Comparison of Three Prosthodontic Treatment Modalities for Patients with Periodontally Compromised Anterior Mandibular Teeth: A 2-year follow-up study

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Abstract
Objectives: To prospectively assess self-perceived chewing function (CF) and oral health-related quality of life (OHRQoL) in geriatric patients after receiving three different treatment modalities in the mandible: removable partial denture (CD-RPD), complete denture (CDs), or complete overdenture supported by mini dental implants (CD-MDI). At baseline, all patients had mobile anterior teeth (1 mm or >) and missing posterior teeth in the mandible. Patients were completely edentulous in the maxilla. After treatment, patients were recalled at the 3-month and the 2-year post-treatment period.

Materials and Methods: A total of 176 patients participated (CD group, n=68; CD-RPD group, n=58; CD-MDI group, n=50). Self-reported CF was assessed using the Chewing Function questionnaire (CFQ). The OHRQoL was evaluated using the OHIP14 questionnaire, which the patients completed 1. before treatment, 2. three months after treatment, and 3. at the 2-year post-treatment stage.

Results: The OHRQoL and the self-perceived CF significantly improved in all groups after treatment (p<0.01). The highest improvement of a CF was recorded in the CD-MDI group. The OHRQoL was significantly higher in the CD-MDI group in comparison to the CDs group after treatment (p<0.01). At the 2-year post-treatment stage, self-perceived CF significantly further improved in the CD-MDI group, while it worsened in the CD and the CD-RPD groups (p<0.01). The same pattern was recorded for the OHIP14 summary scores. The highest amount of denture repairs and adjustments was recorded in the CD-RPD group, although maintenance was also demanding in the CD-MDI group.

Conclusion: Within the limitations of this study, rehabilitation with mandibular MDI retained overdenture can be considered as preferred treatment with the constant improvement of OHRQoL and a chewing function in comparison to mandibular CD or mandibular RPD option in patients with mobile anterior mandibular teeth.

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Introduction
It has been well documented that prosthodontic rehabilitation improves patients’ oral health-related quality of life (OHRQoL) (1–3). Treatment modalities for complete or almost complete edentulism in geriatric patients have changed over time, from complete (CDs) and removable partial dentures (RPD) to implant-supported fixed or removable constructions (1–5). Moreover, in the year 2002, a panel of experts in prosthodontics and dental implantology concluded that the restoration of edentulous mandible with convention-
al complete dentures was no longer the first choice prostho-
odontic treatment due to overwhelming evidence that a 
two-implant overdenture should become the first choice of 
treatment for the edentulous mandible (6,7). However, ma-
ny geriatric patients are not optimal candidates for placement of 
dental implants of standard dimensions, either due to their 
irrespective ridge resorption and inadequate buccolingual bone 
volume, or due to their financial limitations, chronic diseases, 
or fear to undergo complicated surgical treatments, which 
include flap reflection, osteotomy and/or different modalities of 
bone augmentation (8-11).

In the past, dentists needed to compromise and maintain 
the remaining anterior teeth in the mandible despite their 
mobility and advanced periodontal disease in order to pro-
vide the patients a transient period in which the removable 
denture would be retained by clasps to allow better retention of 
removable dentures. Before dental implants had proved their 
usefulness for removable denture retention and stabi-
lization, keeping teeth with mobility due to the severe bone 
loss was the only possible option allowing dentists to avoid a 
complete mandibular denture.

More than a decade ago, slim implants (mini dental im-
plants or MDI) were released to the dental market to support 
and retain complete dentures. Insertion of MDIs is a quicker 
and simpler option than the placement of standard size im-
plants (12-15). Most of the time there is also no need for flap 
reflection (12-25). In many cases, when the insertion torque is 
adequate (i.e., from 25 up to 45 N/cm²) the MDIs can be 
immediately loaded (13,17). The MDIs also represent an ad-

