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Contents / Sadržaj

Serbian Dental Journal, vol. 69, N° 3, 2022

„Ko nije u stanju ispuniti i
minimum dužnosti što od njega
zakoni traže, ne može se nazvati
ni građaninom, još manje herojem
a najmanje svetiteljem."
Vladika Nikolaj Velimirović

U aktuelnoj realnosti, jedina i svekolika opcija našeg opstanka je „pobedonosni poraz", a iskrene „samopohvale i samoobožavanje" najsvetiji su odraz „moćnih zlovremenika" koji „bezočno" falsifikuju stvarnost. Sveprisutna apatičnost je i dalje u senci „samopromotera" i monoumnog tumačenja svakodnevice. Odjeci „prostačke" retorike dodatno „zagađuju" i truju svaki oblik normalnosti.

U medijskoj atmosferi obogaćenoj lažima, „bahati i neuki" bez trunke morala unižavaju sopstveni narod i institucije, velikodušno nudeći „podaništvo" i dezorijentisano bauljanje u uslovima simulirane demokratije. Medijska „lobotomija" i agresivna „brbljaonica" intelektualno neprosvećenih, ogrnuta primitivnom patetikom i optimizmom bez osnova, dodatno pojačava „ambijent besmisla" i hrabro „plasira" sopstvenu nemoć.

„Zlatno doba", koje živi samo u glavama punim fantazmagorije i besmisla, nedri samo strah, tragediju i ožiljke, a najodgovorniji se ponosno „kite lažima" kao ordenjem, a sopstvena „nedela valorizuju" kao najvrednije moralne parametre.

U poremećenom sistemu vrednosti, neukost, bahatost i partijska pripadnost su „upravo srazmerni" podobnosti za najviše funkcije. Ne treba zaboraviti ni „stepen poltronstva" odnosno „beskonačnost sopstvenog unižavanja" kao važne faktore u promovisanju „anonimnih" na „pijedestal besmisla". Ovako izvitoperena stvarnost je, kako reče veliki Vladika Nikolaj, vrlo plodno tle za one „koji će te uvek obasipati pohvalama, ako budeš pravdao njihove grehe".

Sigurno je da su aktuelna „apatičnost i beznađe" posledica izneverenih očekivanja, niskog standarda, ali i agresivne propagande koja besomučno „zaobilazi istinu" i promoviše mržnju kao jedini preduslov opstanka i očuvanja „lagodnih pozicija".

Kultura nasilja, primitivizma i „mržnja kao smisao života" mogu se eliminisati iz decenijskog „trenutka koji traje" jedino upornim nepristajanjem na sistematsko uređenje nenormalnosti.

Sloboda i hrabrost učenih ljudi, njihov moralni kodeks, znanje, odgovornost i nadasve borba za istinu, najvažniji su, ali i jedini put za iskorak iz beznađa koje kao zloćudni tumor podriva i parališe svaki segment društva.

Beg iz „kolektivne kaljuge" i moralnog sunovrata je neophodan i jedini ispravan put u pristojniju budućnost. Poštujući sopstveni moralni kodeks i znanje, akademska zajednica mora biti luč i iskra koja će osvetliti tunel bezizlaza i izopštiti „laž i neukus" kao formulu „aktuelnog trenutka".

Samo čestitost obrazovanih (bez kupljenih diploma) može vratiti poljuljane vrednosti. Hrabrošću, znanjem i neiscrpnom energijom „izvitoperena stvarnost" se može vratiti u normalni kolosek. Odlučnost učenih mora biti „najsvetija" obaveza za dekontaminaciju „laboratorije besmisla" koja kao kišobran natkriljuje svaki segment našeg bitisanja.

Ovaj komentar ću završiti onako kako sam i započeo, opet citatom velikog vladike Nikolaja Velimirovića: „Ljudi preziru vlast, kada ga nosi čovek bez dostojanstva", jer je to paradigma „trenutka koji predugo traje".

Prof. dr Slavoljub Živković

ORIGINAL ARTICLE
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Analysis of cyclic fatigue resistance of protaper universal and protaper next rotary instruments

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SUMMARY

Introduction Root canal preparation is one of the most important active phases in the treatment of infected and non-infected teeth. Nickel-titanium (NiTi) instruments are increasingly used in endodontic therapy due to their superior properties compared to those made of stainless steel. The aim of this research was to perform an analysis and comparison of cyclic fatigue in ProTaper Universal and ProTaper Next rotary NiTi instruments in full rotation in simulated canals.
Material and methods Twelve ProTaper Next and twelve ProTaper Universal instruments were analyzed in the study. The instruments were tested in an artificial canal stuffed in a metal block at an angle of 45° and a corner radius of 5 mm. The operating time of each instrument until fracture was measured and the number of cycles to fracture (NCF) calculated.
Results ProTaper Next instruments showed greater resistance to cyclic fatigue compared to ProTaper Universal. The NCF value was significantly higher in ProTaper Next (1,296.83±20.2) instruments ($p<0.001$). The average length of fractured fragments was statistically significantly higher in ProTaper Universal (4.52±0.33) instruments compared to ProTaper Next (3.82±0.27) ($p<0.001$).
Conclusion It was concluded that the cyclic fatigue resistance of ProTaper Next instruments was higher compared to ProTaper Universal instruments.
Keywords: Cyclic fatigue; NiTi, ProTaper Universal; ProTaper Next

INTRODUCTION

Root canal preparation is one of the most important active phases in the treatment of infected and non-infected teeth. Nickel-titanium (NiTi) instruments are increasingly used in endodontic therapy due to their superior properties compared to those made of stainless steel [1, 2, 3]. The use of rotary NiTi instruments has increased the success of the treatment due to their elasticity which is necessary to clean and shape curved root canals [4]. However, in addition to all its advantages, a sudden fracture of the instrument without previous warning signs represents the highest problem and is one of the most difficult complications during endodontic therapy [5, 6]. The main causes of instrument breakage are torsional load and cyclic fatigue [7, 8, 9]. In the case when the tip of the file is stuck in the canal during the rotation of the instrument or part of the instrument is twisted into the wall of the canal, the tip of the instrument is larger than the diameter of the root canal or when excessive pressure is applied to the instrument during operation, the instrument breaks due to torsion loads [10, 11]. A much more common cause of broken instruments is cyclic fatigue that occurs due to the continuous alternating compression and stretching at each point of bent instrument in the region of the canal curvature. This mechanism is responsible in 90% of instrument breakage cases [10, 11]. There are a number of additional factors that can affect the occurrence of fractures of NiTi instruments, such as the size, conicity and cross-sectional shape of instruments, as well as the training of the therapist [12].

The aim of this research was to analyze and compare cyclic fatigue of ProTaper Universal and ProTaper Next rotary NiTi instruments in full rotation in simulated canals.

MATERIALS AND METHODS

The research was conducted at the Clinic for Dental Medicine, Faculty of Medicine, University of Niš. Twelve ProTaper Universal instruments and twelve ProTaper Next instruments (Dentsply Sirona, Ballaigues, Switzerland) were tested for cyclic fatigue resistance. The instruments of both groups were size 25, taper 0.04, and length 25 mm.

For the purposes of the experiment, a special metal block made of stainless steel was constructed in accordance with the research of Plotino et al. [13]. The block contained a machine-cut artificial canal 19 mm in length and 1.4 mm in internal diameter, 45-degree angle of curvature, with a corner radius of 5 mm. The center of the

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curve was 5 mm away from the tip of the instrument. The block was placed on a base with feet and was enabled to move in two directions for easier placement of instruments in the canal. The canal was covered with tempered glass to allow observation of the rotating instrument and prevent the broken fragment from falling out. Glycerin was used to reduce the friction of instruments with stainless steel walls. The handpeace was fixed in a metal ring holder perpendicular to the canal. The instruments were inserted into the canal to the tip and rotated using an electric endomotor (X-smart plus, Dentsply Sirona, Ballaigues, Switzerland). All instruments were continuously rotated to the right, with constant resistance and speed as recommended by the manufacturer. A constant speed of 250 rpm and a torque of 2.5 Ncm were used for the ProTaper Universal, while a speed of 300 rpm and a torque of 2.0 Ncm were used for the ProTaper Next instruments. The rotation of the instrument was analyzed visually, and the fracture was registered visually and by sound. The rotation time until the instrument breaks was measured in seconds with a digital stopwatch. The number of cycles to fracture (NCF) was calculated according to the formula:

NCF = rotational speed of the instrument × time to fracture in seconds/60

The length of the fractured fragment (FL) was measured by using a Vernier caliper with an accuracy of 0.02 mm.

Statistical analysis was performed using the Mann Whitney U and Student t-test with a significance of $p<0.001$.

RESULTS

ProTaper Next instruments showed greater resistance to cyclic fatigue compared to ProTaper Universal. It was found that there is a statistically significant difference in the number of cycles to instrument fracture (NCF) between the analyzed groups ($Z=4.163$; $p<0.001$) (Table 1).

Table 1. Number of cycles to fracture (NCF) and length of fractured fragment (FL)
Tabela 1. Broj ciklusa do frakture (NCF) i dužina frakturisanog fragmenta (FL)

	ProTaper Next	ProTaper Universal	p
NCF	1296,83 ± 20,21	364,23 ± 14,37	< 0,001[1]
FL	3,82 ± 0,27	4,52 ± 0,33	< 0,001[2]

[1]Mann–Whitney U test; [2]Student t-test
[1]Man–Vitnijev U test; [2]Studentov t-test

The average length of fractured fragments was greater in ProTaper Universal instruments compared to ProTaper Next. Statistical analysis showed that there was a significant difference in fragment length (FL) between the studied groups ($t=5.669$; $p<0.001$) (Table 1).

DISCUSSION

Root canal preparation with endodontic instruments and continuous irrigation is the most important phase of endodontic treatment [14]. The instruments are expected to be flexible and have a high cutting efficiency, which would ensure preservation of the initial form of the canal. However, sudden fracture of instruments inside the root canal is a major concern in daily clinical practice [15]. Cyclic fatigue is the main reason of instrument fracture occurring at the point of maximum instrument flexure while rotating within curved root canals [16]. Therefore, it is of great importance to constantly perform cyclic fatigue tests on new NiTi instrument systems to provide clinicians with information on their fracture resistance [17].

In our study, the cyclic fatigue resistance of two different types of NiTi rotary instruments - ProTaper Universal and ProTaper Next - was compared in simulated root canals. The results showed extremely high resistance to cyclic fatigue in ProTaper Next instruments, compared to ProTaper Universal. This difference may be due to the continuous modification of the NiTi alloy and structure, as well as the material processing technique, which has been shown to be a factor that greatly influenced the increase in cyclic fatigue resistance. The manufacturing of ProTaper Next instruments is based on M-wire technology, which involves a series of heat treatments to which NiTi wire is exposed during the production process, which is why M-wire is much more elastic and resistant to cyclic fatigue than conventional instruments [18]. Conventional NiTi alloy is in the austenite phase at room and oral temperature. At room temperature, M-wire that has been subjected to thermal treatments is in the austenite and martensite phase. It is precisely the higher content of martensite, which is softer, in M-wire instruments that has a positive effect on the resistance to cyclic fatigue. A number of studies have reported results consistent with this claim [19, 21].

In addition to alloy differences, instrument cross-sectional differences are a significant contributing factor to the greater fatigue resistance of NiTi rotary instruments. The larger contact area of the rotating NiTi instrument in the canal leads to less flexibility and less resistance to cyclic fatigue [20]. ProTaper Universal instruments have a triangular cross-section and are manufactured using the cutting technology that is standard for conventional instruments. Such manufacturing technology leads to the appearance of microcracks and defects on the surface of the working part, which represent points of stress concentration that weakens the instrument and leads to its sudden breakage [21].

The ProTaper Next has a rectangular cross-section with an off-center position that reduces the area of contact with the root canal walls during instrumentation providing greater resistance to cyclic fatigue [20, 22]. Asymmetric movements during the rotation of the ProTaper Next instrument ensure efficiency in canal instrumentation, while the rectangular section ensures superior mechanical properties [18]. In the study by Zhang et al. [23], the cross-sectional shape and design of NiTi instruments were analyzed and it was proved that both factors significantly influence their mechanical properties during canal preparation. Uygun et al. [24] used ProTaper Universal,

ProTaper Next and ProTaper Gold in simulated canals with a curvature angle of 60 degrees to evaluate cyclic fatigue and found that ProTaper Next and ProTaper Gold showed the highest resistance to cyclic fatigue.

In the case of ProTaper Next instruments, the occurrence of fractured fragments of a significantly shorter length compared to ProTaper Universal was observed. The results of our study are correlated with the results of the study conducted by Mohamed et al. [25] who compared the cyclic fatigue resistance of five different NiTi rotary instruments. In the study by Peng et al. [15], the fragment length of ProTaper Next instruments was significantly smaller compared to ProTaper Universal when they were examined in the canal at an angle of 90 degrees. However, there was no statistically significant difference in the length of fractured fragments in canals at an angle of 45 and 60 degrees.

CONCLUSION

ProTaper Next instruments showed greater resistance to cyclic fatigue compared to ProTaper Universal instruments. The breaking point of the ProTaper Next instruments was appically positioned compared to ProTaper Universal.

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Analiza otpornosti na ciklični zamor rotirajućih instrumenata ProTaper Universal i ProTaper Next

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KRATAK SADRŽAJ

Uvod Preparacija kanala korena predstavlja jednu od najvažnijih aktivnih faza u lečenju inficiranih i neinficiranih zuba. Nikl-titanijumski (NiTi) instrumenti se sve više koriste u endodontskoj terapiji zbog superiornijih osobina u odnosu na one od nerđajućeg čelika. Cilj ovog istraživanja je bio da se izvrši analiza i poređenje cikličnog zamora kod mašinskih NiTi instrumenata ProTaper Universal i ProTaper Next u punoj rotaciji u simuliranim kanalima.

Materijal i metode U studiji je bilo analizirano 12 ProTaper Next i 12 instrumenata ProTaper Universal. Instrumenti su testirani u artificijelnom kanalu preparisanom u metalnom bloku pod uglom od 45° i radijusom ugla od 5 mm. Mereno je vreme rada svakog instrumenta do pojave frakture, a zatim je vršeno izračunavanje broja ciklusa do frakture.

Rezultati Instrumenti ProTaper Next su pokazali veću otpornost na ciklični zamor u odnosu na ProTaper Universal. Vrednost broja ciklusa do frakture je bila statistički značajno veća kod instrumenata ProTaper Next (1296,83 ± 20,2) ($p < 0,001$). Prosečna dužina frakturisanih fragmenata je bila statistički značajno veća kod instrumenata ProTaper Universal (4,52 ± 0,33) u odnosu na ProTaper Next (3,82 ± 0,27) ($p < 0,001$).

Zaključak Zaključeno je da je otpornost na ciklični zamor kod instrumenata ProTaper Next bila veća u poređenju sa instrumentima ProTaper Universal.

Ključne reči: ciklični zamor; NiTi, ProTaper Universal; ProTaper Next

UVOD

Preparacija kanala korena predstavlja jednu od najvažnijih aktivnih faza u lečenju inficiranih i neinficiranih zuba. Nikl-titanijumski (NiTi) instrumenti se sve više koriste u endodontskoj terapiji zbog superiornijih osobina u odnosu na one od nerđajućeg čelika [1, 2, 3]. Upotreba mašinskih rotirajućih NiTi instrumenta je povećala uspešnost tretmana zbog njihove elastičnosti neophodne za čišćenje, širenje i oblikovanje zakrivljenih kanala korena [4]. Međutim, pored svih svojih prednosti, iznenadni prelom istumenta bez prethodnih znakova upozorenja predstavlja najveći problem i jedna je od težih komplikacija u toku endodontske terapije [5, 6]. Glavne uzroke preloma instrumenata predstavljaju torziono opterećenje i ciklični zamor [7, 8, 9]. U slučaju kada je vrh turpije zaglavljen u kanalu tokom rotacije instrumenta, kada se deo instrumenta uvije u zid kanala, kada je vrh instrumenta veći od promera kanala korena, ili kada se vrši prekomerni pritisak na instrument u toku rada, dolazi do preloma instrumenta usled torzionog opterećenja [10, 11]. Mnogo češći uzrok preloma instumenata je ciklični zamor koji nastaje usled neprekidnog smenjivanja kompresije i istezanja u svakoj tački savijenog instrumenta u predelu krivine kanala. Ovakav mehanizam je odgovoran u 90% slučajeva preloma instrumenata [10, 11]. Postoji veliki broj dodatnih faktora koji mogu uticati na pojavu preloma NiTi instrumenata, kao što su veličina, koničnost i oblik poprečnog preseka instrumenata, kao i obučenost samog terapeuta [12].

