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ISPITIVANJE UTICAJA HRAPAVOSTI BRUŠENIH ZUBA NA VEZIVANJE LIVENIH KRUNICA CINK FOSFATNIM CEMENTOM

INVESTIGATION OF THE PREPARED TEETH ROUGHNESS EFFECT ON THE CAST CROWNS BONDING BY ZINC PHOSPHATE CEMENT

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Kratak sadržaj

Cilj rada je bio da se u in vitro uslovima utvrdi uticaj hrapavosti brušenih zuba na jačinu vezivanja cinkfosfatnim cementom krunica od legure NiCrMo.
U eksperimentu je korišćeno 20 intaktnih humanih premolara preparisanih za livenu krunicu i podeljenih u dve grupe u zavisnosti od postignute hrapavosti. Površine brušenih zuba izračunate su matematičkim putem, hrapavost dentina merena je profilometrom i verifikovana SEM-om. Za svaku grupu napravljene su standardnom metodom krunice od legure NiCrMo i cementirane cinkfosfatnim cementom. Nakon 7 dana obavljeno je testiranje jačine veze brušenih zuba i eksperimentalnih livenih krunica, u kidalici, mehaničkim putem.
Utvrđena je veza između profila ostvarene hrapavosti patrljaka sa dobijenim vrednostima retencionih sila.
Sa povećanjem hrapavosti brušenih zuba povećava se i jačina vezivanja između livenih krunica i patrljaka kada se kao vezivni materijal koristi cinkfosfatni cement. Poboljšanje jačine vezivanja na opisani način može da smanji potrebu za dodatnim načinom vezivanja kao što je formiranje okluzalnih ili aproksimalnih žlebova. Ovo nisu isključivi faktori ali svakako mogu biti od značaja za trajnost fiksnih zubnih nadoknada.

Ključne reči: *hrapavost brušenih zuba, livena krunica, cinkfosfatni cement*

Abstract

The purpose of this work was to establish in vitro conditions the effect of the prepared teeth roughness on the NiCrMo crowns bonding strenght by zinc phosphate cement.
Used in the experiment were 20 intact human premolars prepared for a cast crown and divided into two groups depending on the roughness achieved. The surfaces of the prepared teeth were counted mathematically, while the dentin roughness was measured by a surftest and verified by SEM. For each group, crowns made from the NiCrMo alloy were made by a standard method and cemented by zinc phosphate cement. Upon seven days, the prepared teeth and experimental cast crowns bonding strenght test was mechanically carried out in a dynamometer.
Bonding between the profiles of the achieved roughness of the stumps with the obtained retentive forces values was found out.
Increasing the prepared teeth roughness the bonding strenght between the cast crowns and the stumps increases when zinc phosphate cement is used as a bonding material. Increase in the bonding strenght in the described way may cause the need for additional method of bonding to be decreased such as forming of occlusive or approximal grooves. These are not exclusive factors, but they may be of significance for the fixed dentures durability.

Key words*: prepared teeth roughness, cast crown, zinc phosphate cement*

Uvod

Bitan faktor koji determiniše kvalitet fiksnih nadoknada je između ostalog, i postojanost nji-

Introduction

An essential factor that determines quality of fixed dentures is, among other things, stabil-

hove veze sa nosećim strukturama brušenih zuba. Na jačinu vezivanja moguće je delimično uticati i vrstom cementa, ali u mehaničkom smislu ona zavisi od tehničke procedure izrade nadoknade i karakteristika brušenog zuba. Kada se uobičajnim načinom brušenja ne može postići zadovoljavajuća retenciona forma patrljka, nameće se potreba za iznalaženjem povoljnijih rešenja.[1]

Kaufman i Lorey su sugerisali povećanje hrapavosti brušenih zuba, iako za to nisu imali eksperimentalnu potvrdu.[2] Do sličnih rezultata došli su Eick, Witwer u nezavisnim studijama.[3,4] Smanjenje hrapavosti brušenih zuba odgovarajućim načinom poliranja smanjuje retentivnu moć livenih krunica za čak 75% kada se kao vezivni materijal koristi cinkfosfatni cement.[5] Ova vrsta cementa je i danas u značajnoj upotrebi, iako ne poseduje sposobnost hemijske adhezije za dentin. Vezivanje se ostvaruje isključivo na principu mehaničkog uklještenja cementa u hrapavosti na površini brušenog zuba s jedne, odnosno unutrašnje površine fiksne nadoknade s druge strane. U momentu cementiranja nadoknade vezivni materijal je dovoljno viskozan da može zaći u formirana udubljenja na površini patrljka. Posle očvršćavanja cement ostaje zarobljen unutar pomenutih neravnina i sprečava dislokaciju nadoknade.[6]

Cilj rada je bio da se u in vitro uslovima utvrdi uticaj hrapavosti brušenih zuba na jačinu vezivanja cinkfosfatnim cementom krunica od legure nikl hrom i molibdena (NiCrMo).