tantageous option from a financial perspective in compari-
sion to standard size implants, because they are cheaper, and 
there is no need to purchase abutments as MDIs are one-
piece implants. Since the MDIs have been introduced, they 
have been confirmed as a suitable treatment option in many 
follow-up studies ranging from six-month to seven years (12-
26). It has been proven that patients with MDIs and mandib-
ular overdentures achieve even better or at least comparable 
oral health-related quality of life (OHRQoL) and satisfac-
tion when compared to two standard dental implants (2,12-
14,16,20,21). Nevertheless, long-term survival rate studies 
för MDIs are still lacking. The high short-term survival rates 
of MDIs were only recorded for mandibular overdentures, 
whereas for maxillary overdentures retained by the MDIs, 
the short-term survival rates were significantly lower, rang-
ing from 54 to 85% (27,28). In a study by Maryod et al., 
delayed loading of MDIs showed better MDI survival rate 
and less bone loss in comparison to immediate loading in the 
mandible (15). In a 5-year observational prospective clinical 
study of immediately loaded new mandibular overdentures on 
four MDIs, the patient satisfaction increased significantly 
over five years (13).

However, a self-reported chewing function with MDIs has 
not been prospectively followed up yet. It has also not 
been reported yet to which extent MDI-retained mandibu-
lar overdentures improve chewing function when compared to 
patients having CDs in both jaws, or with patients having a 
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tained RPD on anterior teeth in the mandible.
The main objective of this clinical study was to assess a self-perceived chewing function and OHRQoL in three groups of patients dependent on the type of a new mandibular denture (CD, RPD, or MDI supported mandibular overdenture (MDI-CD)). Each patient received a new maxillary CDs. The additional aim of the study was to monitor the after-treatment effects of the three prosthodontic treatment options for the mandible over time.

Materials and methods

All participating patients were informed about the study, and all of them signed the informed consent. The study received the institutional ethical board approval. The patients, who were willing to participate in the study, have been assigned to one of the three study groups and were rehabilitated at the Department of Removable Prosthodontics, School of Dentistry, the University of Zagreb from January 2013 until April 2016.

At baseline, all patients who came seeking treatment were completely edentulous in the maxilla. They had 3-5 mobile anterior teeth in the mandible due to extensive bone loss caused by advanced periodontal disease. The patients were assigned to three different groups. One group comprised of the patients with mobile anterior teeth, which were extracted and the patients were treated with new complete mandibular dentures (CD group). The second group consisted of patients who received mandibular long saddle clasp retained RPDs on the remaining anterior mobile teeth (CD-RPD group). The third group received complete mandibular overdentures supported by four mini dental implants (CD-MDI group) following the extraction of their anterior mandibular teeth.

The selection criteria for the CD-RPD group were: a maxillary CD, mandibular Kennedy Class I status, no teeth distally from the lower canine on one side of the mandibular arch, and no teeth distally from the second incisor on the other side of the arch (i.e., Kennedy Class I). Furthermore, the remaining teeth had at least grade 1 (less than 1 mm of perceptible mobility in buccolingual direction) or grade 2 of tooth mobility (i.e., at least 1 mm, but less than 2 mm) (29,30). Due to their mobility, the remaining teeth were not splinted by a fixed partial denture, and therefore it was not possible to use precision or semi-precision attachments. Nineteen patients in the CD-RPD group had five remaining teeth, twenty-five patients had four remaining teeth, and fourteen patients had only three remaining teeth. The CD-RPD patients received long saddle RPDs with lingual plate major connector made of CoCr alloy to prevent fracture. Cast clasps retained the dentures.

All patients included in this study had suffered a considerable atrophy of the mandibular residual alveolar ridge as no dugoročno praćena. Također nije zabilježeno koliko donje proteze retinirane minidendalnim implantatima poboljšavaju žvačnu funkciju pacijenata u usporedbi s pacijentima koji imaju gornju i donju potpunu protezu ili sa pacijentima koji imaju gornju potpunu protezu i donju djelomičnu protezu dugačkih sedala koja je retinirana kvačicama na preostalim prednjim zubima – Kennedyjeva klasa I.

Glavni cilj ovog istraživanja bio je procijeniti žvačnu funkciju i OHRQoL u tri grupa pacijenata, ovisno o vrsti novih mobilnih proteza u donjoj čeljusti (PP, PP-MDI ili PP-DP). Svaki od tih pacijenata dobio je i novu potpunu protezu u gornjoj čeljusti. Dodatni cilj istraživanja bio je tijekom godina pratiti učinke tih trije različitih vrsta protetičke rehabilitacije u donjoj čeljusti.