Cilj ovog istraživanja je bio da se izvrši analiza i poređenje cikličnog zamora kod mašinskih NiTi instrumenata ProTaper Universal i ProTaper Next u punoj rotaciji u simuliranim kanalima.

MATERIJAL I METODE

Istraživanje je obavljeno na Klinici za dentalnu medicinu Medicinskog fakulteta Univerziteta u Nišu. Dvanaest instrumeta ProTaper Universal i dvanaest instrumenata ProTaper Next (Dentsply Sirona, Ballaigues, Switzerland) testirano je na otpornost na ciklični zamor. Instrumenti obe grupe bili su veličine 25, stepena koničnosti 0,04, i dužine 25 mm.

Za potrebe eksperimenta konstruisan je poseban metalni blok od nerđajućeg čelika u skladu sa istraživanjem Plotina i saradnika [13]. Blok je sadržao mašinski urezan artificijelni kanal dužine 19 mm i unutrašnjeg dijametra 1,4 mm, ugla zakrivljenosti 45 stepeni, sa radijusom ugla od 5 mm. Centar krivine je bio 5 mm udaljen od vrha instrumenta i kanala. Blok je bio postavljen na bazi sa stopama i bile su mu omogućene kretnje u dva pravca radi lakšeg postavljanja instrumenata u kanal. Kanal je bio prekriven kaljenim staklom da omogući posmatranje rotirajućeg instrumenta i spreči ispadanje polomljenog fragmenta. Za smanjenje trenja instrumenata sa zidovima od nerđajućeg čelika korišćen je glicerin. Kolenjak je bio fiksiran u metalnom prstenastom držaču upravno na kanal. Instrumenti su unošeni u kanal do vrha i rotirani korišćenjem električnog endomotora (X-smart plus, Dentsply Sirona, Ballaigues, Switzerland). Svi instrumenti su kontinuirano rotirani udesno, sa konstantnim otporom i brzinom prema preporuci proizvođača. Za ProTaper Universal je korišćena konstantna brzina od 250 rpm i tork od 2,5 Ncm, dok je kod instrumenata ProTaper Next korišćena brzina od 300 rpm i tork od 2,0 Ncm. Rotacija instrumenta je analizirana vizuelno, a prelom je registrovan vizuelno i zvukom. Vreme rotacije do preloma instrumenta mereno je u sekundama digitalnom štopericom. Broj ciklusa do frakture (NCF) računat je prema formuli:

$$NCF = \text{broj obrtaja} \times \text{vreme do frakture u sekundama}/60$$

Dužina prelomljenog fragmenta merena je kaliperom po Vernijeru sa tačnošću 0,02 mm. Statistička analiza je izvršena pomoću Man–Vitnijevog U i Studentovog t-testa sa pragom značajnosti od $p < 0,001$.

REZULTATI

Instrumenti ProTaper Next pokazali su veću otpornost na ciklični zamor u odnosu na ProTaper Universal. Utvrđeno je da postoji statistički značajna razlika u broju ciklusa do frakture instrumenta između ispitivanih grupa ($Z = 4,163$; $p < 0,001$) (Tabela 1).

Prosečna dužina frakturisanih fragmenata je bila veća kod instrumenata ProTaper Universal u odnosu na ProTaper Next. Statistička analiza je pokazala da postoji značajna razlika u dužini fragmenata između ispitivanih grupa ($t = 5,669$; $p < 0,001$) (Tabela 1).

DISKUSIJA

Preparacija kanala korena endodontskim instrumentima sa obilnom irigacijom predstavlja najvažniju fazu endodontskog tretmana [14]. Od instrumenata se očekuje da budu fleksibilni i da imaju visoku sečivnu efikasnost, čime bi se obezbedilo očuvanje inicijalne forme kanala. Međutim, iznenadna fraktura instrumenata unutar kanala korena predstavlja glavnu zabrinutost u svakodnevnoj kliničkoj praksi [15]. Ciklični zamor je glavni razlog preloma instrumenta, koji se javlja na tački maksimalne savijenosti instrumenta dok se slobodno okreće unutar zakrivljenih kanala korenova [16]. Zbog toga je od velike važnosti konstantno sprovoditi testove cikličnog zamora na novim sistemima NiTi instrumenata, čime bi se kliničarima obezbedile informacije o njihovoj otpornosti na prelome [17].

U ovoj studiji je izvršeno poređenje otpornosti na ciklični zamor kod dva različita tipa NiTi rotirajućih instrumenata – ProTaper Universal i ProTaper Next u simuliranim kanalima korenova. Rezultati su pokazali izuzetno visoku otpornost na ciklični zamor kod instrumenata ProTaper Next, u poređenju sa ProTaper Universal. Ova razlika može biti posledica kontinuirane modifikacije NiTi legure i strukture, kao i tehnike obrade materijala, što se pokazalo kao faktor koji u velikoj meri utiče na povećanje otpornosti na ciklični zamor. Izrada instrumenata ProTaper Next bazirana je na M-wire tehnologiji, koja podrazumeva seriju toplotnih tretmana kojima se izlaže NiTi žica u procesu proizvodnje, zbog čega je M-wire mnogo elastičniji i otporniji na ciklični zamor od konvencionalnih instrumenata [18]. Konvencionalna NiTi legura je na sobnoj i temperaturi usne duplje u fazi austenita. Na sobnoj temperaturi, M-wire koji je podvrgnut termičkim tretmanima u fazi je austenita i martenzita. Upravo veći sadržaj martenzita, koji je mekši, kod M-wire instrumenata ima pozitivan efekat na otpornost na ciklični zamor. Brojne studije su objavile rezultate koji su u skladu sa ovom tvrdnjom [19, 21].

Pored razlika u leguri, razlike u poprečnom preseku instrumenata predstavljaju značajan faktor koji doprinosi većoj otpornosti na zamor kod NiTi rotirajućih instrumenta. Veća kontaktna površina rotirajućeg NiTi instrumenta u kanalu dovodi do manje fleksibilnosti i manje otpornosti na ciklični zamor [20]. Instrumenti ProTaper Universal imaju trougaoni poprečni presek i proizvode se tehnologijom klasičnog rezanja, koja je standardna za konvencionalne instrumente. Takva tehnologija izrade dovodi do nastanka mikropukotina i defekata na površini radnog dela koji predstavljaju tačke koncentracije stresa koje oslabljuju instrument i dovode do njegovog iznenadnog pucanja [21].

ProTaper Next ima pravougaoni poprečni presek sa necentriranim položajem koji dovodi do takvog pomeranja tokom instrumentacije da se smanjuje površina radnog dela koja je u kontaktu sa zidovima kanala korena, što obezbeđuje veću otpornost na ciklični zamor [20, 22]. Asimetrični pokreti tokom rotacije instrumenata ProTaper Next obezbeđuju efikasnost u obradi kanala, dok pravougaoni presek obezbeđuje superiorne mehaničke osobine [18]. U studiji koju su objavili Zhang i saradnici [23] analizirani su oblik i dizajn poprečnog preseka instrumenta od NiTi i dokazano je da oba faktora značajno utiču na njihove mehaničke osobine tokom preparacije kanala. Uygun i saradnici [25] za procenu cikličnog zamora koristili su ProTaper Universal, ProTaper Next i ProTaper Gold u simuliranim kanalima sa uglom zakrivljenosti od 60 stepeni i utvrdili su da su najveću otpornost na ciklični zamor pokazali ProTaper Next i ProTaper Gold.

Kod instrumenata ProTaper Next uočena je pojava frakturisanih fragmenata značajno manje dužine u odnosu na ProTaper Universal. Rezultati ove studije su u korelaciji sa rezultatima studije sprovedene od strane Mohameda i saradnika [24], koji su upoređivali rezistentnost na ciklični zamor pet različitih NiTi rotirajućih instrumenta. U studiji Penga i saradnika [15] dužina fragmenta kod instrumenata ProTaper Next bila je statistički značajno manja u poređenju sa ProTaper Universal kad su ispitivani u kanalu pod uglom od 90°. Međutim, nije bilo statistički značajne razlike u dužini prelomljenih fragmenta u kanalima pod uglom od 45° i 60°.

ZAKLJUČAK

Instrumenti ProTaper Next su pokazali veću otpornost na ciklični zamor u poređenju sa instrumentima ProTaper Universal. Tačka preloma kod instrumenata ProTaper Next je imala apeksno pomerenu poziciju u odnosu na ProTaper Universal.

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Analysis of sliding mechanics force degradation during postextraction space closure

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SUMMARY

Introduction Due to its simplicity, sliding mechanism is very often used in clinical practice for post-extraction space closure, however, the efficiency of this method may be reduced due to friction and changes in the properties of the materials used in this method. The most commonly used methods of sliding mechanics are nickel titanium (NiTi) closed coil spring and elastic chain.

The aim of this study was to analyze force degradation in the application of nickel titanium closed coil springs and elastic chains during post-extraction space closure within treatment with fixed orthodontic appliances.

Material and Methods The total sample in this study consisted of 78 post-extraction spaces in patients who were indicated for extraction of first premolars and treatment with fixed orthodontic appliances. Nickel titanium closed coil springs and elastic chains were used to close the post-extraction spaces. Post-extraction spaces were monitored for 6 months with follow up examinations every 4 weeks. Measurements of initial force, at the beginning of mechanism activation and residual force in the observation period were performed during control examinations.

Results Results of this research showed that with both methods of sliding mechanism there was a significant decrease in the observation period. When using NiTi closed coil springs, the value of average initial force at control examination was between 189.00-210.25 g, while residual was in the range of 117.56-133.50 g that NiTi closed coil springs kept an average 61.57% of initial force. The average initial force on the control examinations for elastic chains was between 184.5-205.38 g, while residual force was in range of 100.39-113.00 g, that elastic chains retained an average 53.41% of initial force.

Conclusion There was a significant force degradation between inspections, when sliding mechanics were applied. The loss of force between activation phases of NiTi closed coil springs was smaller compared to the forces produced by elastic chains.

Keywords: sliding mechanics; elastic chain; NiTi closed coil spring; post-extraction space

INTRODUCTION

Optimal orthodontic treatment requires application of mechanics that lead to maximum speed of tooth movement with minimal irreversible damage to root, periodontal ligament and alveolar bone. Optimal force for orthodontic tooth movement is described as the lightest force providing maximum or almost maximum response [1, 2]. Depending on magnitude of the force applied, different types of resorptions may occur in zones of tooth movement. If heavy forces are applied, necrosis of the surrounding tissue and undermining resorption with hyalinization zones can occur and lead to retention in tooth movement. With application of mild continuous forces, there is a uniform movement of teeth with the appearance of the desired form of resorption, that is frontal resorption. In terms of duration, two types of force can be generated with fixed orthodontic appliances: continuous and intermittent. Continuous ones show the same level during 24 hours, and insignificantly decrease between control examinations, while intermittent forces suddenly decrease and at the next checkup, they are equal to zero [2, 3]. More efficient and faster closing of post-extraction space is also influenced by the decrease in force of applied mechanism over time. Orthodontic tooth displacement requires the application of continuous force over a certain period of time, whereby the efficiency increases if the force is maintained for as long as possible [4, 5, 6].

Within treatment with fixed orthodontic appliances, the sliding mechanism is a very simple method for closing post-extraction space and it is therefore most often used in clinical practice. This method performs appropriate application and transmission of force inside the dental arch. Due to occurrence of friction, the efficiency

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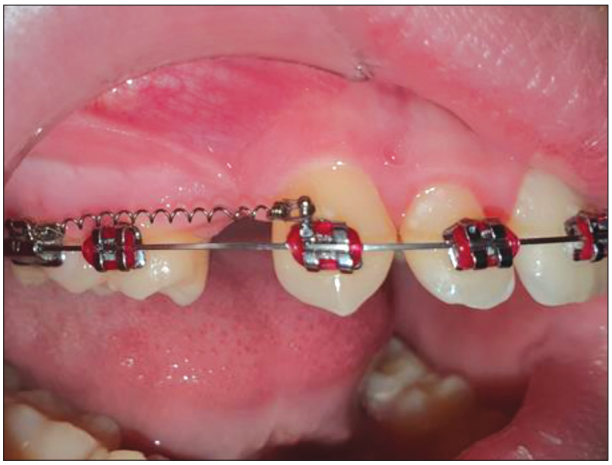

Figure 1. Application of NiTi closed spring
Slika 1. Postavljanje NiTi zatvorene opruge

Figure 2. Application of elastic chain
Slika 2. Postavljanje elastičnog lanca

Figure 3. Dynamometer (Force Gauge Dynamometer, White Oak, USA)
Slika 3. Dinamometar (*Force Gauge Dynamometer, White Oak*, USA)

of this method may be reduced. Friction is a force of resistance that occurs between two surfaces and opposes movement. In sliding mechanics, force and resistance to sliding change as the tooth moves, at first inclines, then a biological response occurs, the tooth then straightens, bone remodels around the root, and then inclines again [7]. There are a number of factors that affect the resistance that occurs with the sliding mechanism, and they can be grouped into physical and biological factors. Physical factors are mainly related to the properties and dimensions of orthodontic arches, braces, as well as the type of ligation, while biological factors include the amount and presence of saliva, plaque and food debris [8].

It is necessary to apply such force that can overcome the resistance to sliding of wire arch through the system of brackets and move teeth along the wire arch [9]. It is recommended that the optimal force should be between 100 and 200 g/cm^2, that is considered a biologically acceptable framework. In order to move the canine with the help of a sliding mechanism, a force of 100 g/cm^2 is needed to move the tooth and an additional 100 g/cm^2 to overcome the resistance (friction) [10].

The aim of this study was to analyze force degradation in the application of nickel titanium closed coil springs and elastic chains during post-extraction space closure within treatment with fixed orthodontic appliances.

MATERIAL AND METHODS

Research was conducted at the Faculty of Medicine - study program of dentistry in Banja Luka, with the consent of the Ethics Committee of the Department of Dentistry. At the beginning of this research, a selection of respondents was made among the patients who came for the first examination. After clinical processing of patients (anamnesis, clinical examination, taking impressions, analysis of study models, analysis of orthopantomography and teleradiography), potential subjects were informed about the research and they signed an informed consent. Subjects ranged in age from 12 to 20 years and had no contraindications for orthodontic therapy, as well as other extractions (except first premolars). Subjects excluded from the study were those who did not came to check-ups regularly, had poor oral hygiene and did not follow the instructions given at the beginning of therapy. The total sample in the study was 78 post-extraction spaces in patients who were indicated for extraction of the first premolars in order to conduct orthodontic treatment.

After extraction of first premolars, subjects were fitted with a fixed orthodontic appliance (Dentaurum, Discovery, Roth prescription, slot 0.022 in) and initial leveling was performed with NiTi arches of round and square cross-section, before application of square steel arches. A square steel arch with a cross section of 0.019×0.025 in was left in the slots of brackets for at least 4 weeks, to become passive and nickel titanium closed springs (American Orthodontics, USA) were applied for 40 and elastic chains (American Orthodontics, USA) for 38 post-extraction spaces. Nickel titanium closed coil springs were placed from the hook on the tube of first molar to the hook of bracket on the canine, where springs were not stretched more than 9 mm (Figure 1). If the spring was too short, a ligature wire was used to connect it to hook on the tube on molar. During the therapy, spring was activated at the control examinations. Elastic chain was placed so that

it connects hook on the tube of the first molar and hook of the bracket on the canine, whereby it was stretched to approximately twice the initial length, and at the control examinations it was replaced with a new one (Figure 2).

Post-extraction spaces were monitored for 6 months from the beginning of the sliding mechanism application at intervals of one month (T_0-T_6). Control examinations were performed every 4 weeks and it was checked whether there was damage on applied mechanisms and their activation.