Materijal i metod

U eksperimentu je korišćeno 20 intaktnih humanih premolara ekstrahovanih iz ortodontskih razloga koji su do eksperimenta čuvani u fiziološkom rastvoru, na temperaturi od 4°C. Brušenja zuba za livenu krunicu obavljena su dijamantskim brusnim instrumentima različite finoće brusnih kristala. Brušenjem je kompletno uklonjena gleđ i deo dentina sa linijskim dizajnom demarkacije. Kontrola i korekcija preparacije patrljaka (ugao konvergencije 6°) obavljena je u dentalnom paralelometru (Parabur-Bego).

ity of their bonding with the supporting structures of the prepared teeth as well. Bonding strenght may also partially be influenced by a type of cement, but in a mechanical sense it depends upon the technical procedure used to make dentures and the prepared teeth characteristics. When a standard method of preparing cannot result in a satisfactory retention form of the stump, a need is felt to find out favourable solutions.[1]

Kaufman and Lorey suggested increase in the prepared teeth roughness, although their suggestion was not experimentally proved[2]. Similar results were also obtained by Erick and Witwer in independent studies.[3,4] Decrease in the prepared teeth roughness by a corresponding method of preparing causes the cast crowns retentive force to decrease as much as 75 percent when zinc phosphate cement is used as a bonding material.[5] This type of cement is also in widespread use nowadays although it does not possess ability of chemical adhesion to dentin. Bonding is exclusively achieved on the principle of mechanical getting stuck of the cement to the roughness of the prepared tooth surface on one, that is inner surface of the fixed dentures, on the other hand. At the moment of cementing the denture, the bonding material is sufficiently viscous to penetrate the formed grooves on the stump surface. After hardening, the cement remains locked within the mentioned rough spots and prevents dislocation of the denture.[6]

The aim of the study was to establish in vitro conditions the effect of the prepared teeth roughness on the NiCrMo crowns bonding strenght by zinc phosphate cement.

Material and methods

Used in the experiment were 20 intact human premolars extracted for the orthodontic reasons, which were, prior to the experiment, kept in a physiological salt solution at the temperature of 4°C. Preparing the teeth for the cast crown was carried out by means of diamond preparing instruments of different fineness of preparing crystals. Preparing was used to completely remove enamel and a part of dentin with line design of demarcation. Control and correction of the stumps preparation (convergence angle of 6°) was carried out in dental parallelometer (Parabur-Bego).

Brušeni zubi svrstani su u dve grupe prema profilu ostvarene hrapavosti čije je registrovanje obavljeno profilometrom (Surftest 201 Mitutoyo Japan, sl. 1). Dobijene vrednosti srednje hrapavosti izražene su u μm. Površina svakog patrljka (izražena u mm^2) izračunata je matematičkim putem.[7] Zatim je izvršeno fiksiranje brušenih zuba pojedinačno u kalup od autopolimerizujućeg akrilata (Simgal – Galenika a.d.) 3mm ispod demarkacione linije. Pre fiksiranja u koren je ubacivan komad čelične žice upravno na uzdužnu osu zuba radi poboljšanja

The prepared teeth were classified into two groups according to the profile of the accomplished roughness registered by SURFTEST 201 Mitutoyo Japan (Fig. 1). The average roughness values obtained were expressed in μm. The surface of each stump (expressed in mm2) was mathematically calculated.[7] Then, fixing of the prepared teeth individually into a die of autopolymerizing acrilate (Simgal – Galenika a.d.) 3 mm below the demarcation line was carried out. Prior to fixing, a piece of steel wire was inserted into the root vertically onto the tooth

Slika 1. Profilometar - SURFTEST 201.

Figure 1. SURFTEST 201.

veze između korena i autopolimerizujućeg akrilata. Krunice od legure NiCrMo (Remanium CS – Dentaurum) urađene su na standardan način. Cementiranje je obavljeno cinkfosfatnim cementom (Cegal, normalvezujući Galenika a.d.) pri statičkom pritisku od 50N u trajanju od 10min. Uzorci su potom ostavljeni 7 dana na temperaturi od 37°C i u uslovima apsolutne vlažnosti. Nakon ovog perioda podvrgnuti su merenju jačine sile (izražene u Njutnima N) koja je potrebna kidalici (Zwick 1445) za odvajanje krunica od patrljaka. Vučno opterećenje ostvareno je pri konstantnoj brzini od 1mm/min. Pojedinačna vrednost retencione sile deljena je sa površinom patrljka. Dobijene vrednosti izražene su u N/mm^2. Razlike u dobijenim vrednostima između grupa utvrđivane su Studentovim t-testom.