Svi pacijenti obaviješteni su o postupcima istraživanja i potpisali su informirani pristanak. Istraživanje je dobilo odbijanje mjerodavnog etičkog odbora. Pacijenti koji su pristali sudjelovati podijeljeni su u tri grupe te su rehabilitirani u Zavodu za mobilnu protezu Stomatološkog fakulteta u Zagrebu od siječnja 2013. do travnja 2016. godine.

Pri dolasku svi su pacijenti bili potpuno bezubi u gornjoj čeljusti, a u donjoj dono su imali od 3 do 5 pomičnih prednjih zuba koji su se klimali zbog opsežnog gubitka kosti kao posljedice parodontne bolesti. Pacijenti su bili podijeljeni u tri skupine. Prva je obuhvatila pacijente čiji su pomični prednji zubi u donjoj čeljusti izvaženi i izrađene su im nov ide potpune proteze (skupina PP). U drugu skupinu svrstani su oni čiji su zubi nisu izvaženi, a rehabilitirani su djelomičnim protezama s dugim produženim sedlima, a retinirane su kvačicama na poničnim prednjim zubima (skupina PP-DP). U trećoj skupini bili su pacijenti koji su pomični zubi izvaženi, a napravljeni su im pokrovne potpune proteze retinirane na ugrađenim četirima minidendalnim implantatima (skupina PP-MDI).

Kriteriji za izbor u skupinu PP-DP bili su potpuna gornja proteza (PP), Kennedyjeva klasa I u mandibuli, ako je najdišnje zub s jedne strane očajčak, a s druge drugi inciziv (tj. Kennedyjeva klasa I). Ti zubi imali su minimalno stupanj 1 (manje od 1 mm vidljive mobilti u bukooralnom smjeru) ili stupanj 2 (tj. minimalno 1 mm, ali manje od 2 mm) poničnosti (29, 30). Zbog poničnosti preostalih zubova nisu bili povezani fiksnim radom te zato nije bilo moguća upotreba nekih drugih retencijskih elemenata kao što su kopče, nego su napravljene kvačice. Devetnaest pacijenata u skupini PP-DP imalo je po pet preostalih zuba, 25 pacijenata po 4, a 14 je imalo samo tri preostala zuba. PP-DP pacijentima izrađene su donje djelomične proteze s produženim sedlima i velikom pločastom spojkom iz CoCr legura kako bi se sprječili lomovi. Proteze su bile retinirane lijevanim kvačicama.

Svi pacijenti uključeni u istraživanje imali su iznimno izraženu atrofiju donjega alveolarnog grebena distalno s obzirom na to da su već nosili djelomične proteze najmanje pet godina. Početna nakana istraživanja bila je slučajno raspodjele prema skupini. Stoviše, unatoč mogućoj bezprijednovoj terapiji za sve tri terapijske opcije, neki su pacijenti odbili nadogradnju
they had already been the removable denture wearers for at least five years. The initial study design was that the patients would be randomly assigned to the three groups. Nevertheless, despite the available option to receive free treatment regardless of the three treatment options, some patients refused to accept mini dental implants and were reassigned to the other two groups. Therefore, the study design was modified into the convenience sample study. All costs for MDIs were covered by a research grant (details in the Acknowledgement section). Patients who rejected MDIs for various reasons including fear of surgical procedure, pain, fear of possible medical complications, thoughts they were too old, etc. were allocated into the other two groups. All mandibular dentures were reinforced by a metal framework.

Absolute exclusion criteria for the insertion of the MDI were uncontrolled diabetes mellitus, acute malignant comorbidity including current or recent chemotherapy, intravenous bisphosphonate intake and any history of radiotherapy to the head and neck region. Prior to the MDI placement, panoramic radiographs and/or CBCTs of the mandible were obtained from each participant in the CD-MDI group. All participants receiving MDIs had buccolingual alveolar width of less than 4.5 mm. They received four MDIs intraorally in the mandible implanted by a flapless technique (a total of 202 mini-dental implants were inserted, Dentium, South Korea). The implant width and length were chosen based on the residual ridge width and length.