Measurements of initial force at the beginning and residual force in the observation period were performed at the control examinations. Force strength was measured with a dynamometer (Force Gauge Dynamometer, White Oak, USA) (Figure 3).

RESULTS

In our research, the effect of applied sliding mechanism activation force at the beginning and residual force at the end was analyzed. The average applied force at the beginning and at the end of each time activation interval was examined. The T test for paired samples showed that applied force significantly differed at the beginning and end of activation in each time interval. In the interval T_1, average force at the beginning was M = 231.02 g, and at the end M = 121.99 g (52.8%). This difference was statistically significant (t = 45.03, df = 117, p = 0.000). In T_2, the average force at the beginning was M = 228.42 g, and at the end M = 120.34 g (52.68%). This difference was statistically significant (t = 42.96, df = 116, p = 0.000). In T_3, the average force at the beginning was M = 230.56 g, and at the end M = 123.70 g (53.65%), this difference was statistically significant (t = 37.99, df = 107, p = 0.000). In T_4 the average force at the beginning was M = 234.93 g, and at the end M = 130.21 g (55.42%), this difference was statistically significant (t = 33.17, df = 71, p = 0.000). In T5 the average force at the beginning was M = 240.73 g, and at the end M = 143.13 g (59.45%), this difference was statistically significant (t = 28.31, df = 47, p = 0.000). In T_6 the average force at the beginning was M = 209.44 g, and at the end M = 140.74 g (67.19%), this difference was statistically significant (t = 12.39, df = 26, p = 0.000) (Table 1).

After examining change in force strength, these changes were examined within each method. The average values of force at the beginning and at the end of each activation time interval within NiTi closed spring method were examined. The T test for paired samples showed that applied force differed significantly at the beginning and end of activation in each time interval. In the interval T_1, the average force at the beginning was M = 210.250 g, and at the end M = 121.625 g (57.84%). This difference was statistically significant (t = 33.37, df = 39, p = 0.000). In T_2, the average force at the beginning was M = 201.154 g, and at the end M = 117.564 g (58.44%). This difference was statistically significant (t = 34.90, df = 38, p = 0.000). In T_3, the average force at the beginning was M = 204.242 g, and at the end M = 123.485 g (60.46%), this difference was statistically significant (t = 28.12, df = 32, p = 0.000).

Table 1. Force applied at the beginning and end of activation
Tabela 1. Primenjena sila na početku i na kraju aktivacije

	N	M	SD	T	Df	P
T_1 Beginning T_1 Početak	78	231.02	39.70	45.035	77	0.000
T_1 End T_1 Kraj	78	121.99	21.72			
T_2 Beginning T_2 Početak	77	228.42	38.31	42.961	76	0.000
T_2 End T_2 Kraj	77	120.34	18.44			
T_3 Beginning T_3 Početak	68	230.56	38.23	37.998	67	0.000
T_3 End T_3 Kraj	68	123.70	20.47			
T_4 Beginning T_4 Početak	52	234.93	39.70	33.173	51	0.000
T_4 End T_4 Kraj	52	130.21	22.00			
T_5 Beginning T_5 Početak	28	240.73	39.88	28.319	27	0.000
T_5 End T_5 Kraj	28	143.13	33.34			
T_6 Beginning T_6 Početak	20	209.44	42.86	12.392	19	0.000
T_6 End T_6 Kraj	20	140.74	38.47			

N – number of subjects; Min – minimum value on the sample; Max – maximum value on the sample; M – arithmetic mean; SD – standard deviation; t – t-test for paired samples; df – degree of freedom; p – statistical significance
N – broj ispitanih prostora; Min – minimalna vrednost na uzorku; Max – maksimalna vrednost na uzorku; M – aritmetička sredina; SD – standardna devijacija; t – t-test za uparene uzorke; df – stepen slobode; p – statistička značajnost

In T_4, the average force at the beginning was M = 204.667 g, and at the end M = 122.667 g (59.93%), this difference was statistically significant (t = 19.43, df = 14, p = 0.000). In T_5, the average force at the beginning was M = 205.417 g, and at the end M = 128.750 g (62.67%), this difference was statistically significant (t = 15.77, df = 11, p = 0.000). In T_6 the average force at the beginning was M = 189,000 g, and at the end M = 133,500 g (70.06%), this difference was statistically significant (t = 10.81, df = 9, p = 0.000) (Table 2).

Force was tested at the beginning and at the end of each activation time interval within the elastic chain method. The T test for paired samples showed that the applied force differed significantly at the beginning and at the end of activation in each time interval. In the interval T_1, the average force at the beginning was M = 199.34 g, and at the end M = 100.39 g (50.36%). This difference was statistically significant (t = 39.75, df = 37, p = 0.000). In T_2, the average force at the beginning was M = 204.47 g, and at the end M = 103.82 g (50.77%). This difference was statistically significant (t = 37.17, df = 37, p = 0.000). In T_3, the average force at the beginning was M = 204.58 g, and at the end M = 104.72 g (51.18%), this difference was statistically significant (t = 25.53, df = 35, p = 0.000). In T_4, the average force at the beginning was M = 198.75 g, and at the end M = 109.17 g (54.92%), this difference was statistically significant (t = 26.73, df = 23, p = 0.000). In T_5 the average force at the beginning was M = 205.38 g, and at the end M = 108.08 g (52.02%), this difference was statistically significant (t = 29.64, df = 12, p = 0.000).

Table 2. Applied force at the beginning and end of activation within the NiTi spring mechanism
Tabela 2. Primenjena sila na početku i na kraju aktivacije u okviru mehanizma NiTi opruge

	N	M	SD	T	Df	P
T_1 Beginning T_1 Početak	40	210.250	15.971	33.376	39	0.000
T_1 End T_1 Kraj	40	121.625	13.746			
T_2 Beginning T2 Početak	39	201.154	17.262	34.909	38	0.000
T_2 End T_2 Kraj	39	117.564	13.854			
T_3 Beginning T_3 Početak	33	204.242	16.683	28.126	32	0.000
T_3 End T_3 Kraj	33	123.485	12.959			
T_4 Beginning T_4 Početak	15	204.667	16.526	19.431	14	0.000
T_4 End T_4 Kraj	15	122.667	14.251			
T_5 Beginning T_5 Početak	12	205.417	18.397	15.778	11	0.000
T_5 End T_5 Kraj	12	128.750	14.001			
T_6 Beginning T_6 Početak	10	189.000	10.220	10.810	9	0.000
T_6 End T_6 Kraj	10	133.500	19.444			

N – number of subjects; Min – minimum value on the sample; Max – maximum value on the sample; M – arithmetic mean; SD – standard deviation; t – t-test for paired samples; df – degree of freedom; p – statistical significance
N – broj ispitanih prostora; Min – minimalna vrednost na uzorku; Max – maksimalna vrednost na uzorku; M – aritmetička sredina; SD – standardna devijacija; t – t-test za uparene uzorke; df – stepen slobode; p – statistička značajnost

Table 3. Applied force at the beginning and end of the activation within the elastic chain mechanism
Tabela 3. Primenjena sila na početku i na kraju aktivacije u okviru mehanizma elastičnog lanca

	N	M	SD	T	Df	P
T_1 Beginning T_1 Početak	38	199.34	17.21	39.759	37	0. 000
T_1 End T_1 Kraj	38	100.39	13.48			
T_2 Beginning T_2 Početak	38	204.47	13.79	37.174	37	0. 000
T_2 End T_2 Kraj	38	103.82	11.12			
T_3 Beginning T_3 Početak	36	204.58	19.17	25.532	35	0. 000
T_3 End T_3 Kraj	36	104.72	12.93			
T_4 Beginning T_4 Početak	24	198.75	14.47	26.739	23	0. 000
T_4 End T_4 Kraj	24	109.17	9.74			
T_5 Beginning T_5 Početak	13	205.38	17.97	29.645	12	0. 000
T_5 End T_5 Kraj	13	108.08	8.79			
T_6 Beginning T_6 Početak	10	184.50	27.13	8.106	9	0. 000
T_6 End T_6 Kraj	10	113.00	6.32			

N – number of subjects; Min – minimum value on the sample; Max – maximum value on the sample; M – arithmetic mean; SD – standard deviation; t – t-test for paired samples; df – degree of freedom; p – statistical significance
N – broj ispitanih prostora; Min – minimalna vrednost na uzorku; Max – maksimalna vrednost na uzorku; M – aritmetička sredina; SD – standardna devijacija; t – t-test za uparene uzorke; df – stepen slobode; p – statistička značajnost

In T_6 the average force at the beginning was M = 184.50 g, and at the end M = 113.00 g (61.24%), this difference was statistically significant (t = 8.10, df = 9, p = 0.000) (Table 3).

DISCUSSION

It is very important that applied mechanisms for post-extraction space closure produce continuous forces for orthodontic tooth movement over a period of time, with their efficiency increasing if the force is maintained for as long as possible [11].

Studies on optimal force for canine retraction showed that a force of 150-200 g leads to the most efficient movement. It is believed that light forces do not have such efficiency, while heavy ones can lead to hyalinization of tissues, which results in obstruction of tooth movement process [12]. In our research, forces with an average value of about 200 g were used. The average force at the beginning of activation was 231.02 g, while at the end of activation period, after 4 weeks, this value averaged 121.99 g.

NiTi closed springs showed an increasing trend in clinical use in post-extraction space closure, that is why they are often a subject of research. In our study, NiTi springs were used from the same manufacturer, so that they produce a force of about 200 g. If they would generate too much force during larger stretches, wire ligatures were used to tie hooks of tubes on molars. When using NiTi closed springs, the value of the average initial force on the control examinations ranged between 189.00 g to 210.25 g, while the residual one ranged from 117.56 g to 133.50 g. It can be concluded that NiTi closed springs retained an average of 61.57% of the initial force.

Influence of oral environmental factors on the force degradation in NiTi closed coil springs has been investigated through numerous studies. It has been confirmed that neither food nor liquids found in the mouth, including saliva, affect the force generated by these springs [13, 14, 15]. It has been established that only large temperature differences can lead to changes in the force level [16, 17]. In this research, it was not possible to control these conditions, except that in communication with patients it was found that it is difficult for them to maintain hygiene, as well as retain food on springs, especially at the end of the activation cycle, when the thread gap decreases.

Kishorekumar et al. monitored force degradation of NiTi springs over certain time intervals. Total sample consisted of 30 NiTi springs, 9 mm length from 3 different manufacturers (Lancer orthodontics, Ortho technology, GAC international). Initially, NiTi springs were stretched to produce a force of 150 g. At the end of 4 weeks the force loss for the GAC spring (29.03%) was higher than the Lancer spring (21.61%) and Orthotech (14.62%). The GAC spring showed significant force degradation during most of the interval, although it was exposed to

the martensite plateau, it did not achieve the target force in the activation range given by the manufacturer (1-12 mm). With the Lancer spring, there was no significant loss of force during the first 24 hours, while Orthotech springs showed less force degradation throughout the period. Authors recommend stretching the Lancer and Orthotech springs by 1/3 of their length, and for GAC springs by 1/2 to 1/3 of its original length [18].

Maganzini et al. measured initial force of 14 different 9 mm NiTi closed springs from 5 different manufacturers. They found that only 6 of them had a change in intensity of less than 50 g when deactivated, while some springs also had a decrease in force of more than 100 g. Authors believe that such results may be primarily due to the fact that in addition to dimensions of 9 and 12 mm, manufacturers put descriptive names (ultra-light, light, medium, heavy, extra heavy), while others mark the constant force generated by springs (100 g, 150 g and 200 g). Such marking can be misleading to clinicians, especially if we take into account the fact that light models of tested springs from one manufacturer produce a force of 103-120 g, and another from 121-226 g [19]. A similar study was conducted by Conti et al. and it was concluded that it is necessary to measure the force produced by NiTi closed springs during orthodontic treatment, in order to achieve optimal force for moving teeth [20].

In a clinical-laboratory study, Geng et al. examined the level of force produced by NiTi closed springs during post-extraction space closure. This study showed that the loss of maximum force and the decrease of forces on the deactivation plateau did not depend on time. Authors conclude that it should be taken care when the spring is applied to avoid excessive stretching. Thermal cycles from daily food and beverages can contribute in force degradation of these springs, while heat treatment can help return them to their original state [21].

Unlike NiTi closed springs, elastic chains in the oral cavity begin to absorb saliva, can break and permanently deform due to the rupture of internal connections. Over time, exposure to saliva and changes in oral temperature can reduce the ability to maintain the same level of strength. Numerous studies have shown that the composition and method of production can affect the transmission of force, so it has been shown that transparent elastic chains retain a certain level of force longer than colored [22, 23, 24]. Only transparent elastic chains were used in this study. The average initial force on the control examinations was between 184.5 g to 205.38 g, while the residual force ranged from 100.39 g to 113.00 g. It can be concluded that the elastic chains retained an average of 53.41% of the initial force.

Several studies have confirmed that elastic chains change the level of force over time, mostly during the first hours and the first day of application, so that it decreases between 40-50% and degradation continued, but to a lesser extent. After 4 weeks, the average degradation was 50-85% depending on the type of research and the type of elastic chain. Although there is a great loss of force, it is considered that it is still sufficient to continue with movement of canine [25, 26].

Elastic chain is most often applied by connecting a hook on the back teeth, usually molars, and for a specific front tooth or a hook on the canine in order to achieve the desired tooth movement. Balhoff et al. conducted a study comparing different techniques for placing 4 different types of elastic chains. They compared three ways of applying elastic chains: configuration 6-5-3 (first molar, second premolar and canine), configuration 6-3 (first molar and canine) and elastic chain loop (first molar, around the hook on the canine and back to molar). They came to conclusion that directly connecting the hook on the molar and the hook of the bracket on the canine is the most efficient for post-extraction space closure and there is the slightest decrease in force. The force loss for the first configuration (6-5-3) was 42-68%, for the elastic chain loop 39-55% and for the second configuration (6-3) 32-60% [27].

In our research, the same type of memory elastic chain (American Orthodontics memory chain) was used with a force of about 200 g. Miraschemi et al. examined elastic chains with memory technology (memory chain), that has the role of enabling them to maintain their power for as long as possible. They analyzed three types of conventional and three types of new memory elastic chains. Results showed that force degradation in the first hour for conventional averaged 17.93% and 4.83% for the memory group, while after 24 hours, elastic chains from the first group remained 74%, and from the second group 90.7% initial forces. After 4 weeks, the remaining force for conventional elastic chains ranged from 26-40%, and for memory from 60-63%. American Orthodontics memory chain showed the best results. In order to achieve a force of 200 g, memory elastic chains had to be stretched more about the initial length ratio than the conventional ones [28].

Some authors recommend "pre-stretching" in order to achieve moderate and relatively stable force over time. This procedure involves stretching the elastic chain before application in order to apply tensile stress to molecular bonds made of a polymeric material in order to improve the force generated by the elastic chain [29]. Kim et al. examined the effect of the "pre-stretching" method on the force degradation over time and found that it has an effect in the first hour, and later decreases as well as this method is not applied [30].

This research did not use the "pre-stretching" method, but initial force that elastic chain had was applied when it was used for the first time from the spool, so that uneven stretching would not disrupt the uniform mechanical properties specified by the manufacturer.

CONCLUSION

When sliding mechanism is used, there is a significant force degradation between inspections. The loss of force between the activation phases of NiTi closed coil springs is smaller compared to the forces produced by elastic chains. Good knowledge of how different types of sliding mechanism work is crucial for efficient tooth movement in biologically accepted frames.

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Analiza opadanja sile kod kliznog mehanizma pri zatvaranju postekstrakcionog prostora

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KRATAK SADRŽAJ

Uvod Zbog svoje jednostavnosti klizni mehanizam se veoma često primenjuje u kliničkoj praksi za zatvaranje postekstrakcionog prostora. Međutim, efikasnost ove metode može biti smanjena zbog pojave trenja i promene osobina materijala kojima se ova metoda sprovodi. Najčešće korišćene metode klizne mehanike su nikl-titanijumska (NiTi) zatvorena opruga i elastični lanci.
Cilj ovog rada je bio da se analizira opadanje sile kod primene NiTi zatvorenih opruga i elastičnih lanaca prilikom zatvaranja postekstrakcionog prostora u okviru terapije fiksnim ortodontskim aparatima.

Materijal i metode rada Ukupan uzorak u istraživanju činilo je 78 postekstrakcionih prostora kod pacijenata kojima je indikovana ekstrakcija prvih premolara uz primenu fiksnog ortodontskog aparata u cilju sprovođenja terapije. Za zatvaranje postekstrakcionih prostora primenjeni su NiTi opruge i elastični lanci. Postekstrakcioni prostori su praćeni tokom šest meseci sa kontrolnim pregledima svake četiri sedmice. Na kontrolnim pregledima su izvršena merenja inicijalne sile, na početku aktivacije mehanizma i rezidualne sile u opservacionom periodu.

Rezultati Rezultati istraživanja pokazuju da kod obe metode kliznog mehanizma dolazi do značajnog pada u opservacionom periodu. Kod primene NiTi zatvorenih opruga vrednost prosečne inicijalne sile na kontrolnim pregledima je iznosila između 189,00 i 210,25 g, dok je rezidualna bila u rasponu od 117,56 do 133,50 g, odnosno NiTi zatvorene opruge zadržavale su u proseku 61,57% početne sile. Prosečna inicijalna sila na kontrolnim pregledima za elastične lance je iznosila između 184,5 i 205,38 g, dok je rezidualna bila u rasponu od 100,39 do 113,00 g, odnosno elastični lanci su zadržavali u proseku 53,41% početne sile.

Zaključak Kod primene kliznog mehanizma dolazi do značajnog pada sile između kontrolnih pregleda. Gubitak sile između faza aktivacije kod NiTi zatvorenih opruga je manji u odnosu na sile koje proizvode elastični lanci.

Ključne reči: klizni mehanizam; elastični lanac; NiTi zatvorene opruge; postekstrakcioni prostor

UVOD

Optimalna ortodontska terapija zahteva primenu mehanike koja vodi do maksimalne brzine pomeranja zuba uz minimalno ireverzibilno oštećenje korena, parodontalnog ligamenta i alveolarne kosti. Optimalna jačina sile za ortodontsko pomeranje zuba se opisuje kao najlakša sila koja pruža maksimalni ili skoro maksimalni odgovor [1, 2]. Zavisno od veličine sile koja se primenjuje mogu se pojaviti različite vrste resorpcije u zonama pomeranja zuba. Ukoliko se primenjuju jake sile, može doći do nekroze okolnog tkiva i podminirajuće resorpcije sa zonama hijalinizacije i to može dovesti do zadržavanja u pomeranju zuba. Primenom blagih kontinuiranih sila dolazi do ujednačenog kretanja zuba uz pojavu poželjnog oblika resorpcije, odnosno frontalne resorpcije. U odnosu na trajanje, fiksnim ortodontskim aparatima se mogu proizvesti dve vrste sila: kontinuirane i intermitentne. Kontinuirane pokazuju isti nivo u toku 24 sata i trend neznačajnog pada između kontrolnih pregleda, dok intermitentne sile naglo padaju, tako da se pri sledećoj kontroli nalaze na nuli [2, 3]. Na efikasnije i brže zatvaranje postekstrakcionog prostora utiče i opadanje sile primenjenog mehanizma kroz vreme. Za ortodontsko pomeranje zuba potrebna je primena kontinuirane sile kroz određeni period, pri čemu se efikasnost povećava ukoliko se jačina sile održi što duže [4, 5, 6].

U okviru terapije fiksnim ortodontskim aparatima klizni mehanizam predstavlja veoma jednostavnu metodu za zatvaranje postekstrakcionog prostora i zbog toga se najčešće primenjuje u kliničkoj praksi. Ovom metodom se unutar zubnog luka vrši odgovarajuća primena i prenos sile. Zbog pojave trenja efikasnost ove metode može biti smanjena. Trenje predstavlja silu otpora koja se javlja između dve površine i suprotstavlja se kretanju. U kliznoj mehanici, sila i otpor klizanju se menjaju kako se zub pomera, tako da se on prvo naginje, zatim se dešava biološki odgovor, zub se zatim ispravlja, kost se remodeluje oko korena i zatim se ponovo naginje [7]. Postoje brojni faktori koji utiču na otpor koji se javlja kod kliznog mehanizma, a mogu se grupisati u fizičke i biološke činioce. Fizički faktori se, uglavnom, odnose na osobine i dimenzije ortodontskih lukova, bravica, kao i na vrstu ligiranja, dok biološki faktori uključuju količinu i prisustvo pljuvačke, plaka i ostataka hrane [8].

Suština je da je neophodno primeniti takvu silu koja može savladati otpor klizanju žičanog luka kroz sistem bravica i pomeriti zube duž žičanog luka [9]. Preporučeno je da optimalna sila iznosi između 100 i 200 g/cm^2, što se smatra biološki prihvatljivim okvirom. Da bi se pomoću kliznog mehanizma pomerio očnjak, potrebna je sila od 100 g/cm^2 za pomeranje zuba i još dodatnih 100 g/cm^2 da se prevaziđe otpor, odnosno trenje [10].

Cilj ovog rada je bio da se analizira opadanje sile kliznih mehanizama kroz vreme prilikom zatvaranja postekstrakcionog prostora primenom NiTi zatvorenih opruga i elastičnih lanaca u okviru terapije fiksnim ortodontskim aparatima.

MATERIJAL I METODE

Istraživanje je sprovedeno na Medicinskom fakultetu u Banjoj Luci, studijski program Stomatologija, uz saglasnost Etičkog ko-

miteta Zavoda za stomatologiju. Na početku istraživanja izvršen je izbor ispitanika među pacijentima koji prvi put dolaze na pregled. Nakon kliničke obrade pacijenata (anamneza, klinički pregled, uzimanje otisaka, analiza studijskih modela, analiza ortopantomografskog i telerendgenskog snimka), potencijalni ispitanici su bili informisani o istraživanju, nakon čega su potpisali informisani pristanak. Ispitanici su bili uzrasta od 12 do 20 godina i nisu imali kontraindikacije za ortodontsku terapiju, kao ni druge ekstrakcije (osim prvih premolara). Iz istraživanja su isključeni oni ispitanici koji su neredovno dolazili na kontrolne preglede, koji su imali lošu oralnu higijenu i oni koji se nisu pridržavali datih uputstava na početku terapije. Ukupan uzorak u istraživanju iznosio je 78 postekstrakcionih prostora kod pacijenata kojima je indikovana ekstrakcija prvih premolara u cilju sprovođenja ortodontske terapije.

Posle ekstrakcije prvih premolara ispitanicima je postavljen fiksni ortodontski aparat (*Dentaurum, Discovery, Roth preskripcija, slot 0,022 in*), nakon čega je izvršena početna nivelacija sa NiTi lukovima okruglog i četvrtastog preseka, pre postavljanja čeličnih četvrtastih lukova. Četvrtasti čelični luk preseka 0,019 × 0,025 in stajao je u slotovima bravica najmanje četiri sedmice, da postane pasivan, nakon čega su aplicirane NiTi zatvorene opruge (*American Orthodontics, USA*) za 40 i elastični lanci (*American Orthodontics, USA*) za 38 postekstrakcionih prostora. NiTi zatvorene opruge su postavljane od kukice na tubi prvog molara do kukice bravice na očnjaku, pri čemu opruge nisu bile istegnute više od 9 mm (Slika 1). Ukoliko je opruga bila prekratka, korišćena je žičana ligatura za povezivanje sa kukicom tube na molaru. Za vreme terapije opruga je aktivirana na kontrolnim pregledima. Elastični lanac je postavljan tako da povezuje kukicu na tubi prvog molara i kukicu bravice na očnjaku, pri čemu je rastegnut na približno dvostruku početnu dužinu, a na kontrolnim pregledima je zamenjen novim (Slika 2).

Postekstrakcioni prostori su praćeni šest meseci od početka primene kliznog mehanizma u intervalima od mesec dana (T_0–T_6). Kontrolni pregledi su obavljani svake četiri sedmice i na njima je proveravano da li je došlo do oštećenja apliciranih mehanizama i izvršena njihova aktivacija.

Na kotrolnim pregledima su izvršena merenja inicijalne sile na početku i rezidualne sile u opservacionom periodu. Jačina sile je merena dinamometrom (*Force Gauge Dynamometer, White Oak, USA*) (Slika 3).

REZULTATI

U okviru ovog istraživanja analizirano je dejstvo primenjene sile na početku i kraju aktivacije kod kliznog mehanizma. Ispitana je prosečna primenjena sila na početku i na kraju aktivacije svakog vremenskog intervala. T-test za uparene uzorke pokazuje da se primenjena sila statistički značajno razlikuje na početku i na kraju aktivacije u svakom vremenskom intervalu. U intervalu T_1 prosečna sila na početku iznosila je M = 231,02 g, a na kraju M = 121,99 g (52,8%); ova razlika je statistički značajna (t = 45,03, df = 117, p = 0,000). U T_2 prosečna sila na početku iznosila je M = 228,42 g, a na kraju M = 120,34 g (52,68%); ova razlika je statistički značajna (t = 42,96, df = 116, p = 0,000). U T_3 prosečna sila na početku iznosila je M = 230,56 g, a na kraju M = 123,70 g (53,65%); ova razlika je statistički značajna (t = 37,99, df = 107, p = 0,000). U T_4 prosečna sila na početku iznosila je M = 234,93 g, a na kraju M = 130,21 g (55,42%); ova razlika je statistički značajna (t = 33,17, df = 71, p = 0,000). U T_5 prosečna sila na početku iznosila je M = 240,73 g, a na kraju M = 143,13 g (59,45%); ova razlika je statistički značajna (t = 28,31, df = 47, p = 0,000). U T_6 prosečna sila na početku iznosila je M = 209,44 g, a na kraju M = 140,74 g (67,19%); ova razlika je statistički značajna (t = 12,39, df = 26, p = 0,000) (Tabela 1).

Nakon ispitane promene u jačini sile, ispitane su ove promene u okviru svake metode.

Ispitane su prosečne vrednosti sile na početku i na kraju aktivacije svakog vremenskog intervala u okviru metode NiTi opruge. T-test za uparene uzorke pokazuje da se primenjena sila statistički značajno razlikuje na početku i na kraju aktivacije u svakom vremenskom intervalu. U intervalu T_1 prosečna sila na početku iznosila je M = 210,250 g, a na kraju M = 121,625 g (57,84%); ova razlika je statistički značajna (t = 33,37, df = 39, p = 0,000). U T_2 prosečna sila na početku iznosila je M = 201,154 g, a na kraju M = 117,564 g (58.44%); ova razlika je statistički značajna (t = 34,90, df = 38, p = 0,000). U T_3 prosečna sila na početku iznosila je M = 204,242 g, a na kraju M = 123,485 g (60,46%); ova razlika je statistički značajna (t = 28,12, df = 32, p = 0,000). U T_4 prosečna sila na početku iznosila je M = 204,667 g, a na kraju M = 122,667 g (59,93%); ova razlika je statistički značajna (t = 19,43, df = 14, p = 0,000). U T_5 prosečna sila na početku iznosila je M = 205,417 g, a na kraju M = 128,750 g (62,67%); ova razlika je statistički značajna (t = 15,77, df = 11, p = 0,000). U T_6 prosečna sila na početku iznosila je M = 189,000 g, a na kraju M = 133,500 g (70,06%); ova razlika je statistički značajna (t = 10,81, df = 9, p = 0,000) (Tabela 2).

Sila je ispitana na početku i na kraju aktivacije svakog vremenskog intervala u okviru metode elastičnog lanca. T-test za uparene uzorke pokazuje da se primenjena sila statistički značajno razlikuje na početku i na kraju aktivacije u svakom vremenskom intervalu. U intervalu T_1 prosečna sila na početku iznosila je M = 199,34 g, a na kraju M = 100,39 g (50,36%); ova razlika je statistički značajna (t = 39,75, df = 37, p = 0,000). U T_2 prosečna sila na početku iznosila je M = 204,47 g, a na kraju M = 103,82 g (50,77%); ova razlika je statistički značajna (t = 37,17, df = 37, p = 0,000). U T_3 prosečna sila na početku iznosila je M = 204,58 g, a na kraju M = 104,72 g (51,18%); ova razlika je statistički značajna (t = 25,53, df = 35, p = 0,000). U T_4 prosečna sila na početku iznosila je M = 198,75 g, a na kraju M = 109,17 g (54,92%); ova razlika je statistički značajna (t = 26,73, df = 23, p = 0,000). U T_5 prosečna sila na početku iznosila je M = 205,38 g, a na kraju M = 108,08 g (52,02%); ova razlika je statistički značajna (t = 29,64, df = 12, p = 0,000). U T_6 prosečna sila na početku iznosila je M = 184,50 g, a na kraju M = 113,00 g (61,24%); ova razlika je statistički značajna (t = 8,10, df = 9, p = 0,000) (Tabela 3).

DISKUSIJA

Kod zatvaranja postekstrakcionih prostora veoma je važno da primenjeni mehanizmi proizvode kontinuirane sile za ortodontsko pomeranje zuba kroz određeni period, pri čemu se njihova efikasnost povećava ukoliko se jačina sile održi što duže [11].

Studije o optimalnoj sili za retrakciju očnjaka pokazuju da sila od 150 do 200 g dovodi do najefikasnijeg pomeranja. Smatra

se da slabije sile nemaju takvu efikasnost, dok jače mogu da dovedu do hijalinizacije tkiva, što za posledicu ima ometanje procesa pomeranja zuba [12]. U ovom istraživanju su korišćene sile sa prosečnim vrednostima oko 200 g. Prosečna sila na početku aktivacije je iznosila 231,02 g, dok je na kraju aktivacionog perioda, posle četiri sedmice, ova vrednost prosečno iznosila 121,99 g.

NiTi zatvorene opruge pokazuju sve veći trend u kliničkoj upotrebi kod zatvaranja postekstrakcionog prostora, zbog čega su veoma često predmet ispitivanja. U ovom istraživanju su primenjivane NiTi opruge istog proizvođača, tako da proizvode silu oko 200 g. Ukoliko bi pri većim rastezanjima generisale preveliku silu, vezivane su preko žičanih ligatura za kukice tuba na molarima. Kod primene NiTi zatvorenih opruga vrednost prosečne inicijalne sile na kontrolnim pregledima iznosila je između 189,00 g do 210,25 g, dok je rezidualna bila u rasponu od 117,56 g do 133,50 g. Iz ovog se može zaključiti da su NiTi zatvorene opruge zadržavale u proseku 61,57% početne sile.

Uticaj faktora oralnog okruženja na opadanje sile kod NiTi zatvorenih opruga je ispitan kroz mnogobrojne studije. Utvrđeno je da ni hrana ni tečnosti koje se nađu u ustima, uključujući i pljuvačku, ne utiču na silu koju generišu ove opruge [13, 14, 15]. Ustanovljeno je da jedino velike temperaturne razlike mogu dovesti do promene nivoa sile [16, 17]. U ovom istraživanju nije bilo moguće kontrolisanje ovih uslova, osim što je u komunikaciji sa pacijentima konstatovano da im je otežano održavanje higijene, kao i zadržavanje hrane na oprugama, posebno na kraju aktivacionog ciklusa, kada se smanji razmak između navoja.

Kishorekumar i saradnici su pratili opadanje sile NiTi opruga kroz određene vremenske intervale. Ukupan uzorak činilo je 30 NiTi opruga od 9 mm od tri različita proizvođača (*Lancer orthodontics, Ortho technology, GAC international*). Na početku su NiTi opruge istegnute kako bi proizvele silu od 150 g. Na kraju četiri sedmice gubitak sile za oprugu *GAC* (29,03%) bio je veći od opruga *Lancer* (21,61%) i *Orthotech* (14,62%). Opruga *GAC* je pokazala značajnu degradaciju sile tokom većine intervala. Iako je bila izložena martenzitnom platou, nije postigla ciljanu silu u opsegu aktiviranja koju je dao proizvođač (1–12 mm). Kod opruge *Lancer* nije došlo do značajnijeg gubitka sile tokom prva 24 sata, dok su opruge *Orthotech* pokazale manju degradaciju sile tokom celog perioda. Autori preporučuju istezanje opruge *Lancer* i *Orthotech* za 1/3 dužine, a za opruge *GAC* od 1/2 do 1/3 njegove originalne dužine [18].

Maganzini i saradnici su merili inicijalnu silu kod 14 različitih NiTi zatvorenih opruga dužine 9 mm od pet različitih proizvođača. Ustanovili su da samo šest od njih pri deaktivaciji ima promenu u intenzitetu manju od 50 g, dok su neke opruge imale i opadanje sile za iznos veći od 100 g. Autori smatraju da do ovakvih rezultata prvenstveno može doći zbog toga što pored dimenzija 9 mm i 12 mm proizvođači uz njih stavljaju i opisna imena (*ultra light, light, medium, heavy, extra heavy*), dok drugi obeležavaju konstantnu silu koju opruge generišu (100 g, 150 g i 200 g). Ovakvo obeležavanje može da zavara kliničare, naročito ako se u obzir uzme činjenica da light modeli testiranih opruga jednog proizvođača proizvode silu od 103 do 120 g, a kod drugog od 121 do 226 g [19]. Sličnu studiju je sprovela Konti sa saradnicima, u kojoj se zaključuje da je neophodno merenje sile koju proizvode NiTi zatvorene opruge tokom ortodontske terapije kako bi se postigla optimalna sila za pomeranje zuba [20].

U kliničko-laboratorijskoj studiji Geng i saradnici su ispitivali nivo sile koju proizvode NiTi zatvorene opruge tokom zatvaranja postekstrakcionih prostora. Ova studija je pokazala je da gubitak maksimalne sile i opadanje sila na deaktivacijskom platou nisu zavisili od vremena. Autori zaključuju da treba obratiti pažnju da prilikom postavljanja opruge ne dolazi do prekomernog istezanja. Termički ciklusi iz dnevne hrane i pića mogu doprineti opadanju sile ovih opruga, dok termička obrada može pomoći da se vrate u početno stanje [21].

Za razliku od NiTi zatvorenih opruga, elastomerni lanci u usnoj šupljini počinju da apsorbuju pljuvačku, mogu da se preboje i trajno deformišu zbog kidanja unutrašnjih veza. Kroz duži period izloženost pljuvački i promenama oralne temperature može da smanji mogućnost održavanja istog nivoa sile. Brojnim studijama je utvrđeno da sastav i način proizvodnje mogu da utiču na prenos sile, pa se tako pokazalo da bezbojni elastični lanci duže zadržavaju određeni nivo sile u odnosu na obojene [22, 23, 24]. U ovoj studiji su korišćeni isključivo bezbojni elastični lanci. Prosečna inicijalna sila na kontrolnim pregledima iznosila je između 184,5 g do 205,38 g, dok je rezidualna bila u rasponu od 100,39 g do 113,00 g. Iz ovog se može zaključiti da su elastični lanci zadržavali u proseku 53,41% početne sile.

U nekoliko studija je potvrđeno da elastični lanci menjaju nivo sile kroz vreme, i to najviše tokom prvih sati i prvog dana primene, tako da ona opada između 40 i 50%, nakon čega se opadanje nastavilo ali u manjem iznosu. Posle četiri sedmice prosečna degradacija je iznosila od 50 do 85% u zavisnosti od tipa istraživanja i vrste elastičnog lanca. Iako dolazi do velikog gubitka sile, smatra se da je ona i dalje dovoljna da nastavi da deluje na pomeranje očnjaka [25, 26].

Elastični lanac se najčešće primenjuje spajanjem kukice na bočnim zubima, obično molarima, za određeni prednji zub ili kukicu na očnjaku kako bi se postiglo željeno pomeranje zuba. Balhoff i saradnici su sproveli studiju u kojoj su poredili različite tehnike postavljanja četiri različite vrste elastičnih lanaca. Poredili su tri načina aplikacije elastičnih lanaca: konfiguracija 6–5–3 (prvi molar, drugi premolar i očnjak), konfiguracija 6–3 (prvi molar i očnjak) i omča od elastičnog lanca (prvi molar, oko kukice na očnjaku i nazad na molar). Došli su do zaključka da je direktno povezivanje kukice na molaru i kukice bravice na očnjaku najefikasnije kod zatvaranja postekstrakcionog prostora, kao i da dolazi do najmanjeg opadanja sile. Gubitak sile za prvu konfiguraciju (6–5–3) iznosio je 42–68%, za omču od elastičnog lanca 39–55% i za drugu konfiguraciju (6–3) 32–60% [27].

U ovom istraživanju je korišćena ista vrsta memorijskog elastičnog lanca (*American Orthodontics memory chain*) uz primenu sile od oko 200 g. Mirashemi i saradnici su ispitivali elastične lance sa memorijskom tehnologijom (*memory chain*) koja ima ulogu da im omogući što duže održavanje sile kroz vreme. Analizirali su tri vrste konvencionalnih i tri vrste novih memorijskih elastičnih lanaca. Rezultati pokazuju da je opadanje sile u prvom satu za konvencionalne u proseku iznosilo 17,93%, a 4,83% za memorijsku grupu, dok je posle 24 sata elastičnim lancima iz prve grupe preostalo 74%, a iz druge grupe 90,7% početne sile. Posle četiri sedmice preostala sila za konvencionalne elastične lance se kretala u rasponu 26–40%, a za memorijske 60–63%. Najbolje rezultate je pokazao memorijski elastični lanac *American Orthodontics memory chain*. Da bi se postigla sila od 200 g, memorijski elastični lanci su se morali više istegnuti u odnosu na početnu dužinu u odnosu na konvencionalne [28].

Neki autori preporučuju „pre-stretching“ kako bi se postigla umerena i relativno stabilna sila kroz vreme. Ovaj postupak podrazumeva da se pre aplikacije elastični lanac rastegne kako bi se primenio stres istezanja na molekularne veze iz polimernog materijala u cilju poboljšanja sile koju generiše elastični lanac [29]. Kim i saradanici su ispitivali uticaj metode „pre-stretching“ na opadanje sile kroz vreme i ustanovili da ona ima efekat u prvom satu, a kasnije opada kao i kad se ova metoda ne primenjuje [30].

U ovom istraživanju nije korišćena metoda „pre-strechinga“, nego je primenjena inicijalna sila koju elastični lanac ima kad se prvi put upotrebi iz koluta, kako nejednakim istezanjem ne bi došlo do narušavanja uniformnih mehaničkih osobina koje određuje proizvođač.

ZAKLJUČAK

Kod primene kliznog mehanizma dolazi do značajnog pada sile između kontrolnih pregleda. Gubitak sile između faza aktivacije kod NiTi zatvorenih opruga manji je u odnosu na sile koje proizvode elastični lanci. Dobro poznavanje načina delovanja različitih vrsta kliznog mehanizma je ključno za efikasno pomeranje zuba u biološki prihvatljivim okvirima.

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Prevalence and severity of TMD in orthodontic patients

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SUMMARY

Introduction Temporomandibular disorder (TMD) is a collective term for numerous symptoms, with the most common being masticatory muscle pain, pain in temporomandibular joints, limited mouth opening, irregular jaw movements, headaches and sound effects in TMJ.

The aim was to determine the prevalence and severity of TMD in orthodontic patients determining whether the type of malocclusion affects the prevalence and severity of TMD.

Material and Methods The study was conducted in the form of Fonseca Anamnestic Index, which classifies TMD severity among examinees (no TMD, mild, moderate and severe TMD). The experimental group consisted of orthodontic patients with confirmed malocclusions, while the control group consisted of dental students with a Class I occlusion and no need for orthodontic treatment. Orthodontic patients were classified into the three subgroups based on malocclusions.

Results In the experimental group, 45.03% of orthodontic patients had some degree of TMD, while among students, that percentage was 56.41%. Compared to Class I, higher percentage of TMD was found among patients with distal and mesial occlusion in experimental group. In the experimental and control groups, the greatest percentage of participants showed mild TMD. The prevalence of TMD was greater in females than in males in the experimental group.

Conclusion The high prevalence of TMD in the control group speaks in favor of its complex etiology, with stress having an important role. Malocclusion is one of many factors which can contribute to the occurrence and severity of TMD, but it cannot be considered the most significant.

Keywords: temporomandibular disfunction – TMD; temporomandibular joint – TMJ; malocclusion; Fonseca questionnaire; Fonseca Anamnestic Index

INTRODUCTION

Temporomandibular dysfunction (TMD) presents a group of masticatory system disorders, which can be a consequence of muscular conditions or those affecting the temporomandibular joint (TMJ). TMD is a common condition, mostly among people aged 20-40 years [1]. The most frequent symptoms are pain in the region of the temporomandibular joint and fatigue of the cranial and fascial muscles, limited or irregular mandible movements, disk displacements and presence of articular clicking [2]. It is prevalent in the non-patient population [3, 4]. The signs appear in up to 60–70% of the population, but only one in four people are aware and seek treatment for their symptoms [5, 6]. The finding that doesn't have a clear explanation is that among the people seeking treatment, the most significant majority are females, almost four times more often than males [5]. Etiology is multifactorial and complex, including anatomical, pathophysiological and psychosocial factors. For the successful management of TMD, it is crucial to identify predisposing and contributing factors and to distinguish between the myofascial cause of TMD and intra-articular disorders of the joint itself [1].

Questionnaires that address the main clinical TMD findings and classify patients in terms of severity levels have been created to simplify evaluation in epidemiologic studies and standardize research samples to obtain and compare results from different studies [7, 8, 9]. According to the recent studies, the Fonseca Anamnestic Index is very sensitive in identifying patients who have TMD, it is indicated for initial screening of patients, and it shows high diagnostic accuracy [10, 11, 12].

The aim of this study was to evaluate the prevalence and severity of TMD in orthodontic patients and determine whether the type of malocclusion affects the incidence and severity of TMD.

MATERIAL AND METHOD

The study was conducted at the Department of Orthodontics, School of Dental Medicine, University of Belgrade. A total of 210 subjects were included in the study. The experimental group consisted of 171 patients who came to seek orthodontic treatment but had not started it yet. Exclusion criteria were the patient's age (older than 12 years), TMD treatment and the presence of orofacial pain or clinical alterations. They received proper instructions about the research goals before answering the Fonseca questionnaire (translated into Serbian) (Figure 1). The patients were

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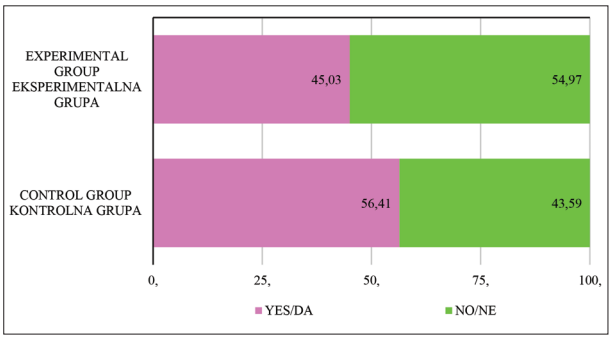
Question Pitanje	NO NE	SOMETIMES PONEKAD	YES DA
1 – Is it difficult for you to open your mouth? 1 – Je li vam teško da otvorate usta?			
2 – Is it hard for you to move your mandible from side to side? 2 – Da li vam je teško da pokrećete vilicu na jednu ili drugu stranu?			
3 – Do you get tired / muscular pain while chewing? 3 – Da li vas bole žvaćni mišići tokom žvakanja?			
4 – Do you have frequent headaches? 4 – Da li imate česte glavobolje?			
5 – Do you have pain on the nape or stiff neck? 5 – Da li imate bol u zadnjem delu vrata ili zatezanje u vratu?			
6 – Do you have earaches or pain in temporomandibular joints? 6 – Da li imate bolove u ušima ili u temporomandibularnom zglobu?			
7 – Have you noticed any TMJ clicking while chewing or when you open your mouth? 7 – Da li ste primetili klik u TMZ tokom žvakanja ili kada otvarate usta?			
8 – Do you clench or grind your teeth? 8 – Da li stežete zube ili škrgućete zubima kada spavate?			
9 – Do your feel your teeth do not articulate well? 9 – Da li osećate da se vaši zubi ne zatvaraju normalno?			
10 – Do you consider yourself a tense (nervous) person? 10 – Da li smatrate sebe nervoznom osobom?			

Figure 1. Fonseca questionnaire
Slika 1. Fonsekin upitnik



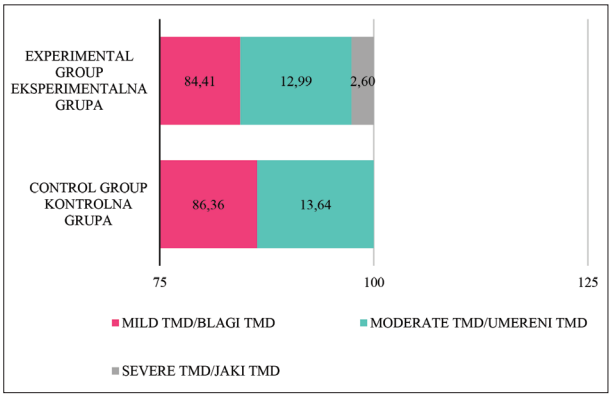
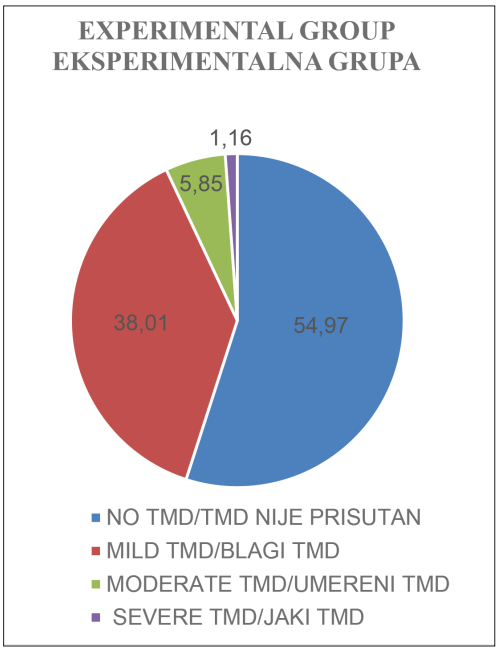


Figure 2. Presence of TMD in experimental and control group
Slika 2. Prisustvo TMD u eksperimentalnoj i kontrolnoj grupi



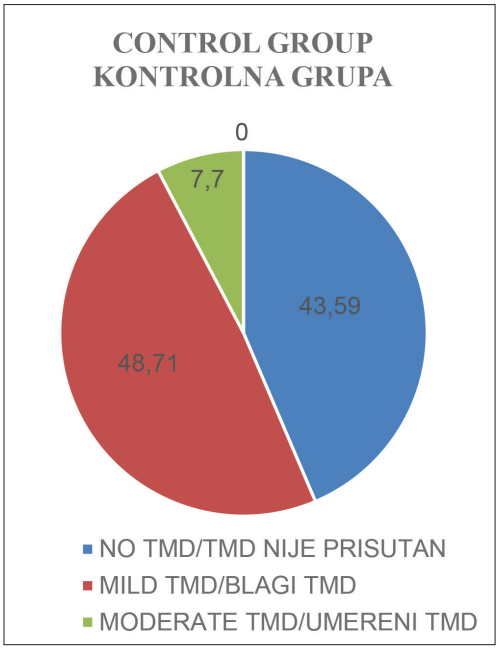


Figure 3. TMD severity in experimental and control group
a) experimental and control group (with TMD); b) experimental group; c) control group
Slika 3. Stepen izraženosti TMD u eksperimentalnoj i kontrolnoj grupi
a) eksperimentalna i kontrolna grupa (sa TMD); b) eksperimentalna grupa; c) kontrolna grupa

instructed to reply to ten questions by choosing only one of the answers indicating different degrees of TMD: yes (10 points), no (0 points), and sometimes (5 points). The sum of the points was used to classify the participants into four categories: TMD free (0 to 15 points); mild TMD (20 to 40), moderate TMD (45 to 60), and severe TMD (70 to 100). According to type of malocclusion (Angle classification), the patients were divided into the three subgroups: Class I, mesial occlusion (1/2-unit Class III and Class III) and distal occlusion (1/2-unit Class II and Class II).

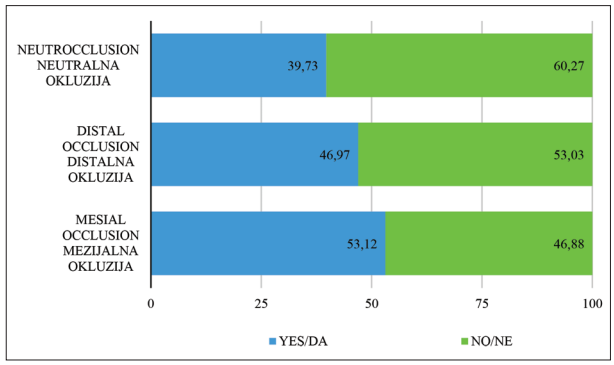


Figure 4. Presence of TMD according to sagittal type of malocclusion (Angle classification)
Slika 4. Prisustvo TMD u odnosu na tip malokluzije u sagitalnom pravcu (klasifikacija po Englu)

Control group consisted of 39 dental undergraduates (24–28 years) with Class I occlusion, and no need for orthodontic treatment. Exclusion criteria for the control group were orthodontic treatment at the moment or in the last two years, TMD treatment and presence of orofacial pain or clinical alterations. The sums of the points were calculated for each patient and student, and compared among the groups and subgroups. A chi-square test was applied to compare the presence and severity of TMD among the groups with the level of significance set at 5% ($p \leq 0.05$).

RESULTS

In the experimental group, 45.03% of patients showed the presence of TMD, and the percentage of participants with TMD in the control group was slightly higher but with no statistical significance (56.41%) (Figure 2). Among orthodontic patients, the great majority showed mild TMD (84.41%), and among dental students, the result was similar, 86.36% had mild TMD according to Fonseca Anamnestic Index (Figure 3). Analyzing results in the experimental group and the influence of malocclusions on the presence and severity of TMD, the presence of TMD was greater in the subgroup with distal and mesial occlusion than in the group with Class I, although the difference was not statistically significant (Figure 4). All the participants who showed severe TMD had mesial occlusion. Considering the gender of the participants, the presence of TMD was slightly greater in females than in males in the group of orthodontic patients, but the difference was not statistically significant (Table 3). Pain during mastication was noticed in 26.9% of participants in the experimental group (answers YES and SOMETIMES), and in the control group that percent was 10.26% (Table 1). More than half of orthodontic patients (53.03%) gave positive answers (YES and SOMETIMES) to the question if they consider themselves a nervous person, whereas that percentage was much higher in the dental students' group (76.93%) (Table 2). Headaches were present in about a third of participants in both groups (Table 1 and Table 2).

Table 1. Answers to each of the questions from the Fonsecca Questionnaire in experimental group
Tabela 1. Odgovori na pitanja iz Fonsekinog upitnika u eksperimentalnoj grupi

EXPERIMENTAL GROUP EKSPERIMENTALNA GRUPA	YES DA	SOMETIMES PONEKAD	NO NE
QUESTION 1 PITANJE BROJ 1	0%	2.92%	97.08%
QUESTION 2 PITANJE BROJ 2	1.75%	8.19%	90.06%
QUESTION 3 PITANJE BROJ 3	4.68%	22.22%	73.10%
QUESTION 4 PITANJE BROJ 4	8.77%	22.22%	69.01%
QUESTION 5 PITANJE BROJ 5	8.19%	21.05%	70.76%
QUESTION 6 PITANJE BROJ 6	1.17%	8.77%	90.06%
QUESTION 7 PITANJE BROJ 7	12.87%	14.04%	73.10%
QUESTION 8 PITANJE BROJ 8	9.35%	23.98%	66.67%
QUESTION 9 PITANJE BROJ 9	42.69%	6.43%	50.88%
QUESTION 10 PITANJE BROJ 10	14.04%	33.92%	52.05%

Table 2. Answers to each of the questions from the Fonsecca Questionnaire in control group
Tabela 2. Odgovori na pitanja iz Fonsekinog upitnika u kontrolnoj grupi

CONTROL GROUP KONTROLNA GRUPA	YES DA	SOMETIMES PONEKAD	NO NE
QUESTION 1 PITANJE BROJ 1	0%	7.69%	92.31%
QUESTION 2 PITANJE BROJ 2	0%	0%	100%
QUESTION 3 PITANJE BROJ 3	0%	10.26%	89.74%
QUESTION 4 PITANJE BROJ 4	15.38%	17.95%	66.67%
QUESTION 5 PITANJE BROJ 5	15.38%	25.64%	58.97%
QUESTION 6 PITANJE BROJ 6	0%	15.38%	84.62%
QUESTION 7 PITANJE BROJ 7	15.38%	17.95%	66.67%
QUESTION 8 PITANJE BROJ 8	28.21%	28.21%	43.59%
QUESTION 9 PITANJE BROJ 9	17.95%	7.69%	74.36%
QUESTION 10 PITANJE BROJ 10	23.08%	53.85%	23.08%

Table 3. Presence of TMD in experimental and control group according to gender
Tabela 3. Prisustvo TMD u eksperimentalnoj i kontrolnoj grupi u odnosu na pol

	EXPERIMENTAL GROUP EKSPERIMENTALNA GRUPA	CONTROL GROUP KONTROLNA GRUPA	PRESENCE OF TMD (EXPERIMENTAL GROUP) PRISUSTVO TMD (EKSPERIMENTALNA GRUPA)	PRESENCE OF TMD (CONTROL GROUP) PRISUSTVO TMD (KONTROLNA GRUPA)
TOTAL UKUPNO	171	39	n = 77 (45.03%)	n = 22 (56.41%)
FEMALE ŽENSKI	111	25	n = 54 (48.65%)	n = 14 (56%)
MALE MUŠKI	60	14	n = 23 (38.3%)	n = 8 (57.14%)

DISCUSSION

The aim of this study was to determine whether there is a connection between malocclusions (Class I occlusion, distal and mesial occlusion) and the prevalence and severity of TMD, using Fonseca Anamnestic Index. Interestingly, the percentage of participants with TMD was greater in the group of dental students than in a group of orthodontic patients. In our study, 56.41% of dental students showed some degree of TMD. A high percentage of dental students with some degree of the disorder is in agreement with the literature. Nomura et al. found a similar percentage (53.21%) of students with TMD [9]. Pedroni et al. showed that TMD was present in 68% of dental students, and in the study Garcia et al. that percent was 61% in a sample of 200 university students, using the same questionnaire [3, 4]. In a study of Bevilaqua-Grossi et al. also among university students, TMD was present in even higher percent (78%) [8]. The fact that our sample included only students with Class I and no need for orthodontic treatment, can be the reason for slightly higher percentages in literature than in the present study.

A recent study also found that professional athletes suffer TMD more frequently than non-athletes [2]. Professional athletes are exposed to greater stress, or psychological pressure caused by the increased training effort and competitions, which can lead to development of temporomandibular dysfunctions [2]. Similarly, academic stress has an impact on student's health and the presence of TMD, which can be explanation for a high percentage of students with TMD in our study [13, 14, 15].

In our control group, analyzing only the group of dental students with TMD, 90.9% of them answered positive (YES or SOMETIMES) to question number 10 - if they considered themselves tense/nervous. That suggests that stress and anxiety have significant correlation with TMD, that was confirmed in numerous studies [13, 14, 15].

Our study also showed that mesial occlusion (1/2-unit class III and Class III) was present in all cases of severe TMD. This is not in line with the study of Pedroni et al. where all the participants with severe TMD had distal occlusion [4]. Henrikson et al. analyzing a sample of girls with Class I and Class II concluded that normal occlusion has lower odds for symptoms and signs of TMD, while some occlusal characteristics, more frequently found in the class II malocclusion group, increased the chance for symptoms and signs of TMD [16]. All these findings suggest that there can be a relationship between the occlusal type and TMD, although the number of study participants should be more significant for that kind of conclusion.

Analyzing the gender of the participants and the presence of TMD, in the experimental group TMD was more frequent in females than in males, which is in agreement with the literature [3-9]. The reason can be found in different physiological characteristics, hormonal status and different characteristics of the connective tissue in females compared to males [5,8,9]. In the control group, this difference between genders was not found, which is in line with the study of Grey et al. who reported that the prevalence of signs and symptoms of TMD should not be different in males and females, in a group of non-patients [17].

Sign and symptoms of TMD can be assessed in different methods. The Fonseca questionnaire allows collecting a large quantity of information in a relatively short period, and at low cost, it is easy to understand and compare with other assessment tools [8]. It shows high diagnostic accuracy and is indicated for the initial screening of patients with TMD [11, 12, 13]. Early and correct identification of the possible etiologic factors will help find the appropriate treatment scheme to reduce or eliminate signs and symptoms of TMD.

CONCLUSION

The results showed that the presence of TMD was not greater in a group of patients with malocclusions compared to a group of dental students with Class I and no need for orthodontic treatment. The high prevalence of TMD in the control group speaks in favor of its complex etiology. TMD was more frequent in patients with mesial and distal occlusion than in orthodontic patients with Class I. Although further studies with more participants are needed, we can conclude that malocclusion is one of many factors that can contribute to the occurrence and severity of TMD but cannot be considered the most significant one.

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Učestalost i izraženost TMD kod ortodontskih pacijenata

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KRATAK SADRŽAJ

Uvod Temporomandibularna disfunkcija (TMD) manifestuje se kao skup simptoma od kojih su najčešći bol u regiji mastikatornih mišića, bol u temporomandibularnim zglobovima, ograničeno otvaranje usta, neregularne kretnje donje vilice, glavobolje i zvučni efekti u temporomandibularnom zglobu.

Cilj ovog rada bio je da se utvrdi učestalost i izraženost TMD kod ortodontskih pacijenata i da se odredi da li tip malokluzije utiče na učestalost i izraženost TMD.

Materijal i metode Istraživanje je sprovedeno u vidu Fonsekinog upitnika koji ispitanike klasifikuje na osnovu izraženosti TMD (bez TMD, blaga, umerena i izražena TMD). Eksperimentalnu grupu činili su ortodontski pacijenti sa potvrđenim ortodontskim nepravilnostima, dok su kontrolnu grupu činili studenti Stomatološkog fakulteta sa okluzijom I klase po Englu, bez nepravilnosti zagrižaja i potrebe za ortodontskom terapijom. Ortodontski pacijenti su podeljeni u tri podgrupe na osnovu sagitalnih nepravilnosti zagrižaja.

Rezultati U eksperimentalnoj grupi 45,03% pacijenata pokazalo je neku formu TMD, dok je među studentima taj procenat bio 56,41%. U eksperimentalnoj grupi pacijenti sa distalnom ili mezijalnom okluzijom pokazali su viši procenat TMD u odnosu na pacijente sa I klasom. I u eksperimentalnoj i u kontrolnoj grupi najveći je bio procenat ispitanika sa blago izraženom TMD. Učestalost TMD je bila veća kod pacijenata ženskog pola u eksperimentalnoj grupi.

Zaključak Visoka učestalost TMD u kontrolnoj grupi govori u prilog njenoj jako kompleksnoj etiologiji, u kojoj stres ima značajnu ulogu. Ortodontske nepravilnosti su samo jedan od mnogih faktora koji mogu doprineti nastanku i izraženosti TMD, ali se ne mogu smatrati najvažnijim.

Ključne reči: temporomandibularna disfunkcija – TMD, temporomandibularni zglob – TMZ; malokluzija; Fonsekin upitnik; Fonsekin anamnestički indeks

UVOD

Temporomandibularna disfunkcija (TMD) predstavlja grupu poremećaja mastikatornog sistema, koji mogu biti posledica mišićnih stanja ili poremećaja temporomandibularnog zgloba (TMZ). TMD je vrlo učestalo stanje, uglavnom kod osoba starosti 20–40 godina [1]. Najčešći simptomi su bol u predelu temporomandibularnog zgloba i umor kranijalnih i facijalnih mišića, ograničeni ili nepravilni pokreti donje vilice, pomeranje diska i prisustvo zvučnih efekata u zglobu [2]. Jako se često javlja u zdravoj populaciji [3, 4]. Znaci se javljaju kod do 60–70% populacije, ali samo jedna od četiri osobe je svesna simptoma i zbog njih traži terapiju [5, 6]. Nalaz koji nema jasno objašnjenje je da među ljudima koji traže lečenje većinu čine žene, skoro četiri puta češće nego muškarci [5]. Etiologija je multifaktorijelna i kompleksna i uključuje anatomske, patofiziološke i psihosocijalne faktore. Za uspešno lečenje TMD ključno je identifikovati predisponirajuće i doprinoseće faktore i napraviti razliku između mišićnih uzroka TMD i intraartikularnih poremećaja samog zgloba [1].

Upitnici koji se bave TMD i klasifikuju pacijente u smislu stepena izraženosti kreirani su da bi se pojednostavila evaluacija u epidemiološkim studijama i standardizovali uzorci istraživanja kako bi se dobili i uporedili rezultati iz različitih studija [7, 8, 9]. Prema nedavnim studijama, Fonsekin anamnestički indeks pokazuje visoku senzitivnost u identifikaciji pacijenata koji imaju TMD, indikovan je za početni skrining pacijenata i pokazuje visoku dijagnostičku tačnost [10, 11, 12].

Cilj ove studije bio je da se proceni učestalost i izraženost TMD kod ortodontskih pacijenata i da se utvrdi da li tip malokluzije utiče na učestalost i izraženost TMD.

MATERIJAL I METOD

Studija je sprovedena na Klinici za ortopediju vilica Stomatološkog fakulteta Univerziteta u Beogradu. U studiju je bilo uključeno ukupno 210 ispitanika. Eksperimentalnu grupu činili su pacijenti koji su došli zbog želje da započnu ortodontski tretman, ali ga još nisu započeli, ukupno 171 pacijent. Kriterijumi isključenja bili su starost pacijenta (stariji od 12 godina), započeta terapija TMD i prisustvo orofacijalnog bola ili kliničkih promena. Dobili su odgovarajuća uputstva o ciljevima istraživanja pre nego što su odgovorili na Fonsekin upitnik (preveden na srpski jezik) (Slika 1). Pacijentima je objašnjeno da treba da odgovore na deset pitanja birajući samo jedan od odgovora koji ukazuju na različite stepene TMD: da (10 poena), ne (0 poena), ponekad (5 poena). Zbir bodova je korišćen za klasifikaciju učesnika u četiri kategorije: bez TMD (0 do 15 poena); blaga TMD (20 do 40), umerena TMD (45 do 60) i teška TMD (70 do 100). Prema vrsti malokluzije (klasifikacija po Englu) pacijenti su podeljeni u tri podgrupe: I klasa, mezijalna okluzija (1/2 III i III klasa) i distalna okluzija (1/2 II i II klasa). Kontrolnu grupu činilo je 39 studenata stomatologije (24–28 godina) sa okluzijom I klase, bez potrebe za ortodontskim tretmanom. Kriterijumi isključenja za kontrolnu grupu bili su ortodontski tretman u trenutku istraživanja ili u poslednje dve godine, započeta terapija TMD i prisustvo orofacijalnog bola ili kliničkih promena. Zbir bodova izračunat je za svakog pacijenta i studenta i rezultati su upoređeni među grupama i podgrupama. Hi-kvadratni test je primenjen da uporedi prisustvo i težinu TMD među grupama sa nivoom značajnosti postavljenim na 5% ($p \leq 0,05$).

REZULTATI

U eksperimentalnoj grupi 45,03% pacijenata je pokazalo prisustvo TMD, a procenat učesnika sa TMD u kontrolnoj grupi je bio nešto veći ali bez statističke značajnosti (56,41%) (Slika 2). Među ortodontskim pacijentima velika većina je pokazala blagu TMD (84,41%), a među studentima stomatologije rezultat je bio sličan – 86,36% je imalo blagu TMD prema Fonsekinom upitniku (Slika 3). Analizirajući rezultate u eksperimentalnoj grupi i uticaj malokluzija na prisustvo i težinu TMD, prisustvo TMD je bilo veće u podgrupi sa distalnom i mezijalnom okluzijom nego u grupi sa I klasom, iako razlika nije bila statistički značajna (Slika 4). Svi učesnici koji su pokazali tešku TMD imali su mezijalnu okluziju. Što se tiče pola ispitanika, prisustvo TMD je bilo nešto veće kod žena nego kod muškaraca u grupi ortodontskih pacijenata, ali razlika nije bila statistički značajna (Tabela 3). Bol tokom žvakanja primećen je kod 26,9% učesnika u eksperimentalnoj grupi (odgovori DA i PONEKAD), a u kontrolnoj grupi taj procenat je bio 10,26% (Tabela 1). Više od polovine ortodontskih pacijenata (53,03%) dalo je pozitivne odgovore (DA i PONEKAD) na pitanje da li sebe smatraju nervoznom osobom, dok je taj procenat bio znatno veći u grupi studenata stomatologije (76,93%) (Tabela 2). Glavobolje su bile prisutne kod oko trećine učesnika u obe grupe (tabele 1 i 2).

DISKUSIJA

Cilj ovog istraživanja bio je da se utvrdi da li postoji veza između malokluzija (okluzija I klase, distalna i mezijalna okluzija) i učestalosti i izraženosti TMD korišćenjem Fonsekinog anamnestičkog upitnika. Zanimljivo je to da je procenat učesnika sa TMD bio veći u grupi studenata stomatologije nego u grupi ortodontskih pacijenata. U našem istraživanju 56,41% studenata stomatologije pokazalo je neki stepen TMD. Visok procenat studenata stomatologije sa određenim stepenom poremećaja se slaže sa literaturom. Nomura i sar. [9] pronašli su sličan procenat (53,21%) studenata sa TMD. Pedroni i sar. [4] pokazali su da je TMD prisutan u 68% među studentima stomatologije, a u studiji koju su objavili Garcia et al. [3] taj procenat je bio 61% na uzorku od 200 studenata, korišćenjem istog upitnika. U istraživanju, takođe među studentima, koje su objavili Bevilaqua-Grossi i sar. [8], TMD je bio prisutan u još većem procentu (78%). Činjenica da su u našem uzorku bili samo studenti sa I klasom po Englu i bez potrebe za ortodontskim tretmanom može objasniti nešto veće procente u literaturi nego u ovoj studiji.

Nedavna studija [2] takođe je otkrila da profesionalni sportisti češće pate od TMD od onih koji se time ne bave profesionalno. Profesionalni sportisti su izloženi većem stresu, odnosno psihičkom pritisku izazvanom povećanim naporima i takmičenjima, što može dovesti do razvoja temporomandibularnih disfunkcija [2]. Slično, akademski stres ima uticaj na zdravlje studenata i prisustvo TMD, što može biti objašnjenje za visok procenat studenata sa TMD u našoj studiji, kao i mnogim drugim [13, 14, 15].

U našoj kontrolnoj grupi, analizirajući samo grupu studenata stomatologije sa TMD, 90,9% njih je odgovorilo pozitivno (DA ili PONEKAD) na pitanje broj 10 – da li se smatraju napetim/nervoznim. To sugeriše da stres i anksioznost imaju značajnu korelaciju sa TMD, što je dokazano u brojnim studijama [13, 14, 15].

Naša studija je pokazala da je mezijalna okluzija (1/2 klase III i klase III) bila prisutna u svim slučajevima izražene TMD. Ovo nije u skladu sa studijom Pedronija i sar. [4], gde su svi ispitanici sa izraženom TMD imali distalnu okluziju.

Henrikson i saradnici [16], analizirajući uzorak devojčica sa klasom I i klasom II, zaključili su da normalna okluzija ima manje predispozicija za simptome i znake TMD, dok su neke karakteristike okluzije, koje se češće nalaze u grupi malokluzije klase II, stvarale povećanu predispoziciju za simptome i znake TMD.

Svi ovi nalazi mogu sugerisati da može postojati veza između okluzalnog odnosa i TMD, iako bi broj učesnika studije trebalo da bude značajniji za takav zaključak.

Analizirajući pol ispitanika i prisustvo TMD, u eksperimentalnoj grupi TMD je bio češći kod žena nego kod muškaraca, što je u saglasnosti sa literaturom [3, 4, 7, 8, 9]. Razlog se može naći u različitim fiziološkim karakteristikama, hormonskom statusu i različitim karakteristikama vezivnog tkiva kod žena u odnosu na muškarce [5, 8, 9]. U kontrolnoj grupi ova razlika između polova nije utvrđena, što je u skladu sa studijom koju je objavio Grey sa saradnicima [17]. On je tvrdio da prevalencija znakova i simptoma TMD ne bi trebalo da bude različita kod muškaraca i žena u grupi nepacijenata.

Znaci i simptomi TMD mogu se proceniti različitim metodama. Fonsekin upitnik [8] omogućava prikupljanje velike količine informacija u relativno kratkom periodu i po niskoj ceni, lako ga je razumeti i uporediti sa drugim alatima za procenu. Pokazuje visoku dijagnostičku tačnost i indikovan je za početni skrining pacijenata sa TMD [11, 12, 13].

Rana i ispravna identifikacija mogućih etioloških faktora može pomoći u pronalaženju odgovarajućeg protokola lečenja kako bi se smanjili ili uklonili znakovi i simptomi TMD.

ZAKLJUČAK

Rezultati su pokazali da prisustvo TMD nije bilo veće u grupi pacijenata sa malokluzijama u poređenju sa grupom studenata stomatologije I klase i bez potrebe za ortodontskim lečenjem. Visoka prevalencija TMD u kontrolnoj grupi govori u prilog njegovoj složenoj etiologiji. TMD je bio češći kod pacijenata sa mezijalnom i distalnom okluzijom nego kod ortodontskih pacijenata klase I. Iako su potrebne dalje studije sa većim brojem učesnika, možemo zaključiti da je malokluzija jedan od mnogih faktora koji mogu doprineti pojavi i težini TMD, ali se ne može smatrati najznačajnijim.

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CASE REPORT
PRIKAZ BOLESNIKA

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Immediate complete denture – a case report

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SUMMARY

An immediate denture is a temporary or permanent removable denture fabricated in the presence of natural teeth. Patients diagnosed with periodontitis are usually indicated for this type of dentures. Fabrication according to the specific protocol can enhance functional, phonetic, and aesthetic rehabilitation immediately after tooth extraction. Laboratory procedures have few specificities in comparison to conventional complete dentures, but the most important one is trimming the cast according to previously examined periodontal status. Following the production protocol, it is possible to provide functional, phonetic and aesthetic rehabilitation of the patient immediately after tooth extraction. In addition, it is possible to achieve proper remodeling of the residual alveolar ridge owing to the direct contact of the denture base with the extraction wound during the consolidation period.

The aim of this paper is to present clinical and laboratory procedures in the process of making immediate complete denture.

Keywords: immediate denture; interim denture; prosthodontic rehabilitation of periodontitis

INTRODUCTION

In contemporary implant-prosthodontic rehabilitation, conventional complete dentures become an interim therapeutic solution. Carriers are most often partially edentulous patients with and/or generalized periodontitis [1]. Due to immediate functional, phonetic and aesthetic rehabilitation, immediate complete dentures become the most common therapeutic solution. Predictability of the therapeutic success can be achieved by implementing the knowledge from different dental disciplines - prosthodontics, periodontology and oral surgery. Although they are considered to be temporary dentures, pre-extraction fabrication and placement within 1 hour after teeth extraction, divide them from other removable dentures [2, 3].

It is very important to analyze periodontal status using the intraoral examination. Most important difference in clinical and laboratory procedures compared to conventional denture fabrication are: different design of an individual impression tray (closed, opened and semi-opened) [4], and cast trimming according to periodontal status [5].

CASE REPORT

A 48-year-old female was referred to Clinic for Prosthodontics, School of Dental Medicine for initial examination. Based on medical history, clinical examination, and radiological criteria, the present dentition was diagnosed with generalized periodontitis, complicated by tooth hypermobility due to secondary occlusal trauma (IV stage, C grade). The depth of periodontal pockets was measured within 8 measuring points (3 on vestibular, 3 on oral, mesial and distal surface) for each of the remaining 14 teeth. Obtained values were written in the individual periodontal chart. Upon analyzing all the comprehensive results and interview with the patient, it was suggested that the treatment plan included complete immediate dentures. Teeth #12, #13, #23, and #22 were extracted two weeks before prosthodontics rehabilitation due to the presence of purulent suppuration. Preliminary impressions were done using the standard tray and irreversible hydrocolloid material. The final impressions were done using the method of individual open tray and a combination of C-silicone and Zinc oxide eugenol paste. After determining maxillomandibular relations, in the presence of natural teeth, the dentures were modeled in wax. Definitive casts were trimmed according to the previously measured attachment of the junctional epithelium. Thus, the amount of the removed plaster is adjusted to the expected collapse of soft tissues after teeth extraction.

Multiple extractions of present dentition were done and the sutures were placed. After acrylic polymerization, dentures were kept in a conventional disinfectant used at a Department for Prosthodontics until delivery. Upon cleaning with sodium chloride solution, dentures were delivered to the patient one hour after surgical procedure. The aim was to protect the surgical wounds, minimize swelling and prevent bleeding. The patient was given instructions to wear dentures continuously for 24 hours when a control examination was scheduled. A month later, denture bases were relined. During follow-up examinations (3, 6 and 12 months) there was no need for further relining.

DISCUSSION

Prosthodontic rehabilitation with complete immediate dentures provides numerous advantages over

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Figure 1. Extraoral examination of the patient an face
Slika 1. Ekstraoralni izgled pacijenta *an face*

Figure 2. Orthopantomogram X-ray
Slika 2. Ortopantomografski snimak

Figure 3. Intraoral examination of the patient
Slika 3. Intraoralni pregled pacijenta

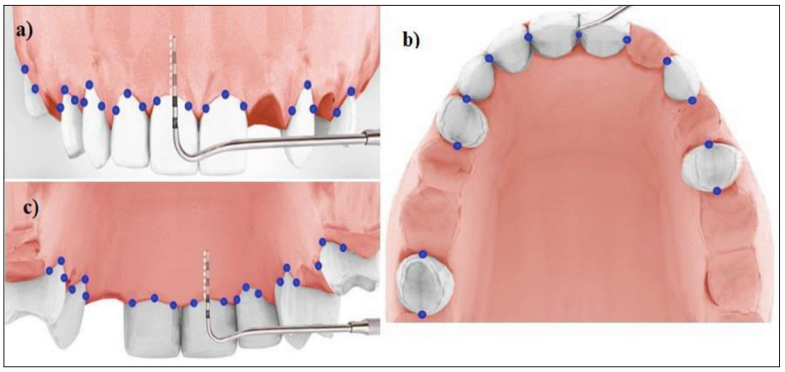

Figure 4. Shematic view of the periodontal pocket measurements.
Slika 4. Shematski prikaz merenja dubine parodontalnih džepova

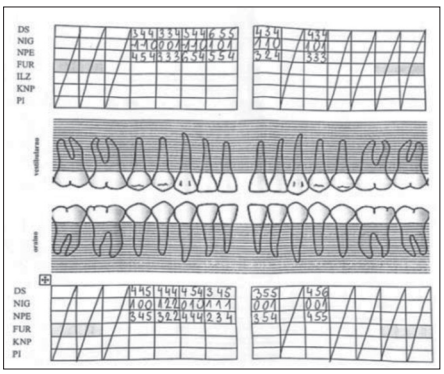

Figure 5. Periodontal chart
Slika 5. Parodontalni karton

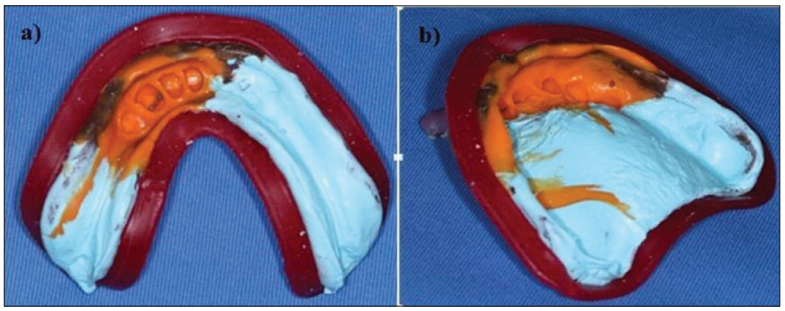

Figure 6. Definitive impressions with special red wax for protection of the borders: a) upper jaw impression; b) lower jaw impression
Slika 6. Realizovani definitivni funkcionalni otisci i postavljena Kelerova traka za zaštitu rubova otiska: a) gornje vilice; b) donje vilice

Figure 7. Jaw relation records
Slika 7. Određivanje međuviličnih odnosa

Figure 8. The wax try-in for dentures
Slika 8. Proba postave zuba u vosku

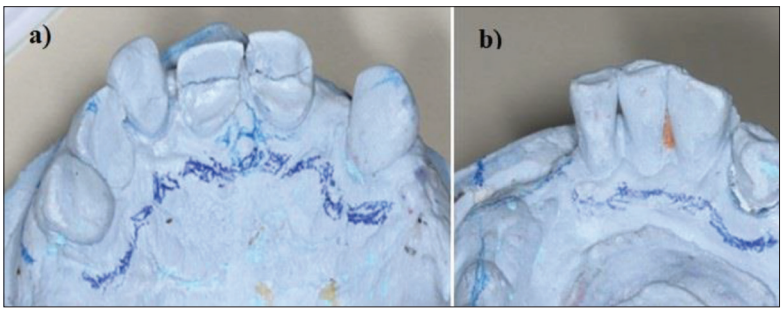

Figure 9. Peridontal pockets depth trasfered to definitive casts: a) palatal aspect of upper teeth; b) linqual aspect of lower teeth
Slika 9. Vrednosti dubine parodontalnih džepova ucrtane na definitivnom radnom modelu: a) palatinalni aspekt gipsanih zuba gornje vilice; b) lingvalni aspekt gipsanih zuba donje vilice

Figure 10. Laboratory procedure of cast trimming: a) Projection of vestibular aspect of cortical bone (45-degree labial bevel); b) cast after trimming; c) denture wax try-in positioned at the cast
Slika 10. Laboratorijska faza pripreme modela donje vilice: a) projekcija vestibularne površine kortikalne kosti na modelu (zakošavanje pod uglom od 45°); b) izgled modela po završenom radiranju; c) voštani model proteze na pripremljenom modelu

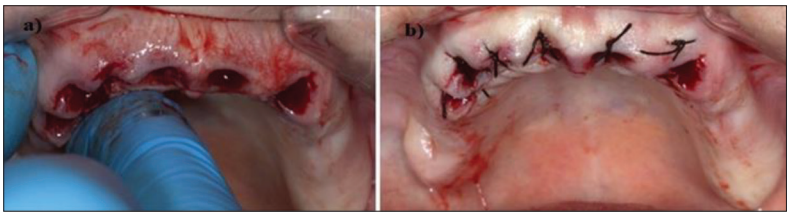

Figure 11. Post-extraction wund: a) procedure of digital pressure; b) surgical sutures
Slika 11. Postekstrakcione alveole: a) postupak reponiranja; b) postavljeni hirurški šavovi

Figure 12. Immediate dentures
Slika 12. Izgled gotovih proteza

rehabilitation with conventional dentures with delayed loading [6]. Besides beneficial effect on post-extraction healing, these dentures preserve vertical occlusal dimension as well as correct position of orofacial muscles. Shah et al. suggested an advantage of the immediate denture as a temporary and preventive solution in order to preserve and prepare the alveolar ridge for implant placement [7].

It is important to mention that the quality of rehabilitation correlates with patient satisfaction [8, 9]. A significant social component for the patient is the avoidance of the period of complete edentulism necessary for osseous consolidation in conventional complete dentures. Furthermore, shape, position and shade of the natural teeth can be copied, which leads to patient's faster biological adaptation [10, 11].

Literature-based evidence suggested that extractions should be done at two stages [11]. In the first stage, it would be preferable to extract posterior teeth and those with signs of acute infection. The second stage includes teeth extraction before denture delivery.

By proper planning, measuring the depth of the periodontal pockets, and subsequent trimming of the cast, optimal retention of denture base can be achieved. With this in mind, negative impact of surrounding muscles and progressive bone remodeling can be minimized [12].

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Imedijatna totalna proteza – prikaz bolesnika

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KRATAK SADRŽAJ
Imedijatna proteza je privremena ili trajna mobilna nadoknada koja se izrađuje u prisustvu prirodnih zuba. Budući nosioci ovih nadoknada su najčešće pacijenti sa uznapredovalim parodontitisom. Laboratorijska specifičnost izrade u odnosu na konvencionalne proteze tiče se pripreme definitivnih radnih modela prema podacima dobijenim na osnovu parodontalnog statusa pacijenta. Uz poštovanje protokola izrade moguće je obezbediti funkcionalnu, fonetsku i estetsku rehabilitaciju pacijenta odmah po vađenju zuba. Pored toga, kontakt protezne ploče sa postekstrakcionim alveolama tokom perioda konsolidacije usmerava pravilnije oblikovanje rezidualnog alveolarnog grebena.
Cilj ovog rada bio je da se prikažu kliničke i laboratorijske procedure u izradi imedijatne totalne proteze.
Ključne reči: imedijatna proteza; privremena proteza; totalna proteza; protetska terapija parodontitisa proteze

UVOD

U eri implantatno-protetske rehabilitacije, konvencionalne totalne proteze preuzele su ulogu privremenog terapijskog rešenja. Nosioci ovih nadoknada su najčešće pacijenti sa prethodno dijagnostikovanom minimalnom krezubošću i/ili uznapredovalim parodontitisom [1]. Zahvaljujući mogućnosti trenutne funkcionalne, fonetske i estetske rehabilitacije, imedijatne totalne proteze postaju najčešći izbor terapeuta. Objedinjavanjem znanja i iskustava iz različitih stomatoloških disciplina, protetike, parodontologije i oralne hirurgije, može se uspostaviti predvidivost terapijskog uspeha. Iako spadaju u grupu privremenih, metoda preekstrakcione izrade i predaja unutar jednog sata od vađenja zuba odvaja ih od ostalih mobilnih nadoknada [2, 3]. Neizostavan deo u okviru kliničkog pregleda podrazumeva analizu obaveznog parodontalnog statusa. Specifičnosti kliničkog rada tiču se mogućnosti realizacije funkcionalnog otiska različitim vrstama individualnih kašika (zatvorene, otvorene i delimično otvorene) [4], uz obavezno radiranje gipsanih zuba na modelu do prethodno izmerenog nivoa koronarnog kraja pripojnog epitela [5].

Cilj ovog rada bio je da se prikažu kliničke i laboratorijske procedure u izradi imedijatne totalne proteze.

PRIKAZ BOLESNIKA

Pacijentkinja starosti 48 godina javila se na Kliniku za stomatološku protetiku Stomatološkog fakulteta Univerziteta u Beogradu na prvi pregled. Na osnovu anamneze, kliničkog pregleda i analize ortopantomografskog snimka (slike 1, 2 i 3), ustanovljen je parodontitis IV stadijuma, C stepena, komplikovan hipermobilnošću zuba usled primarnog okluzalnog traumatizma. Merenje dubine parodontalnih džepova za svaki zub vršeno je u osam tačaka (tri tačke vestibularno, tri tačke oralno, mezijalno i distalno) (Slika 4). Izmerene vrednosti unošene su u individualni parodontalni karton pacijenta (Slika 5). Nakon analize prikupljenih podataka i razgovora sa pacijentkinjom predložena je izrada gornje i donje imedijatne totalne proteze. S obzirom na to da je u regiji zuba #17, #25, #32 i #33 detekovan gnojni eksudat, ekstrakcija ovih zuba prethodila je početku protetske rehabilitacije. Anatomski otisci su realizovani ireverzibilnim hidrokoloidom u standardnim kašikama. Funkcionalni otisci su uzeti kombinacijom C-silikona ređe konzistencije i cink-oksid eugenolne paste u individualno izrađenoj kašici zatvorenog tipa (Slika 6). Nakon određivanja međuviličnih odnosa preko postojećih zuba (Slika 7) usledila je faza preliminarne probe postave zuba u vosku (Slika 6). U okviru naredne laboratorijske procedure gipsani zubi definitivnih radnih modela su radirani prema rezultatima merenja koronarnog kraja pripojnog epitela za svaki zub (slike 8 i 9). Na ovaj način veličina gipsa koji se uklanja je prilagođena očekivanom kolapsu postekstrakcione alveole.

Nakon toga usledila je multipla ekstrakcija svih prisutnih zuba i ušivanje rana (Slika 10) na Klinici za oralnu hirurgiju. Alveole su digitalno reponirane, a šavovi postavljeni u predelu interdentalnih prostora. Modeli gotovih proteza predati su pacijentu sat vremena posle hirurške intervencije (Slika 11) sa ciljem da zaštite hiruršku ranu i prisutne šavove, deluju antiedematozno, kao i da spreče krvarenje. Pacijentkinji su data uputstva da proteze nosi kontinuirano 24 časa, nakon čega je bio zakazan prvi kontrolni pregled.

Nakon mesec dana usledilo je podlaganje proteza. Tokom daljeg opservacionog perioda (3, 6 i 12 meseci) nije bilo potrebe za istim kliničkim postupkom.

DISKUSIJA

Protetska rehabilitacija imedijatnim totalnim protezama sadrži brojne prednosti nad rehabilitacijom konvencionalnim protezama sa odloženim opterećenjem [6].

Pored toga što ostvaruju povoljan efekat na proces zarastanja ekstrakcionih rana, ovim nadoknadama čuva se vertikalna dimenzija okluzije, kao i tonus i funkcija mišića orofacijalne regije. U kliničkim studijama pokazan je značaj imedijatne proteze kao privremenog i preventivnog rešenja u cilju očuvanja i pripreme alveolarnog grebena za ugradnju implantata [7].

Rezultati prospektivnih studija pokazali su da kvalitet rehabilitacije imedijatnim protezama korelira sa zadovoljstvom pacijenta [8, 9]. Značajnu socijalnu komponentu za pacijenta predstavlja odsustvo perioda neizbežne bezubosti neophodnog za konsolidaciju rana kod konvencionalnih totalnih proteza. Takođe, odabir boje, oblika i veličine veštačkih zuba može se mnogo lakše prilagoditi prirodnim zubima, što vodi bržoj biološkoj adaptaciji pacijenta [10, 11].

Prema literaturno dostupnim podacima, ekstrakcije bi trebalo sprovesti u dve faze [11]. U prvoj fazi preporuka je izvaditi zube bočnog segmenta (ukoliko ne održavaju optimalnu vertikalnu dimenziju) i zube sa registrovanom akutnom infekcijom potpornog aparata. Druga faza ekstrakcije podrazumeva vađenje svih preostalih zuba neposredno pre predaje gotovih proteza.

Merenjem dubine parodontalnih džepova, usmerenim odsecanjem zuba na modelu i eventualnim intervencijama na vrhovima koštanih alveola može se unapred isplanirati dobra adaptacija protezne ploče prema nosećim tkivima. Na taj način sprečeni su progresivna koštana remodelacija i negativan uticaj mišića usne duplje na oblikovanje rezidualnih alveolarnih grebenova [12].

Da li ste pažljivo čitali radove?

1. Za zatvaranje postekstrakcionog prostora koriste se klizni mehanizmi?
   a) Da
   b) Ne
   c) Skoro nikad

2. Podlaganje gotovih imedijatnih proteza usledilo je:
   a) posle dve nedelje
   b) posle tri nedelje
   c) posle mesec dana

3. Učestalost TMD je proverena kod:
   a) dece
   b) ortodontskih pacijenata
   c) pacijenata sa kliničke protetike

4. Analiza cikličnog zamora proveravana je kod:
   a) instrumenata PRO TAPER
   b) instrumenata M TWO
   c) instrumenata TWISTED FILE

5. Rezultati su pokazali da kod obe metode kliznog mehanizma:
   a) dolazi do pada vrednosti inicijalne sile
   b) dolazi do povećanja vrednosti inicijalne sile
   c) nema promene vrednosti prosečne inicijalne sile

6. Kod primene kliznog mehanizma dolazi do:
   a) značajnog pada sile između kontrolnih pregleda
   b) značajnog povećanja sile između kontrolnih pregleda
   c) neznatnog povećanja sile između kontrolnih pregleda

7. U kontrolnoj grupi među studentima neku formu TMD je pokazalo:
   a) 45% ispitanika
   b) 48% ispitanika
   c) 56% ispitanika

8. Kod pacijentkinje je urađena:
   a) samo gornja imedijatna proteza
   b) samo donja imedijatna proteza
   c) i gornja i donja totalna imedijatna proteza

9. Klizni NiTi mehanizmi obuhvataju:
   a) zatvorene opruge
   b) elastične konce
   c) zatvorene opruge i elastične konce

10. Kod NiTi zatvorenih opruga prosečna in sila je iznosila:
    a) 189–210 g
    b) 117–133 g
    c) 184–205 g

11. Gubitak sile između faza aktivacije kod zatvorenih opruga je:
    a) veći u odnosu na elastične lance
    b) manji u odnosu na elastične lance
    c) isti kao kod elastičnih lanaca

12. Pacijenti sa mezijalnom ili distalnom okluzijom su u odnosu na pacijente sa I klasom pokazali:
    a) veći procenat TMD
    b) manji procenat TMD
    c) identičan procenat TMD

13. Analiza cikličnog zamora je obuhvatala:
    a) 30 PRO TAPER NEXT instrumenata
    b) 20 PRO TAPER NEXT instrumenata
    c) 12 PRO TAPER NEXT instrumenata

14. Stepen konačnosti testiranih NiTi instrumenata na cikličan zamor iznosio je:
    a) 0,02
    b) 0,03
    c) 0,04

15. Merenje dužine parodontalnih džepova kod pacijentkinje sa imedijatnom protezom vršeno je u:
    a) pet tačaka
    b) šest tačaka
    c) sedam tačaka

16. Kod NiTi elastičnih lanaca prosečna in sila je iznosila:
    a) 189–210 g
    b) 117–133 g
    c) 184–205 g

17. Kod ortodontskih pacijenata je proveravana i određivana:
    a) učestalost i izraženost TMD
    b) samo učestalost TMD
    c) samo izraženost TMD

18. Učestalost TMD u eksperimentalnoj grupi je bila veća kod:
    a) muškog pola
    b) ženskog pola
    c) identična kod osoba ženskog i kod osoba muškog pola

19. Analiza cikličnog zamora je proveravana u arteficijalnom kanalu:
    a) od metala
    b) od akrilata
    c) od plastike

20. Dužina testiranih NiTi instrumenata na cikličan zamor iznosila je:
    a) 21 mm
    b) 25 mm
    c) 28 mm

21. Imedijatna proteza je urađena kod:
    a) pacijenta starosti 48 godina
    b) pacijentkinje starosti 48 godina
    c) pacijentkinje starosti 84 godine

22. Prosečna rezidualna sila kod zatvorenih opruga je:
    a) 117–133 g
    b) 189–210 g
    c) 100–113 g

23. Efikasnost kliznih mehanizama u zatvaranju postekstrakcionog prostora može biti smanjena:
    a) usled trenja
    b) usled promene osobine materijala
    c) usled trenja i promene osobine materijala

24. Učestalost pojave TMD kod ortodontskih pacijenata je proveravana:
    a) na osnovu radiološkog nalaza
    b) na osnovu kliničkih simptoma
    c) na osnovu posebnog upitnika

25. Ortodontske nepravilnosti su samo jedan od faktora u nastanku TMD?
    a) Da
    b) Ne
    c) Skoro nikad

26. Arteficijalni kanal u metalnom bloku je bio pod uglom od:
    a) 30 stepeni
    b) 40 stepeni
    c) 45 stepeni

27. Imedijatne proteze su:
    a) privremena rešenja
    b) trajna rešenja
    c) rešenja za 2-3 godine

28. Klizni mehanizmi su analizirani:
    a) u okviru terapije fiksnim aparatima
    b) u okviru terapije mobilnim aparatima
    c) u okviru terapije fiksnim i mobilnim aparatima

29. Prosečna rezidualna sila kod elastičnih lanaca je:
    a) 117–133 g
    b) 189–210 g
    c) 100–113 g

30. Kontrolnu grupu u istraživanju učestalosti TMD su činili:
    a) studenti Stomatološkog fakulteta sa malokluzijama
    b) studenti Stomatološkog fakulteta sa nepravilnim zagrižajem
    c) studenti Stomatološkog fakulteta bez potrebe za ortodontskom terapijom

31. Ortodontske nepravilnosti su najvažniji faktor u nastanku TMD?
    a) Da
    b) Ne
    c) Vrlo retko utiču

32. Veću otpornost na ciklični zamor pokazali su instrumenti:
    a) PRO TAPER UNIVERSAL
    b) PRO TAPER NEXT
    c) vrednosti su bile identične

33. Imedijatne proteze se pacijentu predaju:
    a) pre ekstrakcije zuba
    b) posle ekstrakcije zuba
    c) do jedan sat posle ekstrakcije

34. Klizni mehanizmi u zatvaranju postekstrakcionog prostora su analizirani:
    a) kod 38 pacijenata
    b) kod 58 pacijenata
    c) kod 78 pacijenata

35. NiTi zatvorene opruge su zadržavale u proseku:
    a) 61,57% početne sile
    b) 47,54% početne sile
    c) 53,41% početne sile

36. Ortodontski pacijenti kod kojih je proveravana učestalost TMD su podeljeni u:
    a) dve podgrupe
    b) tri podgrupe
    c) četiri podgrupe

37. Studija učestalosti i izraženosti TMD kod ortodontskih pacijenata sprovedena je na:
    a) Stomatološkoj klinici u Nišu
    b) Stomatološkoj klinici u Novom Sadu
    c) Klinici za ortopediju vilica Stomatološkog fakulteta u Beogradu

38. Prosečna dužina frakturalnih fragmenata je bila statistički znatno veća kod:
    a) instrumenata PRO TAPER UNIVERSAL
    b) instrumenata PRO TAPER NEXT
    c) vrednosti su bile identične

39. Parodontalni status pacijenta sa imedijatnom protezom je:
    a) važan deo kliničkog pregleda pre izrade
    b) nevažan deo kliničkog pregleda pre izrade
    c) najmanje važan deo kliničkog pregleda pre izrade

40. Za zatvaranje postekstrakcionog prostora korišćene su:
    a) NiTi opruge i elastični lanci
    b) plastične opruge i elastični lanci
    c) opruge i elastični lanci od specijalnog čelika

41. NiTi elastični lanci su zadržavali u proseku:
    a) 61,57% početne sile
    b) 47,54% početne sile
    c) 53,41% početne sile

42. U eksperimentalnoj grupi neku formu TMD je pokazalo:
    a) 45% pacijenata
    b) 52% pacijenata
    c) 56% pacijenata

43. U studiji učestalosti i izraženosti TMD uključeno je:
    a) 150 ispitanika
    b) 210 ispitanika
    c) 320 ispitanika

44. Analiza cikličnog zamora NiTi instrumenata realizovana je na:
    a) Dentalnoj klinici Medicinskog fakulteta u Novom Sadu
    b) Dentalnoj klinici Medicinskog fakulteta u Nišu
    c) Klinici za bolesti zuba Stomatološkog fakulteta u Beogradu

45. Funkcionalni otisak pri izradi imedijatne proteze se uzima:
    a) samo zatvorenom individualnom kašikom
    b) samo otvorenom individualnom kašikom
    c) zatvorenom, otvorenom i delimično otvorenom individualnom kašikom

46. Zatvaranje prostora posle ekstrakcije zuba praćeno je:
    a) tokom 3 meseca
    b) tokom 4 meseca
    c) tokom 6 meseci

47. Testirani instrumenti na ciklični zamor su bili:
    a) veličine 180 20
    b) veličine 180 25
    c) veličine 180 30

48. Radiranje gipsanih zuba na modelu pri izradi imedijatne proteze je:
    a) neophodno
    b) obavezno
    c) potrebno samo u određenim slučajevima

49. Kontrolni pregledi u ortodontskoj terapiji sa kliznim mehanizmima su rađeni:
    a) svake 2 sedmice
    b) svake 4 sedmice
    c) svaka 2 meseca

50. Radiranje gipsanih zuba na modelu pri izradi ime proteze treba realizovati do:
    a) nivoa dubokih prethodno izmerenih parodontalnih džepova
    b) gleđno-cementne granice
    c) nivoa alveolarne kosti

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