Nakon registrovanja vrednosti retencionih sila patrljci su očišćeni u ultrazvučnom kupatilu. Uzorci za skeningelektronomikroskopsko (SEM) ispitivanje brušenih zuba prani su u fiziološkom rastvoru, dehidratisani koncentrovanim rastvorom alkohola i sušeni komprimovanim vazduhom u trajanju od 30 s. Potom je svaki od patrljaka fiksiran u specijalni nosač i unošen u aparat za vakuumsko naparivanje zlata. Opservacija uzoraka i fotografisanje urađeni su na skening elektronskom mikroskopu (JSM 5300 JEOL Japan).

vertical axis for the purpose of improving bonding between the root and the autopolymerizing acrilate. Crowns made from NiCrMo (Remanium CS – Dentaurum) were made by a standard method. Cementing was done by zink phosphate cement (Cegal, normal bonding Galenika a.d.) at the static pressure of 50N over a 10-minute period. The samples were then left 7 days at the temperature of 37°C under the conditions of absolute humidity. Upon this period, they were subjected to measuring the force strenght (expressed in newtons - N) needed by the dynamometer (Zwick 1445) to separate crowns from the stumps. Pulling load was accomplished at the constant speed of 1mm/min. Individual value of the retentive force was divided by the stump surface. The values obtained were expressed in N/mm^2. Differences in the values obtained between the groups were established by the Student t-test.

Upon registering values of the retentive forces the stumps were cleaned in the ultrasonic bath. Samples for the SEM investigation of the prepared teeth were washed in the physiological salt solution, dehidrated by a concentrated solution of alcohol and dried by compressed air over the 30-second period. Then, each of the stumps was fixed into a special support and inserted into the vacuum gold evaporation apparatus. Observation of samples and picture taking were done in a scanning electronic microscope (JSM 5300 JEOL Japan).

Rezultati

Dobijeni rezultati prikazani su u tabelama 1 i 2.

Results

The results obtained are shown in Tables 1 and 2.

Tabela 1. Rezultati testiranja uzoraka ispitivanih grupa (X ± SD, Cv)
Table 1. Test results of the investigated groups samples (X ± SD, Cv)

Grupa Group	Hrapavost patrljaka Stump roughness [μm]	Površina patrljaka Stump surface [mm^2]	Retenciona sila Retentive force [N]	Retenciona sila / površina patrljka Retentive force / Stump surface [N/mm^2]
I	3,035±0,653	120,911±6,103	246,040±7,397	2,037±0,048
	21,527	5,048	3,006	2,363
II	11,755±1,046*	120,224±8,372	260,910±12,344*	2,173±0,062**
	8,898	6,964	4,731	2,850

*- p<0,01, ** p <0,001 srednja vrednost, SD - standardna devijacija, Cv - koeficijent varijacije
* - p<0,01, ** p <0,001 average value, SD - standard deviation, Cv - variation coefficient

Tabela 2. Koeficijenti korelacije (r) retencionih sila sa hrapavošću patrljaka
Table 2. Correlation coefficients (r) of the retentive forces with the samples roughness

Parametar Parametre	Retenciona sila i hrapavost patrljaka Retentive force and stump roughness	
	I grupa / Group I	II grupa / Group II
r	0,403	0,464
t-test	1,2466	1,4832
p	0,2440	0,1722

U tabeli 1 prezentirani su numerički rezultati profila hrapavosti, površine patrljaka kao i vrednosti dobijenih retencionih sila uz odgovarajuću statističku analizu.

Statističkom analizom utvrđena je značajno veća vrednost retencione sile (p<0,01), kao i retencione sile po jedinici površine patrljka (p<0,001) u grupi II.

Tabela 2 prikazuje pozitivnu, ali ne i statistički značajnu korelaciju retencione sile i hrapavosti patrljaka.

Dobijene skeningelektronomikrografije sa uvećanjem 1000 (Sl. 2, 3) i 5000 (Sl. 4, 5) ilustruju razlike u površinskoj hrapavosti patrljaka u zavisnosti od finoće instrumenata za brušenje.

Presented in Table 1 are the numerical results of the roughness profile, surfaces of stumps as well as the values of the retentive forces along with the corresponding statistical analysis.