The MDI width was 2.0 or 2.5 mm, while the MDI length varied from 8, 10, 12, up to 14 mm. The MDIs were placed following the manufacturer’s recommendation using a surgical motor unit (W&H Implantmed GmbH, Austria) with saline solution for external irrigation for drill cooling and calibrated drills at low speed after punching through the cortical bone. The depth of bone preparation was 1-2 mm less than the length of the roughened surface of implants. Implants were screwed at a torque ranging from 25 up to 45 N/cm². The two posterior mini-dental implants were inserted in the tooth location of 34 and 44 in a mature bone, while the position of the two anterior MDIs was dependent on the site of anterior tooth extraction. The implants were inserted near the extraction sites in sites with a mature bone. Only in cases when the extraction socket was very shallow, and the bone anatomy allowed choice of much longer MDIs, the implants were inserted in the extraction socket. The two anterior MDIs were sometimes placed in the sites of mandibular first or second incisors. Antibiotics were prescribed to the patients 2-6 hours prior the MDI insertion and for the following three days. Fifteen days later, when pain from surgery has subsided, impressions for new dentures were obtained. Overdentures were retained by O-ball matrices and were early loaded (6 to 8 weeks after implant insertion). After denture delivery, the patients received detailed instructions on how to maintain oral hygiene with MDIs using a soft toothbrush in the mouth and a hard toothbrush for denture hygiene. The patients who received CDs or CD-RPDS also received instructions about their oral hygiene maintenance. Prosthodontic residents supervised by a specialist of prosthodontics made all dentures. Another specialist of prosthodontics, not

minidentalnih implanta te su bili razvrstani u dvije grupe, Zato je istraživanje promijenjeno iz randomiziranog u odgovarajuću oglednu studiju. Svi troškovi MDI namišljeni su u sredstva istraživačkog projekta (detalji u zahvati). Pacijenti koji su odbili ugradnju MDI-ja iz različitih razloga, poput straha od kirurškog postupka, bolova, straha od mogućih komplikacija, bili su uvršteni u dvije druge grupe. Sve donje proteze bile su ojačane metalom.

Apsolutna kontraindikacija za ugradnju MDI-ja bili su nekontrolirani dijabetes melitus, akutne maligne bolesti – uključujući trenutačnu ili nedavnu kemoterapiju – intravazalna terapija bisfosfonatima i bilo kakva povijest radioterapije u području glave i vrat. Prije ugradnje MDI-ja svim pacijentima u skupini PP-MDI obavljene su ortopantomogramska i/ili CBCT snimka donje češću. Svi pacijenti koji su dobili MDI-je imali su bukolingvalni promjer alveolarnog grebena manji od 4.5 mm. Ugradnja je im potrebno MDI-ja extraoralno, tehnikom bez odzivanja režnja (ukupno su ugrađene u 202 MDI-ja Dentium, Južna Koreja). Dimenzija implantata odabrana je na temelju preostale širine i duljine grebena.

Širina MDI-ja iznosi 2.0 ili 2.5 mm, a duljina je varirala od 8, 10, 12 pa sve do 14 mm. MDI-ji su ugrađeni sljedeći: jako dobro prije ugrađivanja i uz primjenu fiziionspenzera (W&H Implantmed GmbH, Austrija) sa hladjenjem fiziionskom otelinom i kalibriranim svrdlima na niskim okretajima nakon prolaska kroz kortikalnu kost. Dubina preparacije bila je do 2 mm manja od duljine aktivne površine implantata. Ugradnje su ugrađeni u području zuba 34 i 44, a pozicija prednjih MDI-ja ovisila je o području ekstrakcija zuba. Ugradnje ugrađenih blizu područja ekstrakcije, u području sa zrelim kostom, samo u slučaju kada je ekstrakcijska rana bila jako plitka, a anatomijska kosti dopuštalila ugradnju znatno duljih MDI-ja, MDI je ugrađen u ekstrakcijsku alveolu. Dva distalna MDI-ja katkad su bila postavljena u područje prvoga ili drugoga donjeg inciziva. Premedikacija antibioticima određena je svim pacijentima te i od 2 do 6 sati prije operacije te sljedeća tri dana. Petnaest dana nakon ugradnje, kada se bol nakon ugradnje ublažila, suzeti su otisci za proteze. Proteze su retinirane s pomoću O-ball grebenitih prstenja u matricama, a MDI-ji su bili rano opterećeni (6 do 8 tjedana nakon ugradnje). Nakon predaje proteza, pacijentima su dane detaljne upute kako održavati oralnu higijenu s MDI-jem koristeći se mehanizmom i tvrdima za čišćenje proteza.

Pacijenti koji su dobili PP ili DP također su dobili upute za održavanje oralne higijene. Sve proteze izradili su specijalizant stomatološke protekte pod nadzorom specijalista, tj. mentora. Kvalitetu svih novih proteza (nove potpune proteze u maksili i sva tri tipa proteza u mandibuli) procijenio je specijalist stomatološke protekte koji nije bio uključen u istraživanje i njihovu izradu. Donje pokrovne proteze bila su ocijenjene prije ugradnje, a od jastuka do mjesečnog vremena, u održavaju se iste uslovlje i tvrdme.
included in the study or in the denture manufacture, assessed the quality of all new dentures (new complete dentures in the maxilla, as well as all three types of removable dentures in the mandible). Mandibular overdentures on MDIs were assessed prior to loading. Assessments were made for the denture borders, the vertical dimension of occlusion, and the artificial teeth set-up, by using the Likert scale from 1 (unsatisfactory) to 5 (excellent). Only the patients whose quality of new dentures was assessed as excellent or very good were included in the present study for patients' self-assessment of chewing function and OHQoL. Throughout the two years after prosthetic rehabilitation in the mandible, all study participants from all three groups were scheduled for the regular recall visits.

The CD group comprised of 68 patients (40 females, 28 males) with the mean age of 69.6±11.2 years, of the CD-RPD group 58 patients (32 females, 26 males), mean age 66.0±8.0, years, and the CD-MDI group comprised 50 patients (44 females, 6 males), with the mean age of 66.7±9.3 years. All patients from the three groups were previous removable denture wearers.

The Croatian version of the OHIP14 questionnaire (31) and the chewing function questionnaire (CFQ) (32) were completed on three occasions: the first time at baseline immediately before treatment, the second time two to three months after finishing treatment (when all adjustments of new dentures had been completed), and the third time 2 years post-treatment (Fig. 1).

OHRQoL-a. Dvije godine nakon protetičke rehabilitacije u mandibuli, pacijenti iz svih triju grupa pozvani su na redoviti kontrolni pregled.

Skupina PP sastojala se od 68 pacijenata (40 žena, 28 muškaraca) prosječne dobi 69,6 ± 11,2 godine, u skupini PP-DP bilo je 58 pacijenata (32 žene, 26 muškaraca) prosječne dobi 66,0 ± 8,0, a skupina PP-MDI sadržavala je 50 pacijenata (44 žene, 6 muškaraca) prosječne dobi 66,7 ± 9,3 godine. Svi pacijenti, iz svih triju skupina, već su nosili djelomične prothese.

Hrvatske verzije upitnika OHIP 14 (31) i upitnika za procjenu žvačne funkcije (CFQ) (32) ispunjene su tri puta – prvi put prije početka terapije, drugi put dva do tri mjeseca nakon završetka terapije (kada su završene sve prilagodbe novih protesa) i treći put dvije godine nakon terapije (slika 1).

Svaka stavka u OHIP-u 14 traži od pacijenata da odgovore kako često su osjetili ili su se suočili s određenom poteškoćom tijekom posljednjih tjedana (33) i to su označavali kao nikada, rijetko, kadkad, često i vrlo često (Likertova ljestvica od 0 do 4). Nula je značila da nema nikakvih problema, a više bodova označavalo je kompromitiranije oralno zdravlje. Pri ispunjavanju upitnika za procjenu žvačne funkcije (CFQ) i upitnika OHIP 14 pacijenti su procjenjivali poteškoće tijekom žvakanja različite vrste hrane u posljednjih tjedan dana (33). Poremećaji žvačne funkcije ocijenjeni su na Likertovoj ljestvici od 0 do 4 (0 = nema problema, 4 = najviše poteškoća sa žvakanjem ili nemogućnost žvakanja odredene vrste hrane). Za oba upitnika izračunat je zbroj bodova. Raspon zbroja OHIP-a je 0–40, a CFQ-a 0–20.
For each of the OHIP14 items, the patients were asked how frequently they had experienced the impact during the previous week (33). The five categories of choice per item were never, rarely, occasionally, often, and very often; (Likert scale from 0 to 4). Zero indicated an absence of problems, while higher scores indicated more impaired oral health. When filling-in the CFQ or the OHIP14 questionnaire, the patients were asked to assess their difficulties while chewing different foods during the previous week (33). The CFQ answers were graded on the Likert scale from 0 to 4 (0 = absence of problems, up to 4 = the highest problem or inability to chew specific food). For both questionnaires, summary scores were used for statistical analysis. Summary scores for the OHIP14 questionnaire range from zero to 56, and the summary scores for the CFQ range from zero to 40.

Statistical analysis (SPSS 20 for Windows, IBM) included one sample Kolmogorov-Smirnov test for testing normality of the data distribution, descriptive statistics, paired t-test (pretreatment vs. post-treatment data), and one-way ANOVA (post hoc Scheffe’s test). The linear mixed model (general linear model) was also used (summary scores were dependent variables; treatment option, gender, and level of education were fixed factors; age was a covariate). P values <.05 were considered statistically significant.

Results

All summary scores were normally distributed (P>0.05). There were no statistically significant differences in age between the three study groups (F=2.42; P=0.092).

In the CD-MDI group, two mini-dental implant heads broke during insertion in two different patients. Broken implants were left as „sleeping implants”, however, the respective patients received a new MDI, each. Three additional MDIs were lost during the first 6-8 weeks (in three different patients) who received mandibular overdenture retained with only three MDIs (instead of four). Two additional MDIs were lost during the first year, and no MDI was lost during the second year, resulting in the 97% implant treatment survival rate. There were also no clinical signs of moderate or advanced peri-implantitis according to classification for peri-implantitis proposed by Froum and Rosen (34). No significant problems with dentures were registered in the CD-MDI group, and no fracture repairs were necessary. Four patients needed additional adjustments due to sore spots, two matrices were loosened and were remounted, and a total of 34 O-rings (17%) were changed in different patients.

In the CD-RPD group, fourteen teeth were lost in the mandible (in nine patients) and were replaced by acrylic teeth in the respective dentures. If the abutment tooth was lost, the mandibular (in nine patients) and were replaced by acrylic teeth. In the respective dentures. If the abutment tooth was lost, the

ja bodova upitnika OHIP 14 može biti od 0 do 56, a CFQ-a od 0 do 40.

Za statističku obradu (SPSS 20 for Windows, IBM) koristen je Kolmogorov-Smirnov test za ispitivanje normalnosti distribucije, testovi za deskriptivnu analizu, t-test za zavisne uzorke (prije terapije; poslije terapije) i jednosmjerna ANOVA (post hoc Scheffer test). Linearni miješani model (general linear model) također je korišten (zbroj bodo-va u upitniku bile su zavisne varijable, terapijske mogućnosti (3 skupine), spol i razina edukacije bili su liksni čimbenici, a dob je bila kovarijanta. P vrijednost od < ,05 smatra se sta-tistički značajnom.
es between the baseline-, the after-treatment-, and the 2-year post-treatment summary scores are presented separately for the CFQ, and the OHIP14 scores (Figure 2 and Figure 3, respectively).

The treatment significantly reduced both, the OHIP14 and the CFQ scores in comparison to the baseline scores in all treatment groups (p<0.001). However, the amount of score reduction was significantly different among treatment groups (F=4.95, p=0.008 for the OHIP14; F=30.39, p<0.001 for the CFQ). The CFQ score reduction was significantly higher in the CD-MDI group than in both, the CD group (mean difference = -9.89; p<0.001, Scheffe post hoc) and the CD-RPD group (mean difference = -7.53; p<0.001, Scheffe post hoc). The OHIP14 score reduction was significantly higher in the CD-MDI group than in the CD group (mean difference = -5.49; p=0.008, Scheffe post hoc).

Figure 2. OHIP14 summary scores (histograms) with 95% confidence intervals in complete denture wearers (CD), mandibular removable partial long saddle denture (Kennedy Class I) (CD-RPD), and in mini dental implant retained mandibular overdentures (CD-MDI). * = significant difference between patient groups for the amount of score reduction (p<0.05), ++ = significant differences between patient groups for the 3-month after treatment scores; $ = significant differences between patient groups for the 1-year after treatment scores, § = significant score increase in relation to the 3-month after treatment scores.

Figure 3. Summary Scores of the Chewing Function Questionnaire (CFQ) (histograms) with 95% confidence intervals in complete denture wearers (CD), removable partial, long saddle mandibular denture wearers (Kennedy Class I, CD-RPD), and in mini dental implant retained mandibular overdentures (CD-MDI). * = significant difference between patient groups for the amount of score reduction (p<0.05), ++ = significant differences between patient groups for the 3-month after treatment scores, $ = significant differences between patient groups for the 1-year after treatment scores, § = significant score increase in relation to the 3-month after treatment scores, ‡ = significant score decrease in relation to the 3-month after-treatment scores.

Slika 2. Zbroj bodova upitnika OHIP 14; histogrami s 95-postotnim intervalima pouzdanosti kod nositelja potpunih proteza (CD), djelomičnih mobilnih proteza dugih sedala (Kennedyjeva klasa I) (CD-RPD) te kod pacijenata s donjim pokrovnim potpunim protezama retiniranim na minizubnim implantatima (CD-MDI). * = značajna razlika između skupina pacijenata za iznos smanjenja broja bodova (p < 0,05), + = značajne razlike između skupina pacijenata tri mjeseca nakon predaje proteza; $ = značajne razlike između skupina pacijenata dvije godine nakon predaje proteza, § = značajno povećanje broja bodova u odnosu prema rezultatima tri mjeseca nakon predaje proteza.

Slika 3. Zbroj bodova upitnika za procijenu žvakanja (CFQ); histogrami s 95-postotnim intervalima pouzdanosti kod pacijenata s potpunim protezama (CD), djelomičnim mobilnim protezama dugačkih sedala (Kennedyjeva klasa I, CD-RPD) i potpunim pokrovnim protezama retiniranim na minimplantatima (CD-MDI); * = značajna razlika između triju skupina pacijenata ovisno o smanjenju broja bodova nakon terapije (p < 0,05); + = značajna razlika između triju skupina pacijenata nakon dvije godine nošenja proteza; $ = značajno povećanje zbroja bodova u odnosu prema razdoblju nakon terapije i tri mjeseca prilagodbe; § = značajno smanjenje zbroja bodova u odnosu prema razdoblju nakon terapije i tri mjeseca prilagodbe.
The three-month after-treatment (when patients were adjusted to their dentures) summary scores were significantly different among groups (F = 4.84, p = 0.009 for the OHIP-14 questionnaire; F = 7.93, p = 0.001 for the CFQ). The CD-MDI group had significantly lower OHIP-14 scores than the CD-RPD group (mean difference = -3.18; p = 0.009, Scheffe post hoc). Moreover, the CD-MDI group had significantly more improved scores compared to the CD and the CD-RPD groups. The patients in the CD-MDI group improved both, self-perceived quality of life (QoL) (t = 5.609, p < 0.001).

Discussion

The CD-MDI group benefited most from the treatment, compared to the CD and the CD-RPD groups. The patients in the CD-MDI group improved both, self-perceived and QoL compared with the post-treatment scores (t = 5.609, p < 0.001). The patients in the CD-MDI group improved both, self-perceived and QoL compared with the post-treatment scores (t = 5.609, p < 0.001). The patients in the CD-MDI group improved both, self-perceived and QoL compared with the post-treatment scores (t = 5.609, p < 0.001). The patients in the CD-MDI group improved both, self-perceived and QoL compared with the post-treatment scores (t = 5.609, p < 0.001).

Rasprava

Skupina PP-MDI imala je najviše koristi od terapije, u usporedbi sa skupinama PP i PP-DP. U skupini PP-MDI popravili su se žačna funkcija (prema procjeni samih pacijenata).
chewing function and OHRQoL better than the other two groups. The OHRQoL and the chewing function worsened throughout the first two years in the CD and the CD-RPD groups, while in the CD-MDI group the chewing function showed further improvement.

In general, almost all prosthodontic rehabilitation options show high initial treatment effects (1,35-37), which is in accordance with the results of this study. For the overdentures retained by the standard size implants, the excellent initial and long-term treatment effects have already been proven (1-4,35). The CD-MDI treatment in the mandible has become a viable treatment option for patients with atrophic alveolar ridges and/or for those with financial limitations (2,13-23,24-26). One study showed that patients with mandibular overdenture retained with four MDIs had a better OHRQoL in comparison to those with bar and locator overdentures retained by two standard size implants throughout a period of three years (2). Chewing function in patients with the MDI retained overdenture has not been assessed or compared with patients receiving other treatments yet. Therefore, we evaluated patients with three different prosthodontic rehabilitation options in the mandible considering both, OHRQoL and a self-perceived chewing function. All patients had a CD in the maxilla, and all patients were of similar age.

The long saddle mucosa born clasp-retained RPD group of patients represented a transient alternative to complete dentures. Anterior mandibular teeth usually remain as last surviving teeth in patients’ mouth (38-40). Prior dental implants utilization, dentists often preserved mobile anterior mandibular teeth in order to use them for denture retention by clasps to provide a slow transition to the complete mandibular denture. The retention of mandibular CDs depends only on factors such as interfacial surface tension, gravity, a viscosity of the saliva, anatomical and mechanical factors of a denture bearing area, and muscular coordination (40-43). Apart from keeping the last remaining teeth, a contemporary dentist has the alternative to insert dental implants to solve problems inherent to complete denture wearing. The MDI can be used in patients who would otherwise need bone augmentation, and this allows inclusion of a higher number of potential implant patients and less expensive and invasive treatment modalities.

The patients in this study were first offered to receive four MDIs, without any charge, as the research grant covered the costs of implants. Most of the patients who refused the MDI therapy explained that it was due to their fear of pain or fear of possible complications due to their old age, while some of them declined MDIs due to sufficient satisfaction with their old dentures. All patients who refused MDIs were assigned into the CD or RPD groups. The MDI overdentures in this study were early loaded, as this was reported to be a better option than the immediate loading protocol (15).

The impact of oral interventions on individually self-perceived oral health outcomes has been recognized as an important health component (1,2,4,13,23,24,31-33,36-38,40-50,53,58-60). We, therefore, decided to use the self-perceived measures, namely the OHIP14 and the CFQ to assess treatment outcomes. A recent study showed that self-nata) and OHRQoL and to više negoli u ostalim dvjema. Žvačna funkcija i OHRQoL pogošavali su se tijekom prve dvije godine u drugim dvjema skupinama, tj. u PP-u i PP-D-P-u, a u skupini PP-MDI pokazivala je daljnje poboljšanje. Općenitno, gotovo svaki protezi-atutorski postupak pokazuje inicijalno poboljšanje (1,35 – 37), što je u skladu i s rezultatima u ovom istraživanju. Prema podatcima iz literature, pokrovne proteze retinirane standardnim implantatima pokazuju izvrsne inicijalne i dugotrajne rezultate (1 – 4,35). Terapija PP-MDI u donjoj čeljusti postala je metoda izbora za pacijente s atrofičnim alveolarnim grebenom i/ili za one s finansijskim ograničenjima (2,13 – 23,24 – 26). Istraživanje je pokazalo da pacijenti s pokrovnom protezom retiniranom s četirima MDI-ja imaju bolji OHRQoL u usporedbi s pacijentima s pokrovnim protezama retiniranima prečkom ili lokatorima na dvama implantatima standardnih dimenzija tijekom trogodišnjeg razdoblja (2). Žvačna funkcija pacijenata s pokrovnim protezama retiniranima MDI-jem još se nije procijenjala ili uspoređivala s drugim oblicima terapije. U skladu s tim, u ovom istraživanju procjenjivali smo pacijente s trima različitim vrstama protetičke terapije u donjoj čeljusti, uzimajući u obzir OHRQoL i žvačnu funkciju. Svi pacijenti imali su potpunu protezu u gornjoj čeljusti i svi su bili približno isti dobi. Skupina pacijenata s dijelomičnim protezama dugih produženih sedala, koje su bile retinirane kvačicama, bila je alternativa potpunoj bezubosti. Prednji donji zubi obično ostaju kao posljednji u čeljusti (38 – 40). Prije primjene implantata, doktori dentalne medicine nastojali su sačuvati čak i djelomično pