najveći broj koncentrisan u Podgorici i u Nikšiću.

ZAKLJUČAK

Stanje oralnog zdravlja starih osoba u središnjem regionu Crne Gore nije na zadovoljavajućem nivou. Bezubost i njene posledice mogu postati značajan javnozdravstveni problem u budućnosti s obzirom na porast broja starih osoba. Neophodno je da briga o oralnom zdravlju postane sastavni deo državnih opštezdravstvenih preventivnih i kurativnih programa. Propagiranje zdravih stilova života i koncepta aktivnog starenja takođe treba da doprinese poboljšanju stanja oralnog zdravlja celokupne populacije, naročito starih.

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Apical extrusion of root canal filling material during the removal of gutta-percha and resilon

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SUMMARY

Introduction Root canal filling material may be extruded during retreatment through the apical foramen and cause flare-up or chronic infection. The aim of this study was to compare the apical extrusion of gutta-percha and resilon filling materials during retreatment using hand and rotary instruments.

Methods Sixty extracted single-rooted teeth with single, straight canal were selected. Canals were prepared with ProTaper Universal rotary system to a size F2. Two groups (30 teeth in each) were filled with gutta-percha or resilon points, respectively. In both groups teeth were randomly divided into the three subgroups (10 teeth in each), based on the instruments used for retreatment: Hedstrom hand files and two rotary groups- ProTaper and Twisted File instruments. Apical extrusion was detected visually, using a 4-degree scoring system. Mean scores were calculated and analyzed statistically (*t*-test and ANOVA). The level of significance was set at $p < 0.05$.

Results Under tested experimental conditions, the type of canal filling material did not have significant effect on the results of apical extrusion during retreatment. Significantly more material was extruded in the resilon group when manual, Hedstrom file was used (1.80 ± 1.13) than rotary ProTaper (0.60 ± 0.70) and Twisted File (0.50 ± 0.71).

Conclusions The use of a rotary technique is recomended to minimize apical extrusion, especially when resilon obturation material is removed during retreatment.

Keywords: apical extrusion; gutta-percha; resilon; retreatment; root canal obturation; rotary instruments

INTRODUCTION

Non-surgical retreatment is often indicated as the first choice to eliminate or reduce persistent microbial infection of the root canal system. During this procedure, thorough removal of filling material is an important factor, since it enables adequate chemo-mechanical instrumentation and disinfection of the root canal system, in order to reestablish healthy periapical tissues [1]. One inherent problem related to all root canal treatment procedures is the extrusion of intracanal debris and irrigants through the apical foramen into the periapical tissue that could result in inflammation even infection, as both may be contaminated with microorganisms. This could lead to an interappointment flare-up, postoperative pain, delayed healing or even treatment failure as an undesirable occurrence, both for patient and practitioner [1, 2].

It is generally accepted that none of the currently available instruments and techniques can prepare root canals or remove root-filling material without producing apical extrusion. However, selecting the appropriate retreatment technique could minimize the risk of apical extrusion, even though it may not be prevented [3–6]. During mechanical instrumentation, the number and virulence of extruded microorganisms are decisive and critical factors that determine the extent of the periradicular reaction [6]. Although this qualitative factor is not under the control of the practitioner, selecting techniques such as crown-down instrumentation to provide a gradual approach to the apical end is important. This allows the control of the amount of irritants extruded periapically [2]. One of the major tasks of dental practitioner during root canal treatment procedures is to use instruments and techniques that minimize the amount of apically extruded debris in order to avoid or minimize irritation of the periapical tissues [6, 7]. The most often used hand files for retreatment are the Hedstrom files. Recently, several nickel-titanium (NiTi) rotary instruments have been specially designed to remove obturation material. The Protaper Universal Retreatment system (Dentsply, Maillefer, Ballaigues, Switzerland) contains three instruments with various tapers and tip diameters: D1 (size 30/.09 taper), D2 (size 25/.08 taper) and D3 (size 20/.07 taper). Also, a new type of instruments-Twisted File (SybronEndo, Orange, CA, USA) has become available, but it has not been specially designed for the removal of obturation materials. The Twisted File system has been developed through a specific manufacturing process [8]. These files have twisted design, not ground surface treatment, triangular cross-section, variable pitch and safe-ended tip that allow their use in retreatment cases. The manufacturer claims that Twisted Files can be used to remove obturation materials. To the

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author`s knowledge, no studies are present in the current literature on the apical extrusion of gutta-percha and resilon during their removal with Twisted Files and only one study evaluated the cleaning efficacy of Twisted File instruments in retreatment procedures [9].

Until now, several materials have been used to fill root canals, with gutta-percha being the most popular. However, gutta-percha has two major drawbacks: no adhesion to the canal walls and inability to strengthen the teeth [9]. Recently, a new obturation material has been developed that has some properties similar to gutta-percha. Resilon (Resilon Research LLC, Madison, CT, USA) is a thermoplastic synthetic polymer-based root filling material that bonds to dentinal walls when used in conjunction with an adhesive root canal sealer (Epiphany/Real Seal) and forms a "monoblock" within the canal [10]. The retreatment efficacy of this material has been examined, although not in such extent as gutta-percha, while the apical extrusion during resilon removal has been examined in two studies only [11, 12].

The aim of this study was to compare *in vitro* the influence of different filling materials (gutta-percha and resilon) and different instruments (Hedstrom files, ProTaper Retreatment and Twisted Files) on the degree of apically extruded debris during retreatment.

METHODS

Teeth selection and preparation

Sixty extracted single-rooted teeth with single, straight canals without previous root canal treatment and with completely developed root apices were selected. To standardize specimen lengths, all teeth were shortened to 16 mm by removing the crown (with a fissure diamond bur in a high-speed handpiece under copious water cooling). After the root canal orifice was identified, canal patency was confirmed with a size 10 K-file (Senseus FlexoReamer, Dentsply, Maillefer, Ballaigues, Switzerland) until it was visible at the apical foramen. Working length was determined 1 mm short from the observed length. Primary root canal preparation was performed with a NiTi rotary system-ProTaper Universal (Dentsply, Maillefer, Switzerland). Canals were enlarged in a crown-down technique to a size 25 (F2) at working length, for all teeth. Canal irrigation was performed between each successive instrument with 2 ml of 5.25% sodium hypochlorite (NaOCl). Before obturation, a final rinse was performed with 10% citric acid for 1 minute, to remove smear layer, followed by a rinse with 10 ml of distilled water. The teeth were randomly divided into 2 groups of thirty teeth each (n = 30). After drying with paper points, all root canals were filled using cold lateral compaction technique. One group was filled with gutta-percha points (Protaper Universal F2, Dentsply, Maillefer, Switzerland) and an epoxy sealer (AHplus, Dentsply, Detrey GmbH, Germany); the other group was filled with resilon points (Resilon Research LLC, Madison, CT) and an adhesive, methacrylate sealer (RealSeal, Root Canal Sealant, SybronEndo, Kerr Corporation, USA). Additional warm vertical compaction of the obturation material was carried out with pluggers. The coronal surface of the resilon group was light cured for 40 seconds, according to the manufacturer's instruction. Total length of the root canal fillings did not exceed more than 15 mm, so the volume of filling material was approximately equal for all specimens. Obturation quality was confirmed radiographically, in buccolingual and mesiodistal directions. Access openings were sealed with a temporary filling material (Citodur, Dorident, Austria) and samples were stored at 37°C in 100% humidity for 14 days, to allow for complete setting of the sealer.

Retreatment methods

Before beginning the retreatment procedure, teeth from both groups (n = 30) were randomly divided into the three groups of ten teeth each, based on the instruments used for retreatment. Each set of instruments was used to retreat maximally 5 root canals and after that discarded. All instruments were used respecting the manufacturer's instructions. Rotary instruments were used with an endodontic electric motor (X-Smart, Dentsply, Maillefer, Ballaigues, Switzerland) in a crown-down sequence.

In the group 1, hand instrumentation was performed with Hedstrom files (Senseus Hedstroem Dentsply, Maillefer, Switzerland) from size 40–20, in a circumferential quarter-turn push-pull motion and by pushing against the root canal walls until working length was reached. Re-preparation of the canal apical part was carried out with Hedstrom files from size 20 to size 40. In group 2, ProTaper Retreatment instruments (Dentsply, Maillefer, Switzerland) were applied, using D1 file to remove filling material from the coronal portion of the root canal, whereas the material from the middle and the apical third was removed using D2 and D3 files, respectively, using a brushing action with lateral pressing movements. D3 was taken to the working length. After that, ProTaper Universal files size F3 (#30) and F4 (#40) were used, to enlarge the apical preparation. In group 3, Twisted File (TF) instruments (SybronEndo, CA, USA) were used in the following sequence: TF #25/.08 taper instrument was applied in the coronal third and followed by #30 and #35/.06 taper instruments, until reaching the working length. Then, TF #40/.04 was used to enlarge the apical portion of the canal and again TF #25/.08 to additionally clean the canal walls.

During retreatment, the flutes of all instruments were frequently cleaned and 2 ml of 5.25% NaOCl was used after each instrument and also for final irrigation of the canal. Material removal was considered complete when the working length was reached and no more material could be seen on the last instrument and during irrigation. After re-preparation, the canals were irrigated with 10% citric acid for one minute, to remove the smear layer. The canals were finally flushed with 10 ml of distilled water. The same operator performed primary root canal preparation, obturation and retreatment and the procedure was done in the same manner for all samples.

Apically extruded debris

The amount of apically extruded material during the retreatment procedure was detected visually. A different person who was blinded to the experimental group assignment performed scoring of apically extruded debris. The following score system was used [3, 11] :

0 – no extruded debris, no filling material escaping through the foramen

1 – minimal extruded debris, small amounts of filling material escaping through the foramen

2 – moderate extruded debris, greater amounts of filling material escaping through the foramen

3 – severe extruded debris, even greater amounts of filling material escaping through the foramen.

Statistical analysis

The obtained data are presented in tables and numerically processed by standard descriptive methods. Mean scores of apically extruded material were calculated. The data were analyzed statistically by t-test and one-way analysis of variance (ANOVA). Analysis was performed with SPSS (version 20) at a significance level $p < 0.05$.

RESULTS

The mean scores and standard deviations (SD) of apical extrusion for each group of material and for each group of tested instruments are presented in Table 1 and 2. The results indicated that in both groups of materials, all of the tested instruments caused apical debris extrusion at some degree. Comparison by t-test of the mean scores for apical extrusion during gutta-percha and resilon removal (Table 1) did not showed statistically significant differences between the two materials (p=0.101). The highest mean score for apical extrusion (Table 2) was present in the resilon group of material during retreatment with Hedstrom files (1.80±1.13), while the samples that showed the lowest mean score were observed in the gutta-percha group of material when Twisted File instruments were used (0.11 ± 0.33). The difference between these two results was statistically significant (ANOVA, Post Hoc; p = 0.027). Analysis of the results by ANOVA in both groups of materials revealed statistically significant differences between instruments only during resilon removal (p = 0.004; Table 2). Further statistical analysis with Post Hoc tests indicated that the difference was significant between manual Hedstrom files (1.80 ± 1.13) and the two rotary instruments used, ProTaper (0.60 ± 0.70) and Twisted File (0.50 ± 0.71).

Table 1. Mean scores of apically extruded material during retreatment of gutta-percha and resilon
Tabela 1. Srednje vrednosti rezultata apikalno ekstrudiranog materijala tokom retretmana gutaperke i resilona

Material Materijal	N	Mean Srednja vrednost	SD	SE
Gutta-percha Gutaperka	29*	0.55	0.87	0.16
Resilon Resilon	30	0.97	1.03	0.19

* One sample was discarded because of a ledge formation during retreatment with Twisted File instruments.
* Jedan uzorak je odbačen zbog formiranja stepenika tokom retretmana instrumentima Twisted File.

Table 2. Mean scores of apically extruded material during retreatment of gutta-percha and resilon with different instruments
Tabela 2. Srednje vrednosti rezultata apikalno ekstrudiranog materijala tokom retretmana gutaperke i resilona različitim instrumentima

Material Materijal	Instrument	N	Mean Mean Srednja vrednost	SD	SE	Min	Max
Gutta-percha Gutaperka	Hedstrom	10	0.80	1.23	0.39	0	3
	ProTaper	10	0.70	0.67	0.21	0	2
	Twisted File	9*	0.11[a]	0.33	0.11	0	1
Resilon Resilon	Hedstrom	10	1.80[A]	1.13	0.36	0	3
	ProTaper	10	0.60[a]	0.70	0.22	0	2
	Twisted File	10	0.50[a]	0.71	0.22	0	2

* One sample was discarded because of a ledge formation during retreatment using Twisted File.
The mean difference is significant at the 0.05 levels between A-a (Post Hoc).
* Jedan uzorak je odbačen zbog formiranja stepenika tokom retretmana instrumentima Twisted File.
Razlika je značajna na nivou 0,05 između vrednosti obeleženih sa A-a (Post Hoc).

DISCUSSION

Even during primary root canal instrumentation debris such as dentin chips, necrotic pulp tissue, microorganisms and irrigants may be extruded into the periradicular tissues [13]. Successfull non-surgical retreatment depends on complete removal of pre-existing filling material from the canal, where it would be crucial to clean the apical foramen [14]. However, this could promote apical transportation and force obturation material into the periradicular tissues [15]. In addition, extrusion during retretment may be accompanied by solvents, necrotic tissue, bacteria or irrigants, which might be introduced into the apical region [11].

In the present study, apical extrusion was evaluated during removal of gutta-percha and resilon. The results showed that the type of obturation material did not have a significant impact on the mean scores of apical extrusion, although the mean score was higher during resilon removal. Other studies also evaluated the extrusion of obturation material during retreatment [7, 15, 16, 17], but these studies observed only the removal of gutta-percha. Apical extrusion during removal of different materials (gutta-percha, resilon and resin-coated gutta-percha) was compared in one study with a visual technique and a 4-degree scoring system [11]. The authors concluded that the type of filling material did not play a statistically significant role on the amount of apically extruded material, which is consistent with the findings of the presented study. Another group of authors [12] evaluated apical extrusion during gutta-percha and resilon removal using a quantitative method, however the results regarding the difference between the two materials were also not statistically significant.

Using an instrumentation technique that minimizes apical extrusion would be advantageous. Therefore, this aspect should always be investigated for a newly developed root canal instrumentation system [13]. This study evaluated three different instruments (Hedstrom, ProTaper and Twisted File) during retreatment and their impact on apically extruded material. The present study showed that *in vitro,* all of the tested instruments produced apical extrusion of obturation material and these results are consistent with other apical extrusion studies [7, 11, 12, 14, 16, 18]. As already mentioned, no studies are present in the current literature on the apical extrusion during retreatment with Twisted File instruments. In the present study the highest mean score of extruded material during retreatment was observed in the manual Hedstrom group and the lowest when Twisted File rotary instruments were used. The results of the present study are in agreement with previous retreatment studies that also compared hand and engine-driven instruments and their impact on apical extrusion [7, 12, 14, 16, 17]. This could be explained with rotation and a crown-down preparation technique during instrumentation, which tends to pull dentinal debris into the flutes of the file and direct it toward the coronal part of the canal [3, 19]. Also, rotary movements produce a certain degree of frictional heat which might plasticize the obturation material and facilitate removal [3]. Based on the results of this study, it can be concluded that Twisted File instruments, although not primarily intended for use in retreatment, can be associated with the extrusion of smaller degree of apical debris during material removal. However, these instruments should also be tested in different conditions of experimental set up and in relation to other retreatment efficiency indicators such as canal wall cleanliness, time of retreatment and frequency of instrument fracture.

The majority of investigations used a quantitative method to determine the amount of apically transported material and debris, by collecting and measuring their amount in grams [12, 13, 16, 20, 21]. In some studies the amount of apically extruded filling material during retreatment was detected visually and evaluated with a scoring system [3, 11, 14], as in the present study. Criticism of this kind of evaluation methodology can be made due to the existence of a certain degree of subjectivity as well as less precision in assessing the extruded material amount. However, the reaction of periapical tissues does not depend so much on the quantity of extruded material, as much of its infectious and antigenic potential and the host defense system. It must be emphasized that the results of *in vitro* studies should not be directly extrapolated to clinical situations. Transported material amount can be lesser *in vivo* because the presence of periapical tissues may act as a natural barrier against apical extrusion [6].

Further studies on material extrusion with different engine-driven instruments that can be used in retreatment will be needed for clarifying the importance of torque and rotational speed. Also, instruments with reciprocating movements should be evaluated [14, 22, 23]. Moreover, apical extrusion during removal of other obturation materials, such as resilon should be examined in a greater extent.

CONCLUSION

Under the conditions of this *in vitro* study, all retreatment techniques produced apical extrusion of filling material. The difference between results for apical extrusion for the two materials tested (gutta-percha and resilon) was not statistically significant. However, rotary Twisted File and ProTaper instruments resulted in significantly less debris extrusion compared to hand instruments (Hedstrom files) while removing resilon. There was no significant difference among the two rotary instruments. Therefore, the use of a rotary technique can be recomended to minimize apical extrusion, especially when resilon is removed during retreatment.

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Apikalna ekstruzija materijala za kanalno punjenje tokom uklanjanja gutaperke i resilona

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KRATAK SADRŽAJ

Uvod Tokom uklanjanja kanalnog punjenja materijal se može istisnuti kroz apeks u periapikalna tkiva, što može dovesti do akutne egzacerbacije ili nastanka hronične infekcije. Cilj ovog istraživanja bio je da se ispita apikalna ekstruzija materijala tokom uklanjanja gutaperke i resilona, primenom različitih instrumenata.

Materijal i metode rada Istraživanje je sprovedeno na 60 jednokorenih, jednokanalnih ekstrahovanih humanih zuba. Primarna preparacija kanala korena vršena je rotirajućim instrumentima tipa ProTaper Universal, do veličine F2. Zubi su podeljeni u dve grupe od po 30 zuba (n = 30) i opturisani gutaperka, odnosno resilon poenima. Svaka grupa je dalje podeljena na tri podgrupe (n = 10) u odnosu na instrumente korišćene za retretman: ručni, Hedstrom i rotirajući, ProTaper odnosno Twisted File instrumenti. Stepen apikalno istisnutog materijala ocenjivan je vizuelno, pomoću četvorostepene skale. Izračunate prosečne vrednosti su statistički analizirane (t-test i ANOVA). Prag značajnosti definisan je kao $p < 0,05$.

Rezultati U datim uslovima ispitivanja vrsta materijala za punjenje kanala nije imala značajan uticaj na rezultate apikalne ekstruzije u toku retretmana. Stepen apikalno istisnutog materijala bio je najveći u resilon grupi posle upotrebe turpija Hedstrom (1,80 ± 1,13) i razlika je bila statistički značajna u odnosu na rezultate kada su korišćeni rotirajući instrumenti ProTaper (0,60 ± 0,70), odnosno Twisted File (0,50 ± 0,71).

Zaključak Upotreba rotirajućih instrumenata u toku retretmana može da se preporuči u svrhu smanjenja stepena apikalne ekstruzije, u odnosu na ručne turpije Hedstrom, naročito kada se u toku retretmana uklanja resilon, kao opturacioni materijal.

Ključne reči: apikalna ekstruzija; gutaperka; opturacija kanala korena; resilon; retretman; rotirajući instrumenti

UVOD

Nehirurški retretman često je indikovan kao terapija izbora kako bi se uklonila ili bar smanjila uporna mikrobna infekcija u kanalnom sistemu korena zuba. Tokom ovog postupka, temeljno uklanjanje materijala za kanalno punjenje je važan faktor koji omogućava adekvatnu hemomehaničku instrumentaciju i dezinfekciju kanalnog sistema, kako bi se omogućilo ozdravljenje periapikalnih tkiva [1]. Jedan veoma važan problem koji se javlja u toku preparacije kanala korena zuba je istiskivanje intrakanalnog debrisa i sredstava za ispiranje kroz apikalni foramen u periradikularna tkiva. Tokom retretmana kanala korena dentinski opiljci ili materijal za punjenje mogu se istisnuti kroz apikalni foramen, što može rezultovati inflamacijom periradikularnih tkiva ili čak infekcijom, jer oba ova supstrata mogu biti kontaminirani mikroorganizmima. Ovo bi moglo dovesti do akutizacije simptoma, nastanka postoperativnog bola, odloženog periapikalnog zaceljenja ili čak do neuspeha endodontske terapije, kao neželjene pojave, kako za pacijenta, tako i za terapeuta [1, 2].

Opšte je prihvaćeno da se nijednom od trenutno dostupnih tehnika i instrumenata ne može preparisati kanal korena ili ukloniti materijal za punjenje kanala korena bez pojave određenog stepena apikalne ekstruzije. Međutim, iako se ne može sprečiti, odabir odgovarajuće tehnike retretmana može umanjiti rizik od nastanka apikalne ekstruzije [3–6]. U toku mehaničke instrumentacije, broj i virulencija apikalno prebačenih mikroorganizama su presudni i kritični faktori koji određuju stepen periradikularne reakcije [6]. Iako ovaj kvalitativni faktor nije moguće kontrolisati, na kvantitativne faktore se može uticati odabirom odgovarajuće tehnike preparacije, kao što je koronarno-apeksna tehnika, kako bi se postigao postepen pristup apikalnom delu kanala. Na ovaj način se omogućava kontrola količine periapikalno prebačenih iritanasa [2]. Dakle, jedan od glavnih zadataka stomatologa tokom terapije kanala korena je pravilan odabir instrumenata i tehnika kojima se smanjuje količina apikalno ekstrudiranog debrisa da bi se izbegla ili minimizirala iritacija periapikalnih tkiva [6, 7]. Ručni instrumenti koji se najčešće koriste za retretman su turpije Hedstrom. U skorije vreme je dizajnirano nekoliko nikl-titanijumskih (NiTi) rotirajućih instrumenata posebno namenjenih za uklanjanje materijala iz kanala korena. Univerzalni sistem Protaper Retreatment (Dentsply, Maillefer, Ballaigues, Švajcarska) sadrži tri instrumenta različite koničnosti i prečnika vrhova: D1 (veličina 30 / koničnost 0,09), D2 (veličina 25 / koničnost 0,08) i D3 (veličina 20 / koničnost 0,07). Takođe, na tržištu se pojavila nova vrsta instrumenta pod nazivom Twisted File (SybronEndo, Orange, CA, SAD); međutim, ovaj instrument nije posebno dizajniran za uklanjanje opturacionog materijala iz kanala korena. Sistem Twisted File razvijen je kroz drugačiji proizvodni proces [8]. Ovi instrumenti se proizvode uvrtanjem, a ne obradom površine nikl-titanijuma, na preseku su oblika trougla, imaju promenljiv broj sečiva i zaobljen vrh koji, prema tvrdnji proizvođača, omogućava njihovu upotrebu i u svrhu retretmana. U aktuelnoj literaturi ne postoje podaci o apikalnoj ekstruziji opturacionog materijala tokom njihovog uklanjanja instrumentima Twisted File, a samo je jedna studija procenila efikasnost čišćenja zidova kanala korena posle retretmana sa ovim instrumentima [9].

Za punjenje kanala korena zuba do sada je korišćeno više materijala, pri čemu je gutaperka jedna od najzastupljenijih. Međutim, gutaperka ima dva glavna nedostatka: ne prianja za zidove kanala i nema mogućnost ojačavanja korena zuba [9].

Nedavno je razvijen novi materijal za opturaciju, koji je po načinu primene sličan gutaperki. Resilon (Resilon Research LLC, Madison, CT, SAD) jeste materijal za punjenje kanala korena na bazi termoplastičnog sintetičkog polimera koji se vezuje za dentinske zidove kanala korena kada se koristi zajedno sa odgovarajućom adhezivnom pastom (Epiphany / Real Seal) i tako formira „monoblok" unutar samog kanala [10]. Efikasnost uklanjanja ovog materijala iz kanala je ispitivana, mada ne u tolikoj meri kao gutaperka, dok je apikalna ekstruzija tokom uklanjanja resilona ispitana dosad samo u dve studije [11, 12].

Cilj ove studije bio je poređenje uticaja različitih materijala za punjenje (gutaperke i resilona) i različitih instrumenata (Hedstrom, ProTaper Retreatment i Twisted File) na stepen apikalno ekstrudiranog materijala tokom retretmana kanala u eksperimentalnim uslovima.

MATERIJAL I METODE

Odabir i priprema zuba

Odabrano je šezdeset ekstrahovanih jednokorenih zuba sa jednim, ravnim kanalom bez prethodnog tretmana kanala i sa potpuno razvijenim vrhom korena. Da bi se standardizovale dužine uzoraka, svi zubi su skraćeni na 16 mm uklanjanjem krunice (dijamantskim svrdlom za turbinu i vodenim hlađenjem). Posle identifikacije ulaza u kanal potvrđena je prohodnost kanala turpijom veličine 10 K (Senseus FlexoReamer, Dentsply, Maillefer, Ballaigues, Švajcarska) sve dok njen vrh nije postao vidljiv na apikalnom otvoru korena. Radna dužina je određena za 1 mm kraće od posmatrane dužine. Primarna preparacija kanala korena izvedena je pomoću mašinskog, NiTi rotirajućeg sistema – ProTaper Universal (Dentsply, Maillefer, Švajcarska). Kanali svih zuba su preparisani krunično-apeksnom (*crown-down)* tehnikom do veličine 25 (F2), do radne dužine. Ispiranje kanala sprovedeno je između svakog instrumenta sa po 2 ml 5,25% natrijum-hipohlorita (NaOCl). Pre opturacije kanali su isprani 10% limunskom kiselinom u trajanju od jednog minuta, radi uklanjanja razmaznog sloja, a zatim sa 10 ml destilovane vode. Zubi su nasumično podeljeni u dve grupe od po trideset zuba u svakoj (n = 30). Posle sušenja kanala papirnim poenima svi uzorci su opturisani tehnikom hladne lateralne kompakcije. Jedna grupa je napunjena gutaperka poenima (Protaper Universal F2, Dentsply, Maillefer, Švajcarska) i pastom na bazi epoksi smole (AHplus, Dentspli, Detrei GmbH, Nemačka); druga grupa je napunjena resilon poenima (Resilon Research LLC, Madison, CT) i adhezivnom, metakrilatnom pastom (RealSeal, Root Canal Sealant, SibronEndo, Kerr Corporation, USA). Dodatna vertikalna kompakcija kanalnog punjenja izvršena je pomoću vertikalnog kompaktera i nabijača. Koronarna površina kanalnog punjenja resilon grupe je svetlosno polimerizovana u trajanju od 40 sekundi, prema uputstvu proizvođača. Ukupna dužina ispuna kanala korena nije prelazila više od 15 mm, tako da je zapremina materijala za punjenje bila približno jednaka u svim uzorcima. Kvalitet opturacije kanala korena potvrđen je radiografski iz bukolingvalnog i meziodistalnog pravca. Koronarni deo korena zuba zapečaćen je materijalom za privremeno zatvaranje (Citodur, Dorident, Austrija) i uzorci su čuvani na 37°C u 100% vlažnoj sredini tokom 14 dana, kako bi se omogućilo potpuno vezivanje paste za opturaciju.

Metode retretmana

Pre započinjanja retretmana zubi u obe grupe materijala (n = 30) nasumično su podeljeni u tri grupe od po deset zuba, na osnovu instrumenata koji su korišćeni za uklanjanje materijala za opturaciju. Svaki set instrumenata korišćen je za retretman maksimalno pet korenskih kanala i posle toga odbačen. Svi instrumenti su korišćeni poštujući uputstva proizvođača. Rotirajući instrumenti su pokretani pomoću endodontskog elektromotora (X-Smart, Dentsply, Maillefer, Ballaigues, Švajcarska) u *crown-down* maniru.

U grupi 1 ručna instrumentacija izvedena je turpijama Hedstrom (Senseus Hedstroem Dentsply, Maillefer, Švajcarska) veličine 40–20, uz blago potiskivanje vrha instrumenta u materijal, rotaciju za četvtinu kruga i izvlačenje instrumenta potiskivanjem uz zidove kanala korena, sve do postizanja radne dužine. Ponovna preparacija apikalnog dela kanala obavljena je turpijama Hedstrom do veličine 40. U grupi 2 primenjeni su instrumenti ProTaper Retreatment (Dentsply, Maillefer, Švajcarska), korišćenjem instrumenta D1 za uklanjanje materijala za punjenje iz koronarnog dela kanala, dok je materijal iz srednje i apikalne trećine uklonjen pomoću instrumenata D2 i D3, korišćenjem blagog pritisaka apikalno uz bočni pritisak na zidove kanala (tzv. pokreti četkanja). Instrument D3 je dosegao radnu dužinu. Posle toga korišćeni su instrumenti ProTaper Universal veličine F3 (# 30) i F4 (# 40), radi uvećanja apikalnog dela preparacije. U grupi 3 instrumenti Twisted File (TF) (SybronEndo, CA, USA) korišćeni su prema sledećem redosledu: u koronarnoj trećini je primenjen instrument TF # 25 / koničnosti 0,08, a zatim instrumenti # 30 i # 35 / koničnosti 0,06, do dostizanja radne dužine. Zatim je korišćen TF # 40 / 0,04 za proširivanje apikalnog dela kanala i ponovo TF # 25 / koničnosti 0,08, za dodatno čišćenje bočnih zidova kanala.

Tokom retretmana navoji svih instrumenata često su čišćeni i kanali ispirani sa 2 ml 5,25% NaOCl posle svakog instrumenta, kao i posle završenog retretmana. Retretman je smatran završenim kada je postignuta radna dužina i na poslednjem instrumentu, kao i u toku irigacije, nije više bio vidljiv materijal. Posle toga kanali su jedan minut ispirani rastvorom 10% limunske kiseline, kako bi se uklonio razmazni sloj, a nakon toga destilovanom vodom u količini od 10 ml. Primarnu preparaciju, opturaciju i retretman kanala sprovela je jedna osoba, kako bi postupak bio obavljen na isti način za sve uzorke.

Procena apikalne ekstruzije materijala

Količina apikalno istisnutog materijala tokom postupka retretmana posmatrana je vizuelno. Ocenjivanje količine apikalno ekstrudovanog materijala i debrisa izvršilo je drugo lice, kome nije bila poznata pripadnost uzoraka eksperimentalnim grupama. Korišćen je sledeći sistem za ocenjivanje [3, 11]:

0 – bez vidljive ekstruzije debrisa i materijala za punjenje kroz foramen; 1 – minimalna, jedva primetna količina istisnutog materijala za punjenje kroz foramen; 2 – umerena, lako primetna količina materijala za punjenje istisnuta kroz foramen; 3 – ekstruzija znatne količine materijala za punjenje kroz foramen.

Statistička analiza

Dobijeni podaci su predstavljeni u tabelama i numerički obrađeni standardnim deskriptivnim metodama. Izračunate su srednje

vrednosti rezultata apikalno ekstrudiranog materijala. Podaci su statistički analizirani pomoću t-testa i jednosmerne analize varijanse (ANOVA). Analiza je izvršena pomoću programa SPSS (verzija 20) na nivou značajnosti $p < 0,05$.

REZULTATI

Srednje vrednosti i standardna devijacija za apikalnu ekstruziju za svaku grupu materijala i za svaku grupu testiranih instrumenata predstavljeni su u tabelama 1 i 2. Rezultati su pokazali da su u obe grupe materijala svi ispitivani instrumenti doveli do apikalne ekstruzije debrisa u nekom stepenu. Poređenje srednjih vrednosti pomoću t-testa, dobijenih za apikalnu ekstruziju tokom uklanjanja gutaperke i resilona (Tabela 1), nije ukazalo na statistički značajne razlike između dva materijala ($p = 0,101$). Najveća količina apikalno istisnutog materijala (Tabela 2) bila je prisutna u grupi kada je resilon uklanjan turpijama Hedstrom (1,80 ± 1,13), dok su uzorci sa najmanjom količinom istisnutog materijala primećeni u gutaperka grupi kada su korišćeni instrumenti Twisted File (0,11 ± 0,33). Razlika između ova dva rezultata je bila statistički značajna (ANOVA, Post-hoc; $p = 0,027$). Analiza rezultata pomoću ANOVA u obe grupe materijala otkrila je statistički značajne razlike između instrumenata samo tokom uklanjanja resilona ($p = 0,004$; Tabela 2). Dalja statistička analiza sa post-hoc testovima pokazala je da je razlika bila značajna između ručnih, Hedstrom turpija (1,80 ± 1,13) i dva rotirajuća instrumenta, ProTaper (0,60 ± 0,70) i Twisted File (0,50 ± 0,71).

DISKUSIJA

Čak i tokom primarne instrumentacije kanala korena, dentinski opiljci, nekrotično pulpno tkivo, mikroorganizmi i sredstva za irigaciju se mogu istisnuti u periradikularna tkiva [13]. Uspešno sprovođenje nehirurškog retretmana zavisi od potpunog uklanjanja postojećeg materijala za punjenje iz kanala, pri čemu je najvažnije očistiti apikalni foramen [14]. Međutim, time bi se dodatno promovisali apikalna ekstruzija i istiskivanje materijala za opturaciju u periradikularna tkiva [15]. Pored toga, ekstruzija tokom retretmana može biti praćena prisustvom rastvarača, nekrotičnog tkiva, bakterija ili iriganasa, koji mogu biti prebačeni u periapikalnu regiju [11].

U prezentovanoj studiji procenjen je stepen apikalne ekstruzije tokom uklanjanja gutaperke i resilona. Rezultati su pokazali da vrsta materijala za punjenje kanala nije imala značajan uticaj na vrednosti apikalne ekstruzije, iako je dobijena srednja vrednost bila nešto veća tokom uklanjanja resilona. Druge studije su takođe ocenile ekstruziju opturacionog materijala tokom retretmana [7, 15, 16, 17], ali su ove studije ispitivale samo uklanjanje gutaperke. Apikalna ekstruzija tokom uklanjanja različitih materijala (gutaperka, resilon i gutaperka obložena smolom) upoređena je u jednoj studiji, takođe primenom vizuelne tehnike i ocenjivanjem pomoću četvorostepene skale [11]. Autori su zaključili da vrsta materijala za punjenje nije imala statistički značajnu ulogu u količini apikalno istisnutog materijala, što je u skladu i sa nalazima ove studije. Druga grupa autora [12] ispitivala je apikalnu ekstruziju tokom uklanjanja gutaperke i resilona kvantitativnom metodom; međutim, ni u ovoj studiji razlika u rezultatima između dva ispitivana materijala nije bila statistički značajna.

Od velikog značaja bilo bi korišćenje tehnike instrumentacije u toku retretmana koja smanjuje stepen apikalne ekstruzije. Zbog toga ovaj aspekt uvek treba istražiti za novorazvijeni sistem za instrumentaciju kanala korena [13]. U toku ove studije ispitivana su tri različita instrumenta (Hedstrom, ProTaper i Twisted File) tokom retretmana i njihov uticaj na stepen apikalno istisnutog materijala. Pokazalo se da su svi *in vitro* testirani instrumenti doveli do apikalne ekstruzije materijala za opturaciju i ovi rezultati su u skladu sa drugim studijama apikalne ekstruzije [7, 11, 12, 14, 16, 18]. Kao što je već napomenuto, u trenutnoj literaturi ne postoje studije na temu apikalne ekstruzije tokom retretmana instrumentima Twisted File. U ovoj studiji najveća srednja vrednost za količinu ekstrudiranog materijala tokom retretmana primećena je u ručnoj Hedstrom grupi, a najniža kada su korišćeni rotirajući instrumenti Twisted File. Rezultati ove studije slažu se sa prethodnim studijama retretmana u kojima su takođe upoređeni ručni i različiti mašinski pokretani instrumenti i njihov uticaj na apikalnu ekstruziju [7, 12, 14, 16, 17]. Ova pojava bi se mogla objasniti rotacijom i krunično-apeksnom tehnikom instrumentacije, kojom se teži da se dentinski debris i ostaci materijala povuku u navoje instrumenta i usmere prema koronarnom delu kanala [3, 19]. Takođe, pri pokretima rotacije stvara se određeni stepen trenja, što može dodatno omekšati materijal za punjenje i olakšati njegovo uklanjanje [3]. Na osnovu rezultata ove studije može se zaključiti da su instrumenti Twisted File, iako nisu prvenstveno namenjeni u svrhu retretmana, doveli do istiskivanja manjeg stepena apikalnog debrisa tokom uklanjanja materijala. Međutim, ove instrumente bi takođe trebalo testirati u različitim uslovima postavke eksperimenta i u odnosu na druge pokazatelje efikasnosti retretmana, poput čistoće zidova kanala, vremena potrebnog za retretman, kao i učestalosti loma instrumenta.

Većina istraživanja koristila je kvantitativnu metodu za utvrđivanje količine apikalno transportovanog materijala, prikupljanjem istisnutog materijala i debrisa i merenjem njihove količine u gramima [12, 13, 16, 20, 21]. U nekim istraživanjima je količina apikalno ekstrudiranog materijala za punjenje tokom retretmana vizuelno posmatrana i procenjena sistemom bodovanja [3, 11, 14], kao u ovoj studiji. Kritika ove vrste evaluacione metodologije može se dati zbog postojanja određenog stepena subjektivnosti, kao i manje preciznosti u proceni količine istisnutog materijala. Međutim, reakcija periapikalnih tkiva ne zavisi toliko od precizne količine ekstrudiranog materijala koliko od njegovog infektivnog i antigenog potencijala i odbrambenog sistema domaćina. Mora se naglasiti da rezultati *in vitro* studija ne bi smeli biti neposredno primenjeni na kliničke situacije. Količina transportovanog materijala može biti manja *in vivo* jer prisustvo periapikalnih tkiva može delovati kao prirodna barijera i dovesti do manjeg stepena apikalne ekstruzije [6].

Neophodna su dalja ispitivanja ekstruzije materijala različitim mašinski pokretanim sistemima koji se mogu koristiti u svrhu retretmana, kako bi se ispitao i uticaj obrtnog momenta i brzine rotacije, kao i studije sa instrumentima sa recipročnim pokretima [14, 22, 23]. Takođe, apikalno istiskivanje tokom uklanjanja drugih materijala za punjenje kanala, poput resilona, trebalo bi da se ispita u većoj meri.

ZAKLJUČAK

U uslovima ove *in vitro* studije, sve ispitivane metode retretmana proizvele su apikalnu ekstruziju materijala za punjenje. Razlika između rezultata dobijenih za apikalnu ekstruziju tokom uklanjanja dva testirana materijala (gutaperka i resilon) nije bila statistički značajna. Međutim, rotirajući instrumenti Twisted File i ProTaper doveli su do značajno manje ekstruzije materijala u poređenju s ručnim instrumentima (turpije Hedstrom) u toku uklanjanja resilona. Razlika u rezultatima između dva rotirajuća instrumenta nije bila statistički značajna. Zbog toga se upotreba rotirajućih instrumenata generalno može preporučiti za smanjenje apikalne ekstruzije materijala, naročito kada se tokom retretmana uklanja resilon.

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A new approach to extraordinary efficient protection against COVID 19 based on nanotechnology

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SUMMARY

A new approach to the protection against infections caused by bacteria and various viruses, including SARS-CoV-2 is described. In concrete example, protective filters and ALBO nanosilver masks showed extraordinary efficiency in protection against *Staphylococcus aureus.* These results show that it highly overcomes the efficiency of ordinary surgical masks. Besides, systematic meta-analysis given for ordinary surgical masks and filters N95 for masks and respirators, showed no statistical difference between them in the case of SARS-CoV-2. On the base our experimental data and systemic meta-analysis given in this paper, it can be concluded that ALBO nanosilver masks have significant advantages, and show a very perspective concept of developing new protective gear.

Keywords: COVID 19; bacteria; viruses; ALBO nanosilver masks; N95 masks; surgical masks

Background about COVID-19 (disease caused by SARS-CoV-2)

At the end of 2019, three bronchi alveolar lavage samples were collected from a patient with pneumonia of unknown etiology and examined by Real-time PCR (RT-PCR) assays that were positive for pan-Beta coronavirus. Furthermore, using Illumina and nanopore sequencing, the whole genome sequences of the virus were determined, approving similarity between SARS and SARS-CoV-2 virus, which crown-like shape and its cytopathic effects (CPE) were confirmed 96 hours after inoculation. Investigations on transgenic human ACE2 mice and Rhesus monkey induced multifocal pneumonia with interstitial hyperplasia [1].

Histological examination of post-mortem samples of a 50-year old male patient from Wuhan shows bilateral diffuse alveolar damage with cellular fibromyxoid exudates. Besides, his lung showed also acute respiratory distress syndrome (ARDS), desquamation of pneumocytes, and pulmonary edema, while interstitial mononuclear inflammatory infiltrates, dominate in both lungs. Besides, multinucleated syncytial cells with atypical enlarged pneumocytes characterized by large nuclei, amphophilic granular cytoplasm, and prominent nucleoli were identified in the interalveolar spaces, showing viral cytopathic changes [1–6].

As it is now well known, COVID-19 is transmitted via droplets during close unprotected contact between an infector and infected, while the airborne spread has not been reported. Its human-to-human transmission is largely occurring in families. Testing for COVID-19 disease includes RT-PCR testing in influenza-like-illness (ILI) and severe acute respiratory infection (SARI), as well as testing of results among all visitors to fever clinics [1–6]. There is no pre-existing immunity for COVID-19 because it is caused by new human pathogen. That is the main risk factor of infection. Furthermore, its transmission dynamics is very fast, particularly during the epidemic growth phase and in the post-control period [1–6].

Its symptoms are non-specific and the disease can range from no symptoms (asymptomatic) to severe pneumonia and death. Typical symptoms include: fever (87.9%), dry cough (67.7%), fatigue (38.1%), sputum production (33.4%), shortness of breath (18.6%), sore throat (13.9%), headache (13.6%), myalgia or arthralgia (14.8%), chills (11.4%), nausea or vomiting (5.0%), nasal congestion (4.8%), diarrhea (3.7%), and hemoptysis (0.9%), and conjunctival congestion (0.8%) [1–6].

Approximately 80% of laboratory-confirmed cases have mild to moderate disease, which includes non-pneumonia and pneumonia cases, 13.8% have a severe disease (dyspnea, respiratory frequency ≥30/minute, blood oxygen saturation ≤93%, PaO2/FiO2 ratio <300, and/or lung infiltrates >50% of the lung area within 24–48 hours, whereby 6.1% are critical (respiratory failure, septic shock, and/or multiple organ dysfunction/failure). Individuals at the highest risk for severe disease and death are people aged over 60 years and those with underlying conditions such as hypertension, diabetes, cardiovascular disease, chronic respiratory disease, and cancer. Disease in children appears to be relatively rare and mild with approximately 2.4% of the total reported cases amongst individuals aged less than 19 years. A very small proportion of those aged less than 19 years have developed severe (2.5%) or critical disease (0.2%). Mortality increases with age, with the highest mortality among people over 80 years of age (CFR 21.9%) [1–6].

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The CFR is higher among males compared to females (4.7% vs. 2.8%), while patients who reported comorbid conditions had much higher rates of COVID-19: 13.2% were with cardiovascular disease, 9.2% diabetes, 8.4% hypertension, 8.0% chronic respiratory disease, and 7.6% with cancer. This virus is highly contagious, can spread quickly, and must be considered capable of causing enormous health, economic and societal damage, on the global level. It is unique among human coronaviruses because it combines high transmissibility, substantial fatal outcomes in some high-risk groups, and the ability to cause huge societal and economic disruption [1–6].

Nano masks and respirators 95

After the appearance of COVID-19, the use of facemasks has become necessary. The surgical facemasks are widely used by medical workers for protection from infection in contact with patients with respiratory diseases. The used facemasks are often very low quality. In the last time, the best filter and masks among them, like N95 filters in respirators show very low protection efficiency against COVID 19. Besides, model simulations, using data relevant to COVID-19 dynamics in the USA, suggest that broad application of even so relatively ineffective facemasks may significantly reduce community transmission of COVID-19 and decrease patient hospitalizations and deaths. Medical masks (i.e., surgical masks and N95 respirators) have yielded more controversial results [7, 8, 9]. The traditional model for respiratory disease transmission infection via infectious droplets (generally 5–10 μm) that have a short lifetime in the air and infect the upper respiratory tract, or finer aerosols, which may remain in the air for many hours, was applied in the case of SARS-CoV-2 [10, 11, 12]. Although the N95 respirator vs. surgical mask offers better protection, great numbers of medical workers that use them are infected by COVID-19, because medical systems in different countries are generally jeopardized. It is well known that such masks may have only a limited effect (but still nontrivial, in terms of absolute lives saved) in more severe epidemics, such as the ongoing epidemic COVID-19.

Masks with HEPA filters are designed with a filter that can be inserted and replaced made of a double-layered HEPA air filter, such as the 3M Filtrete 2800 Ultrafine Filter. The efficacy of non-fit tested HEPA filter masks, such as the Totobobo mask, is still inferior compared to N95, and it should be used with great caution [9]. Additionally it has been noticed that 3M Filtrete MP 2800 filter out particles as small as 0.3 microns, while the size of some viruses, like SARS-CoV-2 is about 0.06–0.14 microns in size. Therefore, its relative efficacy to filter pathogens of the current pandemic is very suspicious. Besides, many researchers think that their efficiency significantly reduces after washing, even in the case of the polypropylene filters (similar to 3M Filtrates). A particular challenge is the maintenance of reusable filters on hospital premises and their alternative decontamination and sterilization with methods such as ultraviolet germicidal irradiation and autoclaving.

N-95 respirator has 95% filtration efficiency, while surgical mask has < 50% filtration ability for small particles (0.1–0.4 μm in diameter). Corresponding studies showed that airflow through the commercial N-95 respirator was very poor, and inhaled air from the enclosed space of the mask was quite hypoxic, with a fraction of inspired oxygen [FIO2], about 16.4%, that is why it is not safe for patients who have pulmonary or cardiovascular diseases or sepsis and who require a good oxygen supply [10].

Future evaluation of masks should include not only their filtration efficiency and safety of their use but also its efficiency in preventing bacteria and viruses infections. Improved masks are urgently needed in order to help to prevent communicable infectious diseases. Finally, although filters in N-95 respirator and surgical masks can partially prevent inhalation of the nano-metric and submicronic airborne particles, they cannot protect us from viruses, like SARS-CoV-2. This fact is shown in one brilliant way given in the text of meta-analysis, which details are described in the Appendix of this paper [12, 13].

Silver and silver compounds

In general, silver is the most efficient antimicrobial and antiviral metal, although some other metals such as zinc, copper, and cobalt have shown effective inhibition of microbes. It is very often used for preventing bacterial colonization of medical devices, as well as on other textile fabrics [12, 14]. It is believed that heavy metals react with proteins by combining the thiol (–SH) groups, which leads to protein inactivation. In the presence of moisture (e.g. from the air), metal ions are formed and inhibit microbial replication. Proposed antimicrobial mechanism is that metal ions destroy or pass through the cell membrane, and bond to the –SH group of cellular enzymes. The consequent critical decrease of enzymatic activity causes microorganism's metabolisms to undergo change and their growth to be inhibited, up to the death of the cell [14]. As it is known, metal ions catalyze the production of oxygen radicals that interact with the molecular structure of bacteria. Then, silver ions lead to protein denaturation influencing cell death by their reaction with nucleophilic amino acid residues in proteins, and their attachments to sulphydryl, amino, imidazole, phosphate and carboxyl groups of membrane or enzyme proteins. Silver also inhibits a number of oxidative enzymes such as yeast alcohol dehydrogenase, influencing the uptake of succinate by membrane vesicles and respiratory chain of *Escherichia coli*, consequently causing metabolite efflux and interference with DNA replication [14, 15]

The actual mechanisms by which antimicrobial substances control microbial growth vary and depend on the type of agent used. Generally, they prevent cell reproduction, damage cell walls or cell permeability, denature proteins, block enzymes and make cell survival impossible [16, 17], while polycationic antimicrobial compounds damage their cytoplasmic membranes following the mechanism adsorption and diffusion through the cell walls, binding to the cytoplasmic membrane and its disruption, releasing

cytoplasmic constituents like K^+ ion, DNA and RNA, and finally causing the cells death. Antimicrobial agents act in two distinct ways: by contact and by diffusion [16, 17].

Surgical face ALBO – nanosliver mask

For the first time, innovative company ALBOS doo, following the procedure that will be patented soon, started producing new protection facemasks. This concept is completely different from the recently used concepts of protection against viruses. Nanosilver masks are very safe, due to its high activity against viruses and bacteria, as it was shown in the example of the *Staphylococcus aureus* bacteria. This experiment, made in Laboratory for control food and drugs, of Scientific Veterinary Institute of Serbia, using so-called horizontal method for quantification of the number of positive staphylococci, showed that the concentration of the total number and coagulase-positive *Staphylococcus* bacteria measured in CFU/ml is less than 1. For comparison both of these values measured for surgical masks (masks without nanosilver) were higher: 1,500,000 CFU/ml, while the total number of bacteria was 18,180,000 CFU/ml. From these data it is clear that these differences are incredibly high, showing the extraordinary efficiency for the concept with nanosilver in antimicrobial protection, not only for health workers but also for general population.

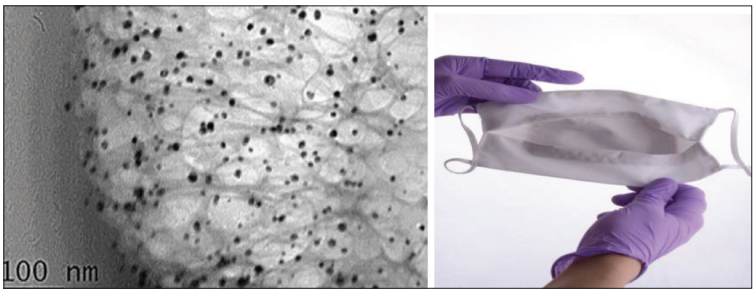

Figure 1. TEM: a) Cross section of thick cotton canvas of ALBO nanosilver mask: average sizes of nanosilver particles are 8–15 nm; b) Typical appearance of ALBO mask with nanosilver
Slika 1. TEM: a) Presek pamučnog dela nanosrebrne maske ALBO: srednja vrednost nanosrebrnih čestica je 8–15 nm; b) Tipičan izgled maske sa nanosrebrnim česticama

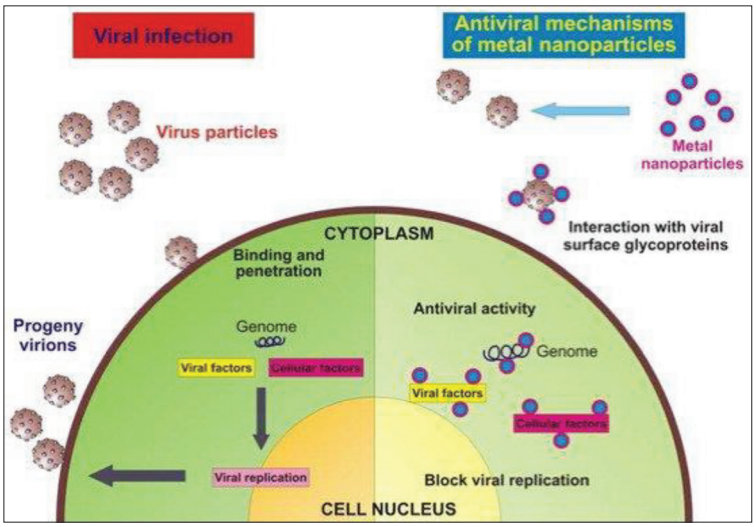

Figure 2. Proposed antiviral mechanisms of action of colloidal silver
Slika 2. Antivirusni mehanizam delovanja koloidalnog srebra

Important question is why *Staphylococcus aureus* was chosen for the experiment. Knowing that they are the leading cause of both healthcare- and community-associated bloodstream infections in the industrialized world influencing significant morbidity and mortality, it was natural to choose such kind of bacteria. Namely, *S. aureus* is a pathogen, which frequently attacks the cardiovascular system inducing its serious complications, such as infective endocarditis or thrombophlebitis, and causing organ failure and death [18–23]. Although similar investigation but on SARS-CoV-2 virus was not done yet, based on the results for *Staphylococcus aureus*, it is possible to extrapolate results. Knowing that virus size is of the order of 100 nm (HIV size is about 120 nm and SARS virus size is also about 100 nm), probably these sizes of NSPs of about 10 nm and less are the most effective in interacting with the virus because the NSPs are significantly smaller than the virus. In the case of the ALBO nanosilver mask, the suitable sizes of NSPs are within the range of 3–10 nm, which are probably the most effective range of NSPs for the killing of any kind of viruses (Figure 1).

Besides, it is approved recently that NSPs of particle sizes between 3 nm – 7 nm are highly effective to suppress viral mechanisms of infection [18–23]. Since biological interactions viruses with human cells are generally multivalent, their attachment and entry into host cells induce strong connections between viral surface components and cell membrane receptors [20–25].

In the case of HIV-1, it is approved that silver nanoparticles inhibit the initial stages of the HIV-1 infection cycle by blocking viral entry, blocking particularly the gp120-CD4 interaction. Besides, silver nanoparticles inhibit also post-entry stages of the HIV-1 life cycle, due to form complexes between silver ions and its donor groups containing sulfur, oxygen, or nitrogen, inside thiols or phosphates in viruses' amino acids and nucleic acids. As a consequence, reverse transcription by direct binding to the RNA or DNA is reduced, as it is shown in Figure 2 [18–23]. Similar kind of interactions can be expected even in the case of SARS-CoV-2.

CONCLUSION

Numerous disadvantages of protective surgical facemasks and masks and respirators with nanofillers N95 are presented. Mata analyses showed no statistically significant differences between them. Besides, it is discussed that a new approach with ALBO filters and masks on the base of nanosilver is new very promising approach. The extraordinary efficiency of these gears on the example of *Staphylococcus aureus*, indicates efficiency of this product

could be much better in case of SARS-CoV-2, comparing to any recently globally applied solution.

Appendix: Meta-analysis of the recently used surgical masks and N95 filters: unexpectedly poor protective efficiency against SARS-CoV-2

There are many conflicting and confusing recommendations for the severe acute respiratory syndrome (SARS) and pandemic influenza: the World Health Organization (WHO) recommends using masks in low risk situations and respirators in high risk situations, but the Centers for Disease Control and Prevention (CDC) recommends using respirators in both low and high risk situations. Besides, N95 respirators are frequently unaffordable [24, 25]. Additionally, previous Meta analyses concluded that real efficiency of N95 respirators is not scientifically and statistically confirmed. More rigorous studies comparing N95 respirators with surgical masks against influenza published in the past decade were not included in previous Meta analyses [26, 27]. However, systematic review and meta analysis on the effectiveness of filters N95 in respirators and surgical masks for prevention of` influenza are extraordinary significant.

One review that compared the efficiency of respirators and ordinary surgical masks was provided for the first time [24]. This review included: i) randomized controlled trial (RCT) study (including cluster randomized trial) and nonrandomized controlled study; ii) humans with influenza (including pandemic strains, seasonal influenza A or B viruses and zoonotic viruses such as swine or avian influenza), and other respiratory viral infections (as a proxy for influenza); iii) N95 respirators versus surgical masks, iv) primary outcome: laboratory confirmed influenza; v) secondary outcomes: laboratory confirmed respiratory viral infections, laboratory confirmed bacterial colonization, laboratory confirmed respiratory infection, and influenza-like illness; and vi) settings: hospital or community [24].

RCTs were selected due to the potential of high evidence level results. Search strategy included all corresponding topic data on PubMed, EMBASE, and The Cochrane Library databases from January 27, 2020; to identify all published papers with the subject related to evaluating the use of masks for preventing influenza. The strategy was adequately adjusted to use in other databases, which included all papers with this topic in the past five years from January 27, 2015, to January 27, 2020. A search also included ClinicalTrials.gov to obtain unpublished data, without publication status and language restrictions on selecting the studies [24–27].

Two reviewers were involved, who independently screened the articles based on the titles, abstracts, and full texts. Then, both of them independently extracted the data included in study like the first author, publication year, country, disease, details of study population and intervention, study design, sample size, settings, and results, while all disagreements were subjected to discussion. Both reviewers independently assessed the risk of bias of the selected RCTs using the Cochrane Risk of Bias tool, which included domains on random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessors, incomplete outcome data, and selective reporting [24–27].

For each RCT, every domain was judged among 3 levels: high risk, unclear risk, and low risk. Disagreements were resolved by discussion. All statistical analyses were performed using Review Manager (RevMan) version 5.3. Comparable data from studies with similar interventions and outcomes were pooled using forest plots. Relative risk (RR) with 95% confidence intervals (CIs) for dichotomous data was used as the effect measure. Between studies heterogeneity was assessed using the I2 for each pooled estimate [28].

It was adopted a random effects model for heterogeneity $p < 0.10$ and performed a subgroup analysis based on the settings (hospital, community) due to the opportunity of clinical heterogeneity. A sensitivity analysis was done to evaluate the robustness of the results by excluding individual studies for each forest plot. A total of 9,171 participants in Canada, Australia, China, or America were included, and the number of participants in each RCT ranged from 435 to 5180 patients. The follow up duration varied from 2 to 15 weeks. Five studies included participants in hospitals and one in households. Because of different definitions of outcome in included studies, it was redefined the laboratory confirmed respiratory infection as respiratory influenza, other viruses, or bacteria infection. Five RCTs involving 8,444 participants reported laboratory confirmed influenza. Meta analysis with fixed effects model revealed no statistically significant differences in preventing influenza using N95 respirators and surgical masks (RR = 1.09, 95% CI 0.92–1.28, $p > 0.05$) [24, 29, 30].

The results of subgroup analyses were consistent regardless of the observed hospital or the community. The results of the sensitivity analysis were not changed after exclusion of any trial. Four RCTs, involving 3,264 participants reported laboratory confirmed respiratory viral infections. Meta analysis with a fixed effects model revealed no statistically significant differences in preventing respiratory viral infections using N95 respirators and surgical masks (RR = 0.89, 95% CI 0.70–1.11, $p > 0.05$). The results of subgroup analyses were also consistent regardless of the hospital or the community [24, 29, 30]. Two RCTs involving 6,621 participants with reported laboratory confirmed respiratory infection. Meta analysis with random effects model revealed no statistically significant differences in preventing respiratory infection using N95 respirators and surgical masks in hospitals (RR = 0.74, 95% CI 0.42–1.29, $p > 0.05$) [24, 29, 30].

Five RCTs involving 8,444 participants reported influenza-like illness [24, 29, 30]. Meta analysis with the random effects model also revealed no statistically significant differences in preventing influenza-like illness using N95 respirators and surgical masks (RR = 0.61, 95% CI 0.33–1.14, $p > 0.05$). The sensitivity analysis showed results remained unchanged after excluding each trial [24, 29, 30]. This meta-analysis showed no statistically significant differences in preventing laboratory confirmed

influenza, laboratory confirmed respiratory viral infections, laboratory confirmed respiratory infection, and influenza like illness using N95 respirators and surgical masks. In subgroup analysis, similar results could be found in the hospital and community for laboratory confirmed influenza and laboratory confirmed respiratory viral infections. However, sensitivity analysis showed unstable results for the prevention of laboratory confirmed respiratory viral infections and laboratory confirmed respiratory infection. Through the course of influenza pandemics, large numbers of facemasks may be required to use in long periods to protect people from infections [24, 31].

Using N95 respirators is likely to result in discomfort, for example, headaches. A previous study reported that there was an inverse relationship between the level of compliance with wearing N95 respirator and the risk of clinical respiratory illness. It is difficult to ensure high compliance due to discomfort of N95 respirators in all studies [24, 31]. The reason for the similar effects on preventing influenza with use of N95 respirators *versus* surgical masks may be related to low compliance to N95 respirators wear, which may lead to more frequent doffing compared to surgical masks [31]. Although N95 respirators in the routine use seem to be less acceptable than surgical masks due to more significant discomfort, it should be noted that surgical masks are primarily designed to protect the environment from the wearer, whereas the respirators are supposed to protect the wearer from the environment [24, 32].

In conclusion, the current meta analysis shows the use of N95 respirators compared to surgical masks is not associated with lower risk of laboratory confirmed influenza. It suggests that N95 respirators should not be recommended for the general public and medical staff that are not in close contact with influenza patients or suspected patients [24, 32].

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Novi pristup efikasnoj zaštiti protiv kovida 19 baziran na nanotehnologiji

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KRATAK SADRŽAJ

U ovom radu opisan je novi pristup zaštiti od bakterija i virusa, uključujući i SARS-CoV-2. Na konkretnom primeru *Staphyloccocus aureus* zaštitni filteri ALBO nanosrebrne maske pokazali su izuzetnu efikasnost. Dobijeni rezultati daleko prevazilaze efikasnost običnih hirurških maski. Pored toga, metaanaliza koja je analizirala hirurške maske i filtere za maske N95 pokazuje da nema statistički značajne razlike u njihovoj efikasnosti kada je u pitanju zaštita od virusa SARS-CoV-2. Na osnovu eksperimentalnih rezultata i metaanalize prikazane u ovom radu može se zaključiti da ALBO nanosrebrne maske imaju značajne prednosti nad svim sada korišćenim maskama i predstavljaju veoma perspektivan koncept razvoja nove zaštitne opreme.

Ključne reči: kovid 19; bakterije; virusi; ALBO maske sa nanosrebrom; maske N95; hirurške maske

O virusu SARS-CoV-2 koji izaziva bolest kovid 19

Krajem 2019. uzorci iz bronhijalnih alveola kod bolesnika sa pneumonijom nepoznate etiologije ispitivani su real-time PCR metodom, koja je pokazala prisustvo pan-beta koronavirusa SARS-CoV-2. Dalje, korišćenjem ilumina i nanopornog sekvenciranja određene su sve sekvence genoma virusa, čime je potvrđena sličnost između SARS i SARS-CoV-2, čiji je oblik krune i citopatogeni efekat potvrđen 96 sati posle inokulacije. Ispitivanja na transgenim miševima soja ACE2 i majmunima vrste Rhesus pokazala su multifokalnu pneumoniju sa intersticijalnom hiperplazijom [1]. Histološko istraživanje postmortem uzoraka 50-godišnjeg bolesnika iz Vuhana pokazalo je difuzno bilateralno oštećenje alveola sa ćelijskim fibromiksoidnim eksudatom. Pored toga, njegova pluća pokazala su akutni respiratorni distres sindrom, ćelijsku i fibromiksoidnu eksudaciju, deskvamaciju pneumocita i plućni edem, dok je intersticijalni mononuklearni infiltrat bio sačinjen pretežno od limfocita u oba plućna krila. Uz to, multinukelarne sincicijalne ćelije, sa atipičnim uvećanim pneumocitima karakterišu velika jedra, granulirana citoplazma i prominentni nukleolusi u intraalveolarnim prostorima, koji pokazuju citopatične promene [1–6].

Kao što je već poznato, SARS-CoV-2 se prenosi putem čestica u bliskom nezaštićenom kontaktu sa inficirane osobe na neinficiranu, dok prenos putem vazduha nije zabeležen. Njegov prenos sa osobe na osobu najčešće se odvija u okviru porodica. Testiranje za SARS-CoV-2 podrazumeva RT-PCR u okviru testiranja na bolesti slične gripu i akutnu respiratornu infekciju, kao i testiranje među svim posetiocima u infektivnoj klinici [1–6].

S obzirom na to da je SARS-CoV-2 novi patogen, ljudi ne poseduju imunitet na njega, što predstavlja glavni faktor rizika za infekciju. Dalje, njegova transmisija je jako brza, posebno u uzlaznoj fazi epidemije i postkontrolnom periodu [1–6].

Simptomi kovida 19 su nespecifični i variraju od izostanka simptoma (asimptomatskih) do ozbiljnih pneumonija i smrti. Tipični simptomi statistički podrazumevaju: groznicu (87,9%), suvi kašalj (67,7%), umor (38,1%), stvaranje sputuma (33,4%), kratak dah (18,6%), zapaljenje grla (13,9%), glavobolju (13,6%), bol u mišićima ili zglobovima (14,8%), drhtavicu (11,4%), muku i povraćanje (5,0%), nazalnu kongestiju (4,8%), dijareju (3,7%), hemoptiziju (0,9%) i konjuktivalnu kongestiju (0,8%) [1–6].

Otprilike 80% laboratorijski potvrđenih slučajeva ima slabo ili umereno izraženo oboljenje koje podrazumeva slučajeve sa pneumonijom i bez nje, 13,8% ima ozbiljne simptome (dispneja – frekvenca disanja ≥ 30/minuta, saturacija kiseonikom ≤ 93%, PaO_2 / FiO_2 ratio < 300, plućni infiltrat infiltrira > 50% plućne regije u roku od 24–48 sati, dok je 6,1% pacijenata kritično (respiratorni zastoj, septični šok, i/ili disfunkcija ili zastoj više organa). Osobe koje su u najvećem riziku za ozbiljno oboljenje i smrt jesu osobe preko 60 godina i osobe sa već postojećim oboljenjima kao što su hipertenzija, dijabetes, kardiovaskularne bolesti, hronične respiratorne bolesti i maligna oboljenja. Oboljenje je kod dece relativno retko i blago, otprilike 2,4% svih obolelih jesu osobe ispod 19 godina. Veoma mali procenat osoba ispod 19 godina je razvio ozbiljno (2,5%) ili kritično oboljenje (0,2%). Mortalitet se povećava sa godinama, a najveći je kod osoba preko 80 godina (CFR 21,9%) [1–6].

Stopa smrtnosti je veća među muškarcima nego među ženama (4,7% vs. 2,8%), posebno kod bolesnika sa udruženim komorbiditetima: 13,2% su kod onih koji su imali kardiovaskularne bolesti, 9,2% dijabetes, 8,4% hipertenziju, 8,0% hronične respiratorne bolesti i 7,6% maligne bolesti. Ovaj virus je visoko kontagiozan, brzo se širi i može se smatrati jako opasnim jer izaziva zdravstvene, ekonomske i socijalne probleme na globalnom nivou. Jedinstven je među humanim koronavirusima jer kombinuje visoku prenosivost, česte fatalne ishode u visokorizičnim grupama, kao i velike socijalne i ekonomske promene [1–6].

Nanomaske i maske N95

Nakon što se pojavio virus SARS-CoV-2, korišćenje zaštitnih maski postaje obevezno. Zaštitne maske se najviše koriste među zdravstvenim radnicima kao zaštita od kapljica u kontaktu sa bolesnicima sa respiratornim infekcijama. Izbor maski je različit za različite zemlje, uključujući i korišćenje maski N95. Simulacije modela, korišćenjem relevantnih podataka o dinamici infekcije kovid 19 u USA, sugerišu da bi široka upotreba čak i relativno neefikasnih maski mogla smanjiti prenos kovida 19 i umanjiti broj

hospitalizovanih bolesnika i smrtnih ishoda. Podaci govore da bi upotreba univerzalnih (80%) ili umereno efikasnih (50%) maski mogla da spreči 17–45% očekivanih smrtnih ishoda. Medicinske maske (hirurške maske i maske N95) ipak pokazuju kontroverzne rezultate [7, 8, 9]. Podsetimo da se kod SARS-CoV-2 najčešće primenjuje tradicionalni model prenosa respiratornih infekcija preko infektivnih čestica (najčešće 5–10 μm), koje imaju kratko preživljavanje u vazduhu i inficiraju gornji deo respiratornog trakta, ili sitnijih čestica koje mogu ostati u vazduhu [10, 11, 12].

Iako maske N95 u odnosu na hirurške maske nude bolju zaštitu, one imaju i mnogo mana, što pokazuje i veliki broj obolelih zdravstvenih radnika od infekcije kovid 19, jer su medicinski sistemi generalno preopterećeni u svim zemljama. Poznato je da maske imaju samo ograničen efekat (ali i dalje nije zanemarljiv, u kontekstu spašenih života) kod ovako ozbiljnih epidemija kao što je kovid 19.

Maske sa HEPA filterima su dizajnirane tako da imaju zamenjivi filter napravljen od duplog HEPA vazdušnog filtera, kao što je 3M 2800 ultrafini filter. Efikasnost maski sa HEPA filterom, kao što je maska Totobobo, pokazuje i dalje njihovu inferiornost u smislu filtrativne sposobnosti u odnosu na maske N95, zato bi zbog svoje izuzetno niske efikasnosti trebalo da se koriste veoma oprezno [9].

Takođe, primećeno je da filteri 3M MP 2800 filtriraju čestice veličine 0,3 mikrona, dok je veličina nekih virusa, npr. SARS-CoV-2, oko 0,06–0,14 mikrona. S tim u vezi, njihova relativna efikasnost u filtriranju patogena u slučaju trenutne pandemije potpuno je upitna. Uz to, mnogi istraživači misle da se efikasnost ovakvih maski značajno smanjuje posle pranja čak i u slučaju polipropilenskih filtera (sličnih 3M filteru). Poseban izazov je održavanje filtera za višekratnu upotrebu u bolničkim prostorijama i njihova dekontaminacija i sterilizacija uz pomoć germicidnih lampi i autoklava.

Maske N95 imaju 95% efikasnost filtracije, dok obične maske imaju 50% efikasnosti filtracije za male čestice (0,1–0,4 mikrona u dijametru). Studije su pokazale da je protok vazduha kroz komercijalnu masku N95 loš. Uz to, primećeno je da je inhalirani vazduh iz maske hipoksičan, sa frakcijom udahnutog kiseonika FIO_2 oko 16,4%, zbog čega nije bezbedan za bolesnike koji imaju plućne i kardiovaskularne bolesti ili sepsu, i koji zahtevaju dobro snabdevanje kiseonikom [10].

Evaluacija maski trebalo bi da uključuje ne samo efikasnost filtracije i bezbednost njihove primene već i efikasnost prevencije da bakterije i virusi prežive pri prolasku kroz filter. Sve navedeno ukazuje na to da su hitno potrebne maske koje mogu mnogo bolje da zaštite posebno medicinske radnike od infektivnih bolesti, od virusa SARS-CoV-2 [12, 13].

Srebro i srebrne legure

Srebro je, generalno, najefikasniji materijal kao antimikrobni i antivirusni metal, iako su neki drugi metali, kao što su cink, bakar i kobalt, takođe pokazali efikasnu inhibiciju mikroba. Najčešće se koristi za prevenciju bakterijske kolonizacije na medicinskim sredstvima, kao i na raznim tekstilnim materijalima [12, 14].

Veruje se da teški metali reaguju sa proteinima interreagujući sa tiol (-SH) grupom, što dovodi do njegove inaktivacije. U prisustvu tečnosti, npr. iz vazduha, oslobađaju se metalni joni koji inhibiraju replikaciju mikroba. Kratko objašnjenje njegovog antimikrobnog mehanizma je sledeće: metalni joni srebra uništavaju ili prolaze kroz ćelijsku membranu i vezuju se za -SH grupe ćelijskih enzima. Oni tako dovode do kritičnog smanjenja enzimske aktivnosti, koja dovodi do promene metabolizma mikroorganizama i inhibicije njihovog rasta, prouzrokujući na kraju ćelijsku smrt [14].

Metalni joni takođe proizvode kiseonične radikale, koji oksidišu molekularnu strukturu bakterija. Joni srebra mogu da dovedu i do denaturacije proteina i ćelijske smrti zbog njihove reakcije sa nuklofilnim reziduama aminokiselina u proteinu i njihovim sulfidnim vezama u amino, imidazol, ili fosfatnim i karboksilnim grupama membrane ili enzimskih proteina. Srebro takođe smanjuje koncentraciju oksidativnih enzima dehidrogenaze, utiče na preuzimanje sukcinata od strane vezikula i respiratornog lanca Ešerihije koli, što dovodi do metaboličkog efluksa i inhibira replikaciju DNK [14, 15].

Pravi mehanizmi kojima antimikrobne supstance kontrolišu mikrobni rast su ekstremno promenljive i zavise od korišćenog agensa. Generalno, oni sprečavaju ćelijsku reprodukciju, oštećuju zid ili ćelijsku propustljivost, denaturišu proteine, blokiraju enzime i onemogućavaju ćelijsko preživljavanje [16, 17], dok polikatjonske antimikrobne smeše oštećuju ćelijske citoplazmatske membrane mikroba kroz adsorpciju na površini ćelijske membrane mikroba, difuziju kroz ćelijski zid, vezivanje za citoplazmatsku membranu, oštećenje citoplazmatske membrane, otpuštanje citoplazmatskih konstituenata kao što su K^+ joni, oštećenja DNK i RNK i smrt ćelije [16, 17].

Hirurške maske sa nanosrebrom – ALBO

Prvi put, ove maske se proizvode od strane inovativne kompanije ALBOS doo, Beograd, procedurom koja će ubrzo biti patentirana. Ovaj koncept je potpuno drugačiji od dosadašnjih koncepata za proizvodnju zaštitne opreme, koji su kroz pomenutu metaanalizu pokazali značajne negativne strane, čak i u slučaju filtera N95 u nanomaskama N95. S druge strane, ove maske su veoma aktivne, kao što je pokazano u primeru njihove interakcije sa bakterijom *Staphylococcus Aureus*. U ovom eksperimentu, koji je sproveden u Laboratoriji za kontrolu hrane i lekova Veterinarskog fakulteta u Beogradu, korišćenjem horizontalne metode kvantifikacije broja pozitivnih stafilokoka pokazano je da je konačni broj bakterija i koagulaza-pozitivnih stafilokoka izmerenih u CFU/ml manji od 1. Radi poređenja, broj koagulaza-pozitivnih stafilokoka za masku bez nanosrebra iznosio je 1.500.000 CFU/ml, dok je ukupan broj bakterija iznosio 18.180.000 CFU/ml. Ove razlike su zaista izuzetno visoke, i pokazuju neverovatnu efikasnost ovog koncepta zaštite, ne samo za zdravstvene radnike već i za obične građane.

Suštinsko pitanje je zašto je *Staphylococcus Aureus* izabran za takav eksperiment. Znajući da su ove bakterije jedan od glavnih uzroka infekcije i u zdravstvu i među stanovništvom u industrijalizovanom svetu, sa visokim stepenom morbiditeta i mortaliteta, bilo je logično izabrati ovakvu bakteriju. Naime, *S. Aureus* je oportunistički veoma opasan patogen koji posle ulaska u kardiovaskularni sistem može dovesti do ozbiljnih komplikacija, kao što su infektivni endokarditis i tromboflebitis, rezultirajući otkazivanjem organa i smrtnim ishodom [18–23].

Iako još uvek nije bilo šanse da se slično istraživanje organizuje za SARS-CoV-2, na osnovu rezultata sa *S. Aureus* može se pretpostaviti da će rezultati biti i za SARS-CoV-2 mnogo bolji nego u slučaju sada dostupnih zaštitnih maski. S obzirom na to

da su čestice virusa veličine 100 nm (HIV je oko 120 nm i SARS virus oko 100 nm), verovatno su veličine nanočestica srebra (NSP) od oko 10 nm i manje najefikasnije u interakciji sa virusom jer su takve čestice značajno manje od virusa. U slučaju nanosilver maske ALBO odgovarajuće čestice nanosrebra su u rangu 7–15 nm, što je verovatno veoma efikasna veličina u ubijanju bilo koje vrste virusa (Slika 1).

Pored toga, dokazano je da su nanočestice srebra veličine 7–15 nm visokoefikasne u supresiji virusnih mehanizama infekcije [18–23]. Uzimajući u obzir da su biološke interakcije virusa i humane ćelije generalno viševalentne, vezivanje i ulazak virusa u ćeliju domaćina predstavlja sjajan primer viševalentne interakcije između površine virusa i ćelijske membrane receptora [18–23].

U slučaju HIV-1 dokazano je da nanočestice inhibiraju inicijalni stadijum HIV1 infektivnog ciklusa, blokirajući posebno interakciju gp120-CD4. Pored toga, nanočestice srebra inhibiraju takođe stadijume životnog ciklusa, ulaska virusa HIV1 u ćeliju jer formiraju komplekse sa ćelijskim elektronskim donorskim grupama koje sadrže sumpor, kiseonik ili azot, koji su normalno prisutni u tiolima i fosfatima aminokiselina i nukleinskih kiselina. To sve ometa reverznu transkripciju direktnim vezivanjem za RNK i DNK molekule, čiji je mehanizam prikazan na slici (Slika 2) [18–23]. Sličan način interakcije se očekuje u slučaju SARS-CoV-2, što će veoma brzo biti provereno, posle prvog istraživanja zaštitnih svojstava nanorebrne maske ALBO, koje se očekuje u bliskoj budućnosti.

ZAKLJUČAK

U radu su prikazane brojne negativne strane zaštitne opreme, hirurških maski i maski N95. Metaanaliza je pokazala da ne postoji statistički značajna razlika između njih sa stanovišta njihove efikasnosti u zaštiti od virusa, uključujući i SARS-CoV-2. Pored toga, predstavljen je novi pristup zaštite sa filterima ALBO na bazi nanosrebra koji pokazuju neuporedivo veću efikasnost zaštite. Neverovatna efikasnost ovakvih maski na primeru bakterije *Staphylococcus Aureus* pokazuje da će očekivana efikasnost ovog proizvoda biti mnogo bolja i za SARS-CoV-2 od bilo kog do sada, bilo gde u svetu, primenjenog rešenja.

Apendiks: Metaanaliza – hirurške maske i filteri N95: neočekivano loša zaštita od kovida 19

Postoji mnogo konfliktnih stavova u vezi sa virusom SARS i pandemijskim gripom – Svetska zdravstvena organizacija (WHO) predlaže korišćenje maski u situacijama niskog rizika, a u situacijama visokog rizika predlažu se maske N95, dok Centar za kontrolu bolesti i prevenciju (CDC) predlaže korišćenje maski N95 u situacijama i niskog i visokog rizika. Pored toga, maske N95 su vrlo često finansijski nepristupačne [24, 25].

Dodatno, prethodna metaanaliza je dokazala da prava vrednost maski N95 nije naučno i statistički dokazana. Rigoroznija klinička testiranja i poređenja efikasnosti hirurških i maski N95 koja se odnose na prošlu deceniju nisu bila uključena u prethodnu metaanalizu [26, 27].

Zbog toga je povećan broj istraživanja na temu korišćenja maski za zaštitu protiv gripa, kao i broj preglednih radova i metaanaliza sa ciljem da se uporedi efikasnost hirurških i maski N95.

U jednom izuzetnom istraživanju na ovu temu dat je prvi pregled efikasnosti hirurških i maski N95. Ovaj rad je obuhvatio: 1) randomizovanu kliničku studiju (koja uključuje klaster-randomizovanu kliničku studiju) i nerandomizovanu kontrolisanu studiju, 2) osobe sa gripom (uključujući pandemijske vrste, sezonski grip A i B, svinjski i ptičji grip), 3) intervenciju i poređenje: maske N95 vs. hirurške maske, 4) primarni ishod: laboratorijski potvrđen grip, 5) sekundarni ishod: laboratorijski potvrđenu virusnu infekciju, laboratorijski potvrđenu respiratornu infekciju i oboljenje slično gripu i 6) okruženje: bolnicu ili lokalnu zajednicu [24].

Kliničke studije odabrane su zahvaljujući mogućnosti dobijanja kvalitetnih naučnih informacija. Strategija pretraživanja podešena je tako da uključi sve podatke u vezi sa tom temom u bazama PubMed, EMBASE i Cochraine Library od 27. januara 2020. kako bi se identifikovali svi objavljeni radovi na temu evaluacije maski u zaštiti od influence. Strategija je adekvatno prilagođena da bi mogla da koristi podatke i u drugim bazama podataka, što je omogućilo da se u ovu analizu uključe svi radovi na ovu temu u proteklih pet godina, od 27. januara 2015. do 27. januara 2020. Pretraga je takođe obuhvatila www.clinicaltrials.gov, da bi se u analizu uključili i neobjavljeni rezultati, bez statusa publikacije i jezičke restrikcije [24–27]. Istraživanje su radila dva istraživača, koja su nezavisno pretraživala radove na osnovu naslova, apstrakta i teksta. Zatim su oba istraživača nezavisno izdvojila podatke kao što je prvi autor, godina publikacije, država, oboljenje, detalji o populaciji i intervenciji, dizajn studije, veličina uzorka, mesto i rezultati, dok su sva neslaganja bila podložna diskusiji. Oba istraživača nezavisno su uključila u sebe i rizik od nezavisnosti odabranih kliničkih studija koristeći *Cochraine Risk of Bias tool* [26–29]. Za svaku kliničku studiju svaki domen je procenjivan na tri nivoa: visok rizik, nejasan rizik i nizak rizik. Neslaganja su rešena diskusijom. Sve statističke analize su sprovedene korišćenjem softvera Review Manager, verzija 5.3. Upoređeni su podaci iz studija sa sličnim intervencijama i svi njihovi rezultati su korišćeni u odgovarajućim bazama podataka. Relativni rizik sa 95% pouzdanosti za dihotomne rezultate je korišćen za procenu efikasnosti maski. Procena heterogenosti podataka je izvedena procenom heterogenosti svakog pojedinačnog seta podataka [28].

Usvojen je random model heterogenosti $p < 0,10$ i sprovedena je analiza podgrupa na osnovu mesta ispitivanja (bolnica, lokalna zajednica) zbog kliničke heterogenosti. Urađena je analiza senzitivnosti zbog evaluacije usklađenosti rezultata za svaku posebnu bazu podataka. U studiju je uključeno ukupno 9171 učesnika u Kanadi, Australiji, Kini, dok je broj učesnika u pojedinačnim studijama bio između 435 i 5180 pacijenata. Period praćenja iznosio je od dve do 15 nedelja. Pet studija obuhvatilo je učesnike u bolnicama, i jedna u domaćinstvu. Zbog različitih definicija ishoda u uključenim studijama laboratorijski potvrđena respiratorna infekcija redefinisana je kao respiratorna influenca, ili neka druga virusna ili bakterijska infekcija. Pet kliničkih studija sa 8444 učesnika su potvrdile laboratorijski potvrđeni grip. Metaanaliza sa modelom fiksnih efekata otkrila je da ne postoji statistički značajna razlika u zaštiti od gripa između hirurških maski i maski N95 (RR = 1,09, 95% CI 0,92–1,28, $p > 0,05$) [24, 29, 30].

Metaanaliza primenom modela fiksnih efekata otkrila je da ne postoji statistički značajna razlika u prevenciji od SARS Cov 2 ili nekog drugog virusa i bakterije sa hirurškom maskom i maskom N95 (RR = 1,09, 95% CI 0,92–1,28, $p > 0,05$).

Rezultati analize podgrupe bili su konzistenti bez obzira na to da li je posmatrana bolnica ili neka lokalna zajednica. Rezultati testa senzitivnosti nisu se promenili posle isključenja bilo koje kliničke studije. Četiri studije koje uključuju 3264 učesnika saopštile su laboratorijski potvrđenu respiratornu virusnu infekciju. Metaanaliza primenom modela fiksnih efekata pokazala je da nema statistički značajnih razlika u prevenciji respiratorne virusne infekcije sa hirurškom maskom i maskom N95 (RR = 0,89, 95% CI 0,70–1,11, p > 0,05). Rezultati analize podgrupe su bili konzistentni bez obzira na to da li je u pitanju bolnica ili neka lokalna zajednica [24, 29, 30].

Dve studije obuhvatile su 6621 učesnika sa laboratorijski potvrđenom respiratornom infekcijom. Metaanaliza primenom modela fiksnih efekata pokazala je da nema statistički značajnih razlika u prevenciji respiratorne virusne infekcije sa hirurškom maskom i maskom N95 u bolnici (RR = 0,74, 95% CI 0,42–1,29, p > 0,05) [24, 29, 30].

Pet kliničkih studija sa 8444 učesnika prijavile su oboljenje slično gripu. Metaanaliza primenom modela fiksnih efekata pokazala je da nema statistički značajnih razlika u prevenciji oboljenja sličnom gripu sa hirurškom maskom i maskom N95 u bolnicama (RR = 0,61, 95% CI 0,33–1,14, p > 0,05). Senzitivnost analize pokazala je da rezultati ostaju isti posle isključivanja bilo koje kliničke studije.

Metaanalize su pokazale da ne postoje statistički značajne razlike kod prevencije laboratorijski potvrđenog gripa, laboratorijski potvrđene respiratorne virusne infekcije, laboratorijski potvrđene respiratorne infekcije i oboljenja sličnom gripu, uključujući i kovid 19, korišćenjem maske N95 i hirurške maske. U analizama podgrupa dobijaju se slični rezultati u bolnicama ili lokalnim zajednicama za laboratorijski potvrđen grip i laboratorijski potvrđenu respiratornu virusnu infekciju. Za vreme pandemije gripa potreban je jako veliki broj zaštitnih maski u dužem periodu kako bi se ljudi zaštitili od infekcije [24, 31].

Korišćenje maski N95, pored toga što su niske efikasnosti, najčešće je udruženo sa poteškoćama disanja, koje mogu dovesti do glavobolje. Prethodna studija pokazala je da postoji obrnuta veza između nivoa saradnje ispitanika pri nošenju maske N95 i rizika za kliničko respiratorno oboljenje. Teško je obezbediti visok nivo saradnje pri nošenju maski N95 u svim studijama, jer je ona izrazito nekomforna za pacijente i bolničko osoblje [26–32].

Razlog za slične efekte u zaštiti od gripa kod maski N95 i hirurških maski može biti loša saradnja pri nošenju maski N95. Zbog toga dolazi i do češćeg skidanja maski N95 u poređenju sa hirurškim [31].

Maske N95 u rutinskoj upotrebi izgledaju manje prihvatljive zbog manjeg komfora pri nošenju. Ovde treba napomenuti da su takve maske primarno dizajnirane da zaštite okolinu od osobe koja je nosi, dok su maske N95 napravljene da zaštite osobu koja je nosi od okoline [24, 32].

Ova metaanaliza je pokazala da korišćenje maski N95 u poređenju sa hirurškim maskama nema za posledicu manji rizik od laboratorijski potvrđenog gripa. Sugeriše se da maske N95 ne bi trebalo da se preporučuju stanovništvu i medicinskom osoblju ukoliko nisu u bliskom kontaktu sa pacijentima koji imaju grip ili sa suspektnim pacijentima [24, 32].

CASE REPORT
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Dental manifestations of the hypophosphatemic rickets – a case report

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SUMMARY

Rickets is a disorder of bone mineralization in children's skeleton. It is most often associated with vitamin D deficiency, however, it can also occur due to a decrease in serum phosphate levels, which leads to inadequate tissue mineralization, with consequent skeletal deformity and growth disorders. Patients with hypophosphatemic rickets show teeth changes at the morphological and histological level, as well as on radiological images.

The aim of this study was to perform clinical and radiological evaluation of dental manifestations of hypophosphatemic rickets in a four-year-old boy, as well as to point out the necessity of including a dentist in the treatment of this disease in order to prevent oral complications.

Keywords: hypophosphatemia; rickets; dentin; periapical abscess

INTRODUCTION

Hypophosphatemic rickets, also known as vitamin D resistant rickets, or X-linked rickets, is an inherited syndrome characterized by inadequate cartilage and bone mineralization leading to skeletal deformities and growth disorders. It is caused by a mutation in the PHEX gene (endopeptidase responsible for the regulation of phosphate encoded by the X chromosome), leading to an increase in fibroblast growth factor 23 (FGF23), which is a regulator of renal phosphate reabsorption [1, 2]. The pathophysiological mechanism is reflected in the reduction of phosphate reabsorption by renal tubules, which leads to hyperphosphaturia and hypophosphatemia, causing rickets [3]. The prevalence of the disease is 1:20,000 [4, 5]. Standard treatment of these patients include the administration of oral phosphate supplements and active vitamin D [1, 3]. Recently, attempts have been made to use anti-FGF23 antibodies that act on the primary disease by blocking FGF23 and thus regulating phosphate homeostasis [1, 2]. Hypophosphatemia is the cause of dentin dysplasia due to disorders in the mineralization of the dentinal matrix when the globular dentin is clearly observed. Tubular defects are also present, which can extend to the dentin-enamel junction. In addition to disturbances in mineralization, thin enamel, dentinal clefts, especially large pulp chambers, as well as prominent pulp horns that extend to the dentin-enamel junction could be clearly observed on radiological images [4]. There are indications in the literature that patients with hypophosphatemic rickets are characterized by the appearance of multiple spontaneous periapical abscesses [5, 6, 7]. Among dental characteristics, taurodontism, poorly defined lamina dura and hypoplasia of the alveolar ridges could be also present [6, 8].

CASE REPORT

A four-year-old boy was referred from the Clinic of Pediatrics, Clinical Center Niš, due to oral complications related to hypophosphatemic rickets. The treatment of the rickets included treatment with phosphate supplements and active form of vitamin D, which led to the correction of clinical and laboratory findings.

General examination revealed a patient with clinical characteristics of the rickets: deformity of the lower extremities, changes in gait and short stature. No extraoral changes were observed. Intraoral examination revealed that all teeth of deciduous dentition were erupted. In the upper jaw, all anterior teeth were completely destructed by decay and residual roots were present. According to the father, there was swelling in the area of the anterior teeth previously, and a dentist provided first aid but further cooperation with the child was not established. Circular decay was observed on the upper canines, large carious lesions with open pulp chamber and necrotic pulp were observed on the upper first molars, while superficial caries in occlusal fissures was observed on the upper second molars. In the lower jaw, anterior teeth were heavily destructed, large class V caries on the canines, large carious lesions with open pulp chamber, necrotic pulp and class V cavities on the first molars, and class I cavities on the

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Figure 1. Carious lesions on mandibular deciduous teeth
Slika 1. Karijesne lezije na mlečnim zubima donje vilice

Figure 2. Large carious lesions on anterior deciduous teeth
Slika 2. Velike karijesne lezije na mlečnim prednjim zubima

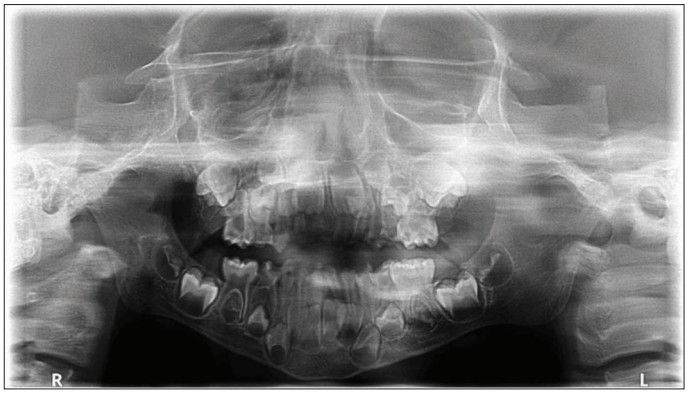

Figure 3. Panoramic radiograph shows large pulp chambers of deciduous molars, large carious destructions of deciduous teeth and unerrupted permanent teeth.
Slika 3. Panoramski snimak pokazuje uvećane komore pulpe na mlečnim molarima, velike karijesne destrukcije na mlečnim zubima i zametke stalnih zuba.

second molars were observed. According to the father, there was no swelling in the lower jaw (Figure 1 and 2).

The analysis of the panoramic radiograph showed the presence of unerrupted permanent teeth, unerrupted first and second mandibular molars and first maxilarry molars. On the deciduous molars, large pulp chambers with prominent horns were clearly visible. The chambers of the other deciduous teeth could not be examined due to large carious destructions (Figure 3).

The recommended treatment included conservative restoration of all four deciduous second molars, which was postponed due to lack of child cooperation. Since extractions of necrotic teeth would lead to even more intensive odontophobia, frequent controls were recommended. Parents were instructed on the need to maintain good oral hygiene.

DISCUSSION

Hypophosphatemic rickets is a skeletal disorder that is characterized by hypophosphatemia. As phosphate is essential for mineralization, this condition affects the tissues in which mineralization takes place physiologically - bones, teeth and the growth plate cartilage [1]. The presence of dental malformations in patients with hypophosphatemic rickets has been reported in numerous studies [7, 9, 10]. Teeth in patients with hypophosphatemic rickets show enlarged pulp chambers, a wide zone of predentin, visible globular dentin, and defects in tubular dentin that extend from the pulp to enamel. Enamel is thin, usually normal structure, but sometimes can be hypoplastic [6, 7]. Histological sections can also show extensive enamel cracking and fissuring, as well as defects in dentin mineralization. Unmerged dentin calcospherites are observed and separated by large non-mineralized interglobular spaces [10].

Although odontoblast function is normal, hypophosphatemia leads to poor mineralization which causes dentin dysplasia with clearly visible globular dentin. Due to the period of formation and mineralization of dentin in deciduous teeth in the period from 4 months in utero to 11 months of age of the child, defects in deciduous dentition usually cannot be prevented [6, 7]. If the treatment of the rickets starts as soon as possible after birth, it could be expected to have a positive effect on the formation and development of permanent teeth [6]. However, despite treatment, abnormalities in tooth development and dentin formation in permanent dentition could be observed [7]. Radiological findings in such patients most often show thin enamel, decreased radiological density of dentin, enlarged pulp chambers, prominent pulp horns, taurodontism and anodontia [8, 10].

The dominant feature of this disease is the appearance of multiple spontaneous periapical abscesses [4, 5, 7, 10]. These abscesses can also occur on teeth that show no signs of caries or trauma. Clinically, the patient's teeth may look normal and healthy, which complicates proving the endodontic origin of the infection and makes it difficult to identify causing teeth. This specificity can be explained by defects in dentin mineralization. Initial caries or even initial attrition can remove a thin layer of enamel, which facilitates the access of microorganisms to the pulp chamber through the exposed horn of the pulp or through poorly mineralized dentin. Thus, a seemingly non-carious or minimally carious tooth could be subject to infection

of the pulp tissue and formation of periapical abscess [4]. Light microscopic examinations showed penetration of microorganisms through enamel microcracks and their further spread along the dentin-enamel junction [5].

Data on the association of hypophosphatemic rickets with the occurrence of malocclusions were not frequently reported. In a study by Souza et al. (2010) that included 20 patients, it was reported that open bite was the most frequent anomaly that can be explained by delayed maxillary growth in relation to the growth of mandible. Although reported as a common occurrence in the literature, none of their patients showed taurodontism [6].

The therapeutic approach is mainly related to the treatment of periapical abscesses. These abscesses, especially those in deciduous teeth, spread rapidly through the jawbone, which is why extraction of such teeth is necessary [6, 7]. Prevention of abscess formation should involve the application of self-etching adhesive systems and filling the tooth surfaces with light-cured flowable resin to form a barrier that would prevent the penetration of microorganisms. Deciduous teeth treated this way should be frequently checked, and, if necessary, resin barriers should be repeated until the teeth exfoliate [10]. At the same time, fluoride should be applied, and oral hygiene should be rigorously maintained. Prophylactic protection of deciduous molars with metal crowns and protection of anterior teeth with composite resins were also found in the literature [4]. However, this protection measure is often criticized because during the preparation of the teeth, the already enlarged pulp could be open, but also if multiple extractions of deciduous posterior teeth are needed it leads to the loss of the vertical dimension [7]. Preventive pulpotomy of all deciduous teeth with superficial caries is also mentioned as one of the treatment options [4, 5].

CONCLUSION

Hypophosphatemic rickets, as a rare form of rickets, present a diagnostic challenge and require extensive laboratory and clinical examinations. Early diagnosis is of great importance in order to prevent the occurrence of bone deformities, as well as dental complications and invasive dental procedures.

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Dentalne karakteristike hipofosfatemijskog rahitisa – prikaz bolesnika

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KRATAK SADRŽAJ

Rahitis predstavlja poremećaj mineralizacije koštanog tkiva u dečjem skeletu. Najčešće je povezan sa deficitom vitamina D; međutim, može nastati i usled pada serumskih fosfata, što dovodi do neadekvatne mineralizacije tkiva, sa posledičnim deformitetom skeleta i poremećajem rasta. Pacijenti sa hipofosfatemijskim rahitisom pokazuju promene na zubima na morfološkom i histološkom nivou, kao i na radiološkim snimcima. Cilj ove studije je bio da se izvrši klinička i radiološka evaluacija dentalnih manifestacija hipofosfatemijskog rahititisa kod četvorogodišnjeg dečaka, kao i da se ukaže na neophodnost uključivanja stomatologa u tretman ovog oboljenja u cilju prevencije oralnih komplikacija.

Ključne reči: hipofosfatemija; rahitis; dentin; periapeksni apsces

UVOD

Hipofosfatemijski rahitis, takođe poznat kao rahitis rezistentan na vitamin D, ili X- vezani rahitis, nasledni je sindrom koga karakteriše neadekvatna mineralizacija hrskavice i kosti, što dovodi do deformiteta skeleta i poremećaja rasta. Uzrokovan je mutacijom gena PHEX (endopeptidaze odgovorne za regulaciju fosfata šifrovane genom na X hromozomu), dovodeći do porasta fibroblastnog faktora rasta 23 (FGF23), koji je regulator renalne reapsorpcije fosfata [1, 2]. Patofiziološki mehanizam se ogleda u smanjenju fosfatne reapsorpcije renalnih tubula, što dovodi do hiperfosfaturije i hipofosfatemije, usled čega se razvija rahitis [3]. Prevalenca pojave oboljenja je 1 : 20000 [4, 5]. Standardna terapija ovih pacijenata podrazumeva nadoknadu elementarnog fosfora i primenu aktivnih oblika vitamina D [1, 3]. U novije vreme pokušava se sa primenom anti-FGF23 antitela koja deluju na primarno oboljenje tako što blokiraju FGF23 i time regulišu homeostazu fosfata [1, 2]. Hipofosfatemija je uzrok nastanka displazije dentina zbog poremećaja u mineralizaciji dentinskog matriksa kada se jasno uočava globularni dentin. Prisutni su i tubularni defekti koji mogu da se pružaju do gleđno-dentinske granice. Pored poremećaja u mineralizaciji, uočavaju se tanka gleđ, rascepi u dentinu, naročito velike pulpne komore, kao i jako visoki rogovi pulpe koji se pružaju do gleđno-dentinske granice, što se jasno vidi na radiološkim snimcima [4]. U literaturi postoje navodi da je kod pacijenata sa hipofosfatemijskim rahitisom karakteristična pojava multipnih spontanih periapeksnih apscesa [5, 6, 7]. Od dentalnih karakteristika prisutni su još i taurodontizam, loše definisana lamina dura i hipoplazija alveolarnih grebenova [6, 8].

PRIKAZ BOLESNIKA

Četvorogodišnji dečak upućen je sa Klinike za dečje interne bolesti zbog oralnih komplikacija vezanih za hipofosfatemijski rahitis. Tretman osnovnog oboljenja podrazumevao je terapiju elementarnim fosforom i aktivnim oblikom vitamina D, uz čiju primenu je došlo do korekcije kliničkih i laboratorijskih nalaza.

Opšte ispitivanje ukazivalo je na pacijenta sa kliničkim karakteristikama osnovnog oboljenja: deformitet donjih ekstremiteta, promene u hodu i nizak rast. Ekstraoralne promene nisu uočene. Intraoralnim pregledom uočeno je da je kod pacijenta došlo do nicanja svih zuba mlečne denticije. U gornjoj vilici su svi frontalni zubi bili potpuno karijesno destruirani i bili su prisutni zaostali korenovi. Prema rečima oca, ranije se javljao otok u predelu prednjih zuba, kod stomatologa je pružena prva pomoć, ali dalja saradnja sa detetom nije uspostavljena. Na gornjim očnjacima uočen je cirkularni karijes, na gornjim prvim molarima su uočene uznapredovale karijesne lezije sa otvorenom komorom pulpe i gangrenom, dok je na gornjim drugim molarima uočen superficijalni karijes u okluzanim fisurama. U donjoj vilici su frontalni zubi bili potpuno karijesno destruirani, uočene su veliki karijesi V klase na očnjacima, uznapredovale karijesne lezije sa otvorenom komorom i gangrenom, karijesi V klase na prvim molarima, i karijesi I klase na drugim molarima. Prema rečima oca, u donjoj vilici nije bilo otoka (slike 1 i 2).

Analizom panoramskog snimka zapaženo je prisustvo stalnih zamenika svih mlečnih zuba, zametaka prvih i drugih donjih molara i prvih gornjih molara. Na mlečnim drugim molarima se jasno vide velike komore pulpe sa prominentnim rogovima. Komore ostalih zuba nisu mogle biti sagledane zbog uznapredovalih karijesnih destrukcija (Slika 3).

Predložena terapija je podrazumevala konzervativnu sanaciju sva četiri druga mlečna molara, koja je odložena zbog nemogućnosti saradnje sa detetom. S obzirom na to da bi ekstrakcije gangrenoznih zuba dovele do još izraženije odontofobije, preporučene su česte kontrole. Roditeljima je ukazano na neophodnost održavanja dobre oralne higijene.

DISKUSIJA

Hipofosfatemijski rahitis je skeletni poremećaj koji se u osnovi karakteriše hipofosfatemijom. Kako su fosfati od suštinske važnosti za mineralizaciju, ovo stanje dovodi do deficita u mineralizaciji, što primarno utiče na tkiva kod kojih se mineralizacija fiziološki odigrava – kosti, zubi i hrskavičavi deo metafize dugih

kostiju [1]. Prisustvo ozbiljnih dentalnih malformacija kod pacijenata sa hipofosfatemijskim rahitisom dokazano je u brojnim studijama [7, 9, 10].

Zubi kod pacijenata sa hipofosfatemijskim rahitisom pokazuju uvećane komore pulpe, široku zonu predentina, jasan globularni dentin i defekte u tubularnom dentinu koji se pružaju od pulpe do gleđi. Gleđ je tanka, najčešće normalne građe, ali nekad može biti i hipoplastična [6, 7]. Na histološkim presecima mogu se videti i široki rascepi u gleđi i defekti u mineralizaciji dentina. Uočavaju se brojni kalcosferiti između kojih su prisutni široki nemineralizovani interglobularni prostori [10]. Iako je funkcija odontoblasta normalna, hipofosfatemija dovodi do loše mineralizacije, što uzrokuje pojavu displazije dentina sa jasno vidljivim globularnim dentinom. Zbog perioda formiranja i mineralizacije dentina mlečnih zuba u periodu od četiri meseca fetalnog života do 11 meseci starosti deteta, defekti u mlečnoj denticiji najčešće ne mogu biti sprečeni [6, 7]. Ukoliko se sa lečenjem osnovnog oboljenja krene što pre po rođenju, može se očekivati da dođe do pozitivnog uticaja na formiranje i razvoj stalnih zuba [6]. Međutim, uprkos terapiji, nekad se mogu uočiti abnormalnosti u razvoju zuba i formiranju dentina u stalnoj denticiji [7].

Radiološki nalaz kod ovakvih pacijenta najčešće pokazuje tanku gleđ, smanjenje radiološke gustine dentina, uvećane komore pulpe, prominentne rogove pulpe, taurodontizam i anodoncije [8, 10].

Dominantna osobenost ovog oboljenja je pojava multipnih spontanih periapeksnih apscesa [4, 5, 7, 10]. Ovi apscesi se javljaju i na zubima na kojima nema znakova karijesa ili traume. Klinički, zubi pacijenta mogu izgledati normalno i zdravo, što komplikuje dokazivanje endodontskog porekla infekcije i otežava identifikaciju zuba uzročnika. Ova specifičnost se može objasniti defektima u mineralizaciji dentina. Početni karijes ili čak i početna atricija mogu ukloniti tanak sloj gleđi, što olakšava pristup mikroorganizama tkivu pulpe preko eksponiranog roga pulpe ili kroz loše mineralizovani dentin. Tako naizgled nekariozan ili minimalno kariozan zub podleže infekciji pulpnog tkiva i stvaranju periapeksnog apscesa [4]. Svetlosno mikroskopska ispitivanja su pokazala penetraciju mikroorganizama i kroz mikropukotine na gleđi i njihovo dalje širenje duž gleđno-dentinske granice [5].

U literaturi se ne sreću često podaci o vezi hipofosfatemijskog rahitisa sa pojavom malokluzija. U studiji Souza i saradnika [2010], koja je obuhvatala čak 20 pacijenta, objavljeno je da je otvoreni zagrižaj bio najčešća anomalija, koja se može objasniti zakasnelim rastom maksile u odnosu na rast mandibule. Iako se u literaturi navodi kao česta pojava, nijedan od njihovih pacijenta nije pokazao taurodontizam [6].

Terapijski pristup se uglavnom odnosi na tretman periapeksnih apscesa. Ovi apscesi, posebno oni kod mlečnih zuba, brzo se šire kroz viličnu kost; zbog toga je ekstrakcija takvih zuba neophodna [6, 7]. Prevencija stvaranja apscesa podrazumevala bi primenu samonagrizajućih adhezivnih sistema i zalivanje površina zuba tečnom smolom da bi se formirala barijera koja bi sprečila penetraciju mikroorganizama. Ovako tretirane mlečne zube treba često kontrolisati i po potrebi ponavljati barijere od smole sve dok ne dođe do smene zuba [10]. Uporedo sa time, treba primenjivati fluoride i rigorozno održavati oralnu higijenu. U literaturi se sreće i profilaktična zaštita mlečnih molara metalnim krunama i zaštita prednjih zuba kompozitnim smolama [4]. Međutim, ova mera zaštite je često kritikovana jer u toku brušenja zuba lako može da dođe do otvaranja već uvećane pulpe, ali i zbog gubljenja vertikalne dimenzije, naročito ukoliko treba izvršiti multipne ekstrakcije mlečnih bočnih zuba [7]. Kao jedna od procedura navodi se i preventivna pulpotomija svih mlečnih zuba sa početnim karijesima [4, 5].

Hipofosfatemijski rahitis, kao retka forma rahitisa, predstavlja dijagnostički izazov i zahteva obimna laboratorijska i klinička ispitivanja. Rana dijagnoza je od velikog značaja da bi se sprečila pojava deformiteta kostiju, kao i većina dentalnih komplikacija i invazivnih dentalnih procedura.

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DECLARATION

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Early Childhood Caries: IAPD Bangkok Declaration

1 | INTRODUCTION

The purpose of this Declaration is to gain worldwide support for an evidence-based definition and a common understanding of the evidence around the aetiology, risk factors, and interventions to reduce Early Childhood Caries (ECC), as well as to mobilize collaborative approaches and policies to diminish this chronic disease. With this background, 11 experts from across the globe convened under the auspices of the International Association for Paediatric Dentistry (IAPD) to create this statement.

2 | THE IAPD BANGKOK DECLARATION

Early Childhood Caries (ECC) is defined as the presence of one or more decayed (non-cavitated or cavitated lesions), missing or filled (due to caries) surfaces, in any primary tooth of a child under six years of age. Primary teeth maintain the space for the permanent teeth and are essential to a child's well-being since dental caries on primary teeth may lead to chronic pain, infections, and other morbidities. ECC is preventable, but currently affects more than 600 million children worldwide, and remains largely untreated. This disease has major impact on the quality of life of children and their families and is an unnecessary burden to society.

Early Childhood Caries, like other forms of caries, is considered to be a biofilm-mediated, sugar-driven, multifactorial, dynamic disease that results in the imbalance of demineralization and remineralization of dental hard tissues. Dental caries is determined by biological, behavioural, and psychosocial factors linked to an individual's environment. ECC shares common risk factors with other non-communicable diseases (NCDs) associated with excessive sugar consumption, such as cardiovascular disease, diabetes, and obesity. Excessive intake of sugars leads to prolonged acid production from tooth adherent bacteria and to a shift in the composition of the oral microbiota and biofilm pH. If sustained, tooth structures are demineralized. ECC is in some cases associated with developmental defects of enamel.

Appropriate management of ECC from informed parents, health professionals, and community health workers, as well as evidence-based health policy, is important to reduce this burden of preventable disease. Caries risk assessment aids in this process by establishing the probability of individual patients, or groups of children developing carious lesions. For the individual child, risk assessment is an essential key element to guide prevention and management. At the community level, the caries risk assessment can guide the design of public interventions and allocate time and resources to those with the greatest need.

Prevention and care of ECC can be structured in three phases. *Primary prevention* includes improving oral health literacy of parents/caregivers and healthcare workers, limiting children's consumption of free sugar in drinks and foods, and daily exposure to fluorides. *Secondary prevention* consists of the effective control of initial lesions prior to cavitation that may include more frequent fluoride varnish applications and applying pit and fissure sealants to susceptible molars. *Tertiary prevention* includes the arrest of cavitated lesions and tooth-preserving operative care.

3 | RECOMMENDATIONS

To reduce the prevalence and burden of ECC worldwide, the IAPD Bangkok Declaration recommends the following actions:

Four key areas requiring action with multiple stakeholders are as follows:

1. Raise awareness of ECC with parents/caregivers, dentists, dental hygienists, physicians, nurses, health professionals, and other stakeholders.
2. Limit sugar intake in foods and drinks and avoid free sugars for children under 2 years of age.
3. Perform twice daily toothbrushing with fluoridated toothpaste (at least 1000 ppm) in all children, using an age-appropriate amount of paste.
4. Provide preventive guidance within the first year of life by a health professional or community health worker (building on existing programs—eg vaccinations—where possible) and ideally, referral to a dentist for comprehensive continuing care.

In addition, it is recommended that:

- Stakeholders advocate for reimbursement systems and educational reform that emphasizes evidence-based prevention and comprehensive management of ECC.

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- In order to standardize comparisons across countries and regions, epidemiology studies should record the presence of non-cavitated and cavitated caries; ideally record initial, moderate, and extensive stages of decay; children should be surveyed at three and five years of age to capture preventive as well as restorative needs.
- An educational curriculum on ECC should be implemented in dental schools worldwide to ensure that evidence- and risk-based preventive care is given equal weight to traditional surgical management.
- Research on ECC inequalities, oral health-related quality of life, interventions, and health economics should be supported to further understand benefits of effective and timely care.

The Appendix below, prepared by the Expert Panel, provides a Communication Statement on Early Childhood Caries designed for a wide range of professional and lay stakeholders. A detailed paper, entitled 'Global Perspective of Early Childhood Caries Epidemiology, Aetiology, Risk Assessment, Societal Burden, Management, Education and Policy', provides the updated evidence and references that informed this declaration.[1]

*Global Summit on Early Childhood Caries was held in Bangkok on November 2–4, 2018. Members of the Expert Panel who drew up this Declaration with input from the IAPD Board were: Drs. N.B. Pitts (U.K), R. Baez (USA), C. Diaz-Guallory (USA), K. Donly (USA), C. Feldens (Brazil), C. McGrath (Hong Kong), P. Phantumvanit (Thailand), K. Seow (Australia), N. Sharkov (Bulgaria), N. Tinanoff (USA), and S. Twetman (Denmark).

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APPENDIX

IAPD Bangkok Declaration: Communication Statement on Early Childhood Caries

What is Early Childhood Caries (ECC)?

- **Dental Caries**: *Scientific definition*—Dental caries is a biofilm-mediated, sugar-driven, multifactorial, dynamic disease that results in the imbalance of demineralization and remineralization of dental hard tissues. Dental caries is determined by biological, behavioural, and psychosocial factors linked to an individual's environment.
- **Early Childhood Caries** is: *Lay definition*—Tooth decay in pre-school children which is common, mostly untreated and can have profound impacts on children's lives. *Clinical definition*—the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled surfaces, in any primary tooth of a child under age six.

The context for ECC

- Dental caries is the most common preventable disease.
- Untreated dental caries in primary teeth affects more than 600 million children worldwide.
- Dental caries shares common risk factors with other non-communicable diseases (NCDs) associated with excessive sugar consumption, such as cardiovascular disease, diabetes, and obesity.

The unacceptable burden of ECC

- ECC is an unacceptable burden for children, families, and society.
- The timely and appropriate prevention and management of ECC is important to reduce this burden and to improve the quality of life of children globally.

How do we reduce ECC and its burden?

- ECC is multifactorial, and there is no easy or single solution to the complex 'Caries Puzzle'. The engagement of multiple stakeholders to address the multiple aspects of caries causation is necessary to prevent ECC.
- **Primary Prevention of ECC**
  - Upstream interventions at the community level.
  - Prevention of new disease at the individual level.
- **Secondary Prevention of ECC**
  - Effective control of initial lesions *prior* to cavitation.
  - Arrest of more advanced lesions, where possible.
- **Tertiary Prevention of ECC**
  - Non-invasive caries control procedures.
  - Appropriate, tooth-preserving restorative care.

Action on ECC needed from multiple stakeholders in four key areas

- **Raise awareness of ECC** with parents/caregivers, dentists, paediatricians, nurses, other health professionals, and other stakeholders.
- **Limit sugar intake in foods and drinks** and avoid free sugars for children under 2 years of age.

The declaration is co-published in *Pediatric Dentistry and Journal of Dentistry for Children*

- **Perform twice daily toothbrushing with fluoridated toothpaste** (at least 1000 ppm) in all children, using an age-appropriate amount of paste.
- **Provide preventive guidance within the first year of life by a health professional or community health worker** (building on existing programs—eg vaccinations—where possible) and ideally, referral to a dentist for comprehensive continuing care.

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Karijes ranog detinjstva: IAPD deklaracija iz Bankoka

Prevod i kulturalna adaptacija: Ana Vuković, Dejan Marković

1. Uvod

Cilj ove deklaracije je da se obezbedi međunarodno jedinstveni stav vezano za definiciju, razumevanje etiologije, faktora rizika i potrebnih intervencija kako bi došlo do smanjenja učestalosti karijesa ranog detinjstva (KRD). Na ovaj način se omogućava zajedničko delovanje i sprovođenje adekvatne zdravstvene politike radi eliminicije ovog hroničnog oboljenja. Sa ovim ciljem je okupljeno jedanaest međunarodnih eksperata pod okriljem Međunarodnog udruženja za dečiju stomatologiju (*International Association of Paediatric Dentistry* – IAPD) kako bi se kreirala ova deklaracija.

2. IAPD deklaracija iz Bankoka

Karijes ranog detinjstva je definisan kao prisustvo jednog ili više mlečnih zuba sa karijesnom lezijom (sa prisutnim kavitetom ili belom mrljom), izgubljenih mlečnih zuba zbog posledica karijesa ili ispuna na mlečnim zubima, kod deteta mlađeg od šest godina. Zubi mlečne denticije imaju važnu ulogu u očuvanju prostora radi postavljanja stalnih zuba zamenika i imaju važnu ulogu u očuvanju opšteg blagostanja organizma s obzirom na to da karijes na mlečnim zubima može dovesti do hroničnog bola, infekcije i drugih tegoba. Iako je KRD oboljenje koje je moguće sprečiti preventivnim merama, činjenica je da trenutno zahvata više od 600 miliona dece širom sveta, pri čemu je KRD većim delom nesaniran. Ovo oboljenje utiče negativno na kvalitet života dece i njihovih porodica i predstavlja nepotreban teret za društvo u celini.

Karijes ranog detinjstva, kao i druge forme karijesa, predstavlja multifaktorijalno oboljenje koje nastaje kao posledica poremećaja homeostaze oralnog biofilma, pod uticajem ugljenih hidrata u ishrani, koji dovode do disbalansa procesa demineralizacije i remineralizacije tvrdih zubnih tkiva. Nastanak karijesa je tesno povezan sa biološkim, bihejvioralnim i psiho-socijalnim karakteristikama specifičnim za individulano okruženje pojedinca. KRD karakterišu isti etiološki faktori koji dovode i do drugih hroničnih nezaraznih oboljenja koje su povezane sa povećanim unosom šećera u ishrani, kao što su kardiovaskularna oboljenja, dijabetes i gojaznost. Nekontrolisana upotreba šećera u ishrani dovodi do prolongiranog stvaranja kiselih metabolita od strane mikroorganizama usne duplje adheriranih za površine zuba, što uzrokuje promene u sastavu oralne flore i promenu pH oralnog biofilma. Ukoliko se ovakvo stanje održi određeno vreme, dolazi do demineralizacije tvrdih zubnih tkiva. U nekim slučajevima KRD može biti povezan sa razvojnim anomalijama gleđi.

Kako bi se smanjilo breme ovog oboljenja, koje je moguće sprečiti preventivnim merama, potrebne su adekvatne aktivnosti od strane obučenih i informisanih roditelja, zdravstvenih radnika, komunalnih zdravstvenih radnika, kao i adekvatna zdravstvena politika zasnovana na naučnim dokazima. Pri tome, važnu ulogu ima procena rizika za nastanak karijesa na individualnom ili grupnom nivou. Posmatrano individualno, procena rizika za nastanak karijesa predstavlja suštinu uspešne prevencije i tretmana KRD. Na nivou društva, procena rizika za nastanak karijesa može omogućiti pravilno usmeravanje preventivnih intervencija, pravovremenost i preraspodelu resursa na rizične grupe.

Prevencija i lečenje KRD se može podeliti u tri faze. *Primarna prevencija* obuhvata zdravstveno-vaspitni rad sa roditeljima/starateljima/negovateljima i zdravstvenim radnicima, ograničavanje unosa slobodnih šećera u hrani i piću i svakodnevno korišćenje nekog od preparata sa fluoridima. *Sekundarna prevencija* predstavlja blagovremeno uočavanje inicijalnih karijesnih lezija pre nastanka kaviteta, učestalu aplikaciju laka sa fluoridima i zalivanje fisura na sumnjivim mlečnim molarima. *Tercijarna prevencija* podrazumeva zaustavljanje napredovanja karijesa i primenu terapijskih mera kako bi se sačuvali zahvaćeni mlečni zubi.

3. Preporuke

Kako bi se smanjilo breme KRD širom sveta, IAPD deklaracijom iz Bankoka predlažu se sledeće aktivnosti:

Postoje četiri ključne u oblasti u okviru kojih je neophodno delovanje, a to su:

1) podizanje zdravstvene svesti i znanja roditelja/staratelja/negovatelja, stomatologa, oralnih higijeničara, lekara, medicinskih sestara, drugih zdravstvenih radnika i ostalih aktera, vezano za KRD.
2) ograničavanje unosa šećera u hrani i piću, i izbegavanje slobodnih šećera, kod dece mlađe od dve godine.
3) održavanje oralne higijene četkanjem uz korišćenje paste za zube sa minimum 1000 ppm fluorida kod sve dece, korišćenjem količine paste za zube u skladu sa uzrastom deteta.
4) obezbeđenje pravovremenih preventivnih saveta tokom prve godine života od strane zdravstvenog radnika ili komunalnog zdravstvenog radnika (na primer, gde je moguće prilikom redovnih vakcijancija), a zatim uput dečjem stomatologu kako bi se obezbedila sveobuhvatna nega.

Dodatno, preporučuje se sledeće:

- Aktivno zalaganje svih učesnika koji će kroz svoja zalaganja omogućiti zdravstvenu i obrazovnu reformu sa ciljem adekvatnog vrednovanja preventivnog

učinka, kako bi se obezbedili preventivna terapija zasnovana na dokazima i sveobuhvatan tretman KRD.
- Beleženje stanja pomoću epidemioloških istraživanja – kako bi se obezbedilo standardizovano poređenje situacije u različitim zemljama, potrebno je da se zabeleži prisustvo kavitiranih karijesnih lezija i početnih karijesnih lezija bez kavitacije (belih mrlja); idealno je da se zabeleže podaci o prisustvu početnih, srednjih i uznapredovalih oblika karijesa; ispitanike bi trebalo pregledati u uzrastu od tri i pet godina kako bi se odredile potrebe za preventivnim i terapijskim tretmanom.
- Uvođenje obuke o KRD kroz plan i program osnovnih studija na stomatološkim fakultetima širom sveta kako bi se obezbedilo adekvatno znanje budućih stomatologa i kako bi se preventivnom tretmanu koji se zasniva na dokazima i proceni rizika dao isti značaj kao tradicionalnim stomatološkim metodama sanacije karijesa.
- Potrebno je dati prednost istraživanjima koja se bave neravnopravnostima u vezi sa KRD, kvalitetom života povezanim sa KRD, intervencijama i istraživanjima iz oblasti zdravstvene ekonomije, kako bi se omogućilo bolje razumevanje pravovremene i adekvatne terapije KRD.

Prilog koji se nalazi u okviru ove deklaracije je pripremljen od strane radne grupe eksperata, pruža adekvatnu informaciju koju mogu koristiti stomatološki zdravstveni radnici ali i drugo medicinsko i nemedicinsko osoblje kojih se tiče prevencija KRD. Dodatne, detaljne informacije, podaci koji su poslužili za pisanje deklaracije, kao i reference, mogu se naći u naučnom radu pod nazivom „Global Perspective of Early Childhood Caries Epidemiology, Aetiology, Risk Assessment, Societal Burden, Management, Education and Policy".

Članovi odbora IAPD po abecednom redosledu su: *M. Bönecker* (Brazil), *A. O'Connell* (Irska), *B. Drummond* (Novi Zeland), *T. Fujiwara* (Japan), *C. Hughes* (SAD), *N. Krämer* (Nemačka), *A. Kupietzky* (Izrael), *A. M. Vierrou* (Grčka), *A. Tsai* (Tajvan).

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Prilog

IAPD deklaracija iz Bankoka: Saopštenje o KRD

Šta je karijes ranog detinjstva (KRD)?

Karijes: *Naučna definicija* – karijes predstavlja multifaktorijalno, dinamično oboljenje koje nastaje kao posledica poremećaja homeostaze oralnog biofilma, pod uticajem ugljenih hidrata u ishrani, koji dovode do disbalansa procesa demineralizacije i remineralizacije tvrdih zubnih tkiva. Na prisustvo karijesa utiču biološki, bihejvioralni i psiho-socijalni faktori specifični za individulano okruženje pojedinca.

Karijes ranog detinjstva: *Nemedicinska definicija* – karijesne lezije koje se često uočavaju kod dece predškolskog uzrasta uglavnom su nesanirane i mogu uticati na kvalitet života deteta. *Klinička definicija* – prisutstvo jedne ili više karijesnih lezija (sa kavitetom ili bez njega), izgubljenog zuba (kao posledice karijesa) ili ispuna na površini ma kog mlečnog zuba kod dece mlađe od šest godina.

Karakteristike KRD

- Karijes zuba je najčešće preventabilno oboljenje.
- Nesanirani karijes mlečnih zuba zahvata više od 600 miliona dece širom sveta.
- Karijes karakterišu isti etiološki faktori koji dovode i do drugih hroničnih nezaraznih oboljenja koja su povezana sa povećanim unosom šećera u ishrani, kao što su kardiovaskularna oboljenja, dijabetes i gojaznost.

Neprihvatljivo breme KRD

- KRD predstavlja neprihvatljivo breme za decu, porodice i društvo.
- Pravovremena i adekvatna primena preventinih mera i sanacija KRD je neophodna kao bi se smanjilo breme KRD i poboljšao kvalitet života dece širom sveta.

Kako smanjiti učestalost i posledice KRD?

- KRD je multifaktorijalno oboljenje, tako da ne postoji lako i jednostavno rešenje koje bi odgonetnulo ovu zagonetku. Da bi se omogućila prevencija KRD, neophodno je aktivno delovanje različitih učesnika koji mogu uticati na različite aspekte etiologije karijesa.

Primarna prevencija KRD:

- programske mere na nivou zajednice,
- sprečavanje novih slučajeva oboljenja na individualnom nivou.

Sekundarna prevencija KRD:

- kontrola inicijalnih lezija (bele mrlje) pre nego što dođe do nastanka kaviteta,

- zaustavljanje uznapredovalih lezija kada god je to moguće.

Tercijarna prevencija KRD:

- neinvazivne mere prevencije karijesa,
- adekvatne terapijske mere kako bi se sačuvali zahvaćeni mlečni zubi.

Potrebne aktivnosti u okviru četiri ključne oblasti

- **Povećanje svesti o značaju KRD** kod roditelja/staratelja, stomatologa, pedijatara, pedijatrijskih medicinskih sestara, drugih zdravstvenih radnika, nemedicinskog osoblja (vaspitača) i ostalih učesnika u procesu.
- **Ograničen unos šećera u hrani i piću** i izbegavanje unosa slobodnih šećera kod dece mlađe od dve godine.
- **Četkanje zuba dva puta dnevno uz korišćenje paste za zube sa fluoridima** (minimum 1000 ppm) kod sve dece, uz korišćenje količine paste za zube koja je prilagođena uzrastu deteta.
- **Obavezan preventivni savet o održavanju oralnog zdravlja u toku prve godine života od strane zdravstvenog osoblja, komunalnih zdravstvenih radnika ili patronažnog osoblja** (preporuka je povezivanje sa posetama povodom redovne vakcinacije) i uput dečjem stomatologu radi sveobuhvatne nege.

Kako citirati članak: Pitts, N, Baez, R, Diaz-Guallory, C, et al. Early Childhood Caries: IAPD Bangkok Declaration. Int J Paediatr Dent. 2019;29:384–386.

Da li ste pažljivo čitali radove?

1. Za direktno prekrivanje pulpe zuba se koriste:
   a) kalcijum-silikati
   b) kalcijum-fluoridi
   c) magnezijum-silikati

2. Stanje oralnog zdravlja starih osoba je proveravano u:
   a) Srbiji
   b) Bosni i Hercegovini
   c) Crnoj Gori

3. Uklanjanje kanalnog punjenja može dovesti do nastanka hronične infekcije u periapeksu?
   a) Da
   b) Ne
   c) Skoro nikad

4. Zaštitni filteri nanosrebrne maske su ukazali na efikasnost:
   a) na primeru *Staphiloccocus aureus*
   b) na primeru *Streptoccocus mutans*
   c) na primeru *Enteroccocus faecalis*

5. Rahitis kod dece je najčešće povezan sa deficitom:
   a) vitamina A
   b) vitamina B
   c) vitamina C

6. Kao sredstvo za direktno prekrivanje pulpe korišćeni su:
   a) theracal LC i biodentin
   b) theracal LC i kalcijum-hidroksid
   c) biodentin i kalcijum-hidroksid

7. Apikalna ekstruzija materijala tokom uklanjanja kanalnog punjenja je proveravana kod:
   a) 60 jednokorenih zuba
   b) 60 višekorenih zuba
   c) 60 jednokorenih i višekorenih zuba

8. Stanje oralnog zdravlja starih osoba u Crnoj Gori je realizovano:
   a) u Podgorici
   b) u Budvi
   c) u Tivtu

9. Efikasnost maski N95 sa filterima je:
   a) značajno bolja od hirurških maski
   b) značajno slabija od hirurških maski
   c) bez značajnih razlika u odnosu na hirurške maske

10. Rahitis kod dece može nastati usled pada:
    a) serumskih fosfata
    b) serumskih nitrata
    c) serumskih nitrita

11. Materijal za direktno prekrivanje je testiran:
    a) na kvalitet veze sa kompozitnim materijalima
    b) sa amalgamskim ispunima
    c) sa GJC

12. Istraživanje stanja oralnog zdravlja u Crnoj Gori je realizovano kod:
    a) 150 ispitanika
    b) 170 ispitanika
    c) 200 ispitanika

13. Istraživanje o apikalnoj ekstruziji je sprovedeno na:
    a) 50 jednokorenih zuba
    b) 60 jednokorenih zuba
    c) 70 jednokorenih zuba

14. Atipični simptomi za kovid19 su:
    a) groznica i suvi kašalj
    b) temperatura i dijareja
    c) kašalj i bol lakta

15. Rahitis kod dece dovodi do poremećaja rasta?
    a) Da
    b) Ne
    c) Ne utiče na rast

16. Provera kvaliteta veze materijala za direktno prekrivanje je testirano:
    a) sa jednim adhezivnim sredstvom
    b) sa dva adhezivna sredstva
    c) sa tri adhezivna sredstva

17. Prosečna starost ispitanika u Crnoj Gori je iznosila:
    a) 72,32
    b) 62,32
    c) 75,32

18. Preparacija kanala kod zuba gde je realizovano istraživanje o apikalnoj ekstruziji je urađena:
    a) rotirajućim instrumentima K3
    b) rotirajućim instrumentima RaCe
    c) rotirajućim instrumentima ProTaper

19. Kovid 19 podrazumeva umereno oboljenje sa pneumonijom ili bez nje u:
    a) 80% slučajeva
    b) 70% slučajeva
    c) 60% slučajeva

20. Deca sa rahitisom imaju promene na zubima?
    a) Da
    b) Ne
    c) Skoro nikad nemaju promene

21. Provera kvaliteta veze materijala za direktno prekrivanje i kompozitnih materijala je urađena:
    a) na 30 intaktnih zuba
    b) na 50 intaktnih zuba
    c) na 60 intaktnih zuba

22. Prosečan broj karijesnih zuba (DT) kod ispitanika u Podgorici je iznosio:
    a) 1,56
    b) 0,63
    c) 2,68

23. U preparaciji kanala za istraživanje o apikalnoj ekstruziji korišćeni su i ručni instrumenti?
    a) Da
    b) Ne
    c) Samo mašinski rotirajući instrumenti

24. Promene na zubima kod dece sa rahitisom su:
    a) samo na histološkom nivou
    b) samo na morfološkom nivou
    c) i na histološkom i na morfološkom nivou

25. Kvalitet veze materijala za direktno prekrivanje i kompozita je testiran na:
    a) intaktnim sekutićima
    b) intaktnim premolarima
    c) intaktnim molarima

26. Prosečan broj izvađenih zuba (MT) kod ispitanika u Podgorici je iznosio:
    a) 10,45
    b) 21,25
    c) 26,25

27. U preparaciji kanala za istraživanje o apikalnoj ekstruziji korišćen je i set instrumenata TWISTED FILE?
    a) Da
    b) Ne
    c) Samo za višekanalne sisteme

28. Stopa smrtnosti od kovida 19 među muškarcima iznosi:
    a) 2,8%
    b) 3,2%
    c) 4,7%

29. Snaga adhezivne veze biodentina i kompozita iznosila je:
    a) 11,24
    b) 19,28
    c) 25,29

30. Opturacija kanala kod zuba gde je proveravana apikalna ekstruzija je realizovana:
    a) gutaperka poenima
    b) resilohom
    c) bez gutaperka poena

31. Stopa smrtnosti od kovida 19 među ženama iznosi:
    a) 2,8%
    b) 3,2%
    c) 4,7%

32. Prosečan broj plombiranih zuba (FT) kod ispitanika u Podgorici je iznosio:
    a) 4,38
    b) 3,78
    c) 2,68

33. Stepen apikalne ekstruzije materijala je ocenjivan:
    a) vizuelno
    b) kompjuterom
    c) mikroskopom

34. Primena univerzalnih maski ukazuje da bi mogla da spreči smrtni ishod:
    a) u 80% slučajeva
    b) u 50% slučajeva
    c) u 20% slučajeva

35. Snaga adhezivne veze TheraCal LC i kompozita iznosila je:
    a) 11,24
    b) 19,28
    c) 25,29

36. Bezubih osoba među ispitanicima u Podgorici je bilo:
    a) 35,47
    b) 42,47
    c) 46,47

37. Stepen apikalne ekstruzije materjala je ocenjivan:
    a) pomoću 3-stepene skale
    b) pomoću 4-stepene skale
    c) pomoću 5-stepene skale

38. Kod biodentina uočen je pretežno:
    a) kohezivni tip preloma
    b) adhezivni tip preloma
    c) kombinovani tip preloma

39. Količina istisnutog materijala u periapeks posle primene instrumenta Twisted File je iznosila:
    a) 0,30
    b) 0,20
    c) 0,11

40. Indeks rehabilitacije kod ispitanika u Podgorici je iznosio:
    a) 53,86
    b) 63,86
    c) 73,86

41. Najveći stepen apikalno istisnutog materijala je bio posle upotrebe:
    a) turpija Pro Taper
    b) turpija Twisted File
    c) turpija Hedsrom

42. Primena rotirajućih instrumenata u uklanjanju kanalnog punjenja dovodi do:
    a) minimalne ekstruzije
    b) maksimalne ekstruzije
    c) prebacivanja kompletnog punjenja u periapeks

43. Prosečna starost zubnih nadoknada kod ispitanika u Podgorici je iznosila:
    a) 7 godina
    b) 11 godina
    c) 15 godina

44. Najveći stepen apikalno istisnutog materijala je uočen posle upotrebe:
    a) ručnih instrumenata
    b) mašinskih turpija
    c) bio je identičan

45. Kod osoba starije dobi u Podgorici sa fiksnim nadoknadama je bilo njih:
    a) 9,41%
    b) 15,41%
    c) 20,41%

46. Primena ručnih instrumenata u uklanjanju kanalnog punjenja dovodi do:
    a) neznatne ekstruzije
    b) veće ekstruzije nego kod mašinskih instrumenata
    c) prebacivanja kompletnog kanalnog punjenja

47. Posle uklanjanja kanalnog punjenja turpijama Hedstrom količina istisnutog materijala je iznosila:
    a) 0,80
    b) 0,70
    c) 0,60

48. Sa fiksnom nadoknadom u jednoj i mobilnom u drugoj vilici među ispitanicima u Podgorici bilo je njih:
    a) 3,88%
    b) 5,88%
    c) 9,88%

49. Sa mobilnim nadoknadama u obe vilice među ispitanicima u Podgorici bilo je njih:
    a) 20,82%
    b) 30,82%
    c) 48,82%

50. Osobe koje koriste duvanske proizvode imaju značajno veće vrednosti od onih koji ne koriste duvan?
    a) Da
    b) Ne
    c) Vrednosti su identične

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