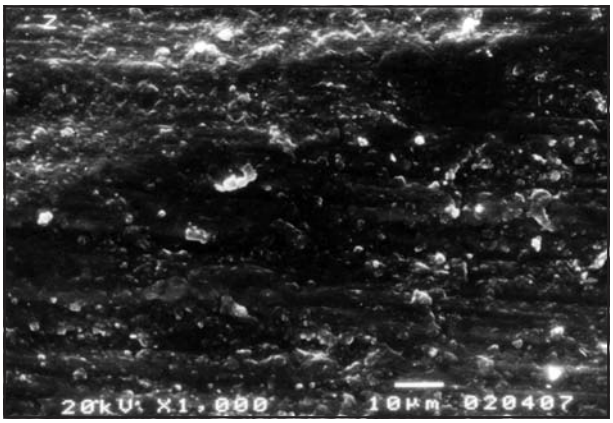
Considerably higher value of the retentive force (p<0.01) was establihed by the statistical analysis as well as that of the the retentive force per the stump surface unit (p<0.001) in Group II.

Shown in Table 2 is a positive, but not statsistiaclly significant correlation of the retentive force and the stump roughness.

The obtained SEMs magnified 1000 times (Figs. 2 and 3) and 5000 times (Figs. 4 and 5) illustrate differences in the surface roughness of the stumps depending upon the drilling instru-

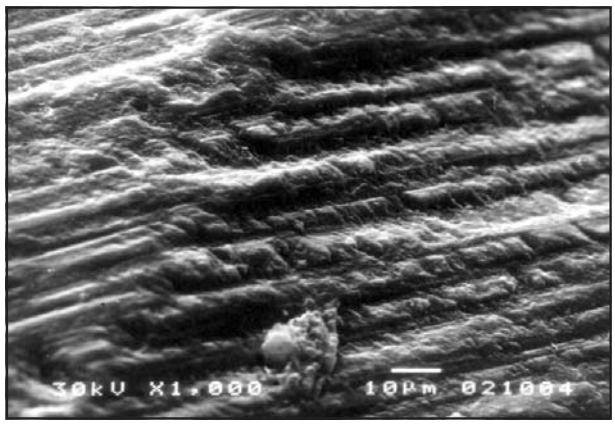
Slike 2 i 4 prikazuju skoro glatku površinu patrljaka sa diskretno naznačenim brazdama. U odnosu na prethodne, slike 3 i 5 ilustruju stanje na površini dentina sa vrlo naglašenim neravninama.

ment fineness. Shown in Figs. 2 and 3 is almost smooth surface of the stumps with discretely indicated grooves. With reference to the previous ones, Figs. 3 and 4 illustrate the state on the surface of the dentin with strongly indicated rough spots.



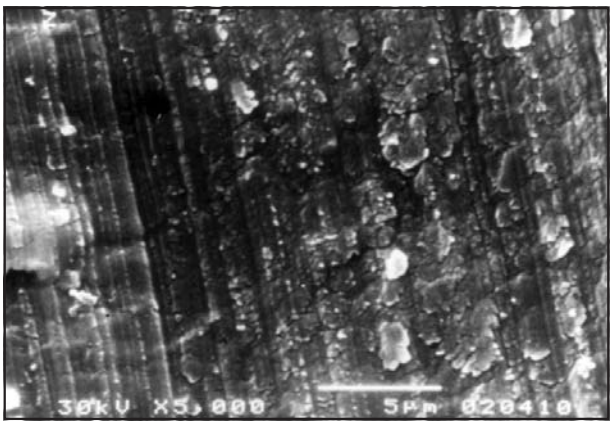
Slika 2. SEM izgled dentinske površine nakon preparacije finim dijamantskim borerima, × 1000.

Figure 2. SEM view of the dentine surface upon the preparation by fine diamond burs, × 1000.



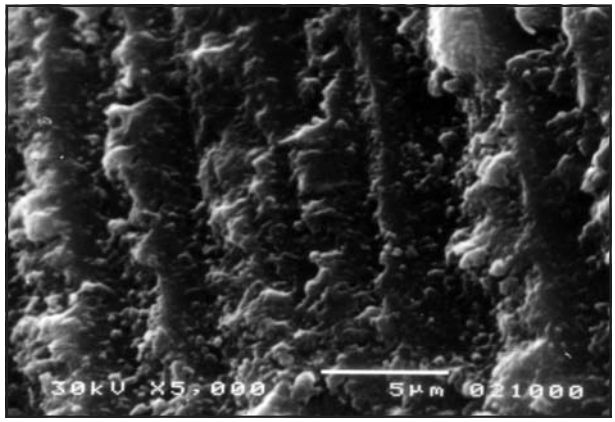
Slika 3. SEM izgled dentinske površine nakon preparacije grubljim dijamantskim borerima, × 1000.

Slika 3. SEM view of the dentine surface upon the preparation by rough diamond burs, ×1000.



Slika 4. SEM izgled dentinske površine nakon preparacije finim dijamantskim borerima, × 5000.

Slika 4. SEM view of the dentine surface upon the preparation by fine diamond burs, × 5000.



Slika 5. SEM izgled dentinske površine nakon preparacije grubljim dijamantskim borerima, × 5000.

Slika 5. SEM view of the dentine surface upon the preparation by rough diamond burs, × 5000.

Diskusija

Kao posledica abrazivnog delovanja dijamantskih kristala za vreme rotacije instrumenata za brušenje na patrljku se formira površina sa manjim ili većim neravninama. Nastala udubljenja su paralelna sa smerom rotacije brusnih instrumenata. Uvažimo li činjenicu da su

Discussion

As a consequence of the abrasive action of the diamond crystals during rotation of the preparing instruments a surface of less or greater rough spots on the stump is formed. The resulting grooves are parallel with the direction of rotation of the preparing instruments. Shall we

ostvarene neravnine na aksijalnim površinama patrljaka orjentisane upravno na osu zuba, te su na putu izvlačenja nadoknade, može se pretpostaviti da imaju uticaj na poboljšanje jačine vezivanja. Naime, više cementa zaostalog na patrljcima sa izraženijim profilom hrapavosti ide u prilog našoj pretpostavci. Ovo ukazuje da je do prekida veze, najverovatnije, došlo usled kohezionog defekta (u samom vezivnom materijalu), a ne na mestu vezivanja za patrljak (adhezivni defekt).[8] Najverovatnije da je u osnovi uticaja značajnije hrapavosti patrljaka na jačinu vezivanja krunica upravo uloga u povećanju površine na kojoj se ostvaruje vezivanje. Dobijeni rezultati su u korelaciji sa nalazima Feltona prema čijim se procenama površina koja dolazi u kontakt sa vezivnim materijalom povećava za čak 8% što svakako nije zanemarljivo.[9]

Zbog toga su i razumljiva nastojanja Chana i Boyera da je za poboljšanje jačine vezivanja poželjna gruba obrada dentina ali i nagrizanje unutrašnje površine fiksne nadoknade.[10] Prevedeno na jezik klinike to znači da stomatolog protetičar može uticati na jačinu veze nadoknade i patrljka i jednostavnim izborom instrumenata za brušenje što dobija na značaju upravo u situacijama kada je teško moguće ostvariti adekvatan dizajn preparacije.[11]

Zaključak

Sa povećanjem hrapavosti brušenih zuba povećava se i jačina vezivanja livenih krunica na iste kada se kao vezivni materijal koristi cinkfosfatni cement. Poboljšanje jačine vezivanja na opisani način može da smanji potrebu za dodatnim načinom vezivanja kao što je formiranje okluzalnih ili aproksimalnih žlebova. Ovo nisu isključivi faktori, ali svakako mogu biti od značaja za trajnost fiksnih zubnih nadoknada.

consider the fact that the rough spots accomplished on the axial surfaces of the stumps are oriented vertically to the tooth axis, so that they are on the way of pulling the denture, it may be assumed that they impact improvement of the bonding strenght. Namely, more cement retained on the stumps with the more expressed profile of roughness favours our assumption. This points to the fact that break in the bonding was, most probably, caused by the cohesion defect (within the bonding material itself), but not at the bonding spot to the stump (adhesive defect)[8]. It is, most probably, that role of increasing the surface on which bonding is effected lies in the base of the impact of more considerable roughness of the stump on the crowns bonding strenght. The results obtained are in correlation with the findings of Felton according to whose estimations the surface which comes in contact with the bonding material increases for almost 8 percent which, in any case, cannot be neglected.[9]

It goes without saying why the strivings of Chan and Boyer that rough processing of dentin and etching of the inner surface of the fixed denture as well are desirable to improve the bonding strenght.[10] Translated into the language of clinic it means that a dentist prosthetist may also influence the denture and stump bonding strenght simply by the selection of preparing instruments, which is of significance exactly in situations when it is hard to achieve an adequate design of preparation.[11]

Conclusion

Increasing roughness of the prepared teeth increases the bonding strength of the cast crowns to those teeth when zinc phosphate is used as a bonding material. Increase in the bonding strenght in the described way may cause the need for additional method of bonding to be decreased such as forming of occlusive or approximal grooves. These are not exclusive factors, but they may be of significance for the fixed dentures durability.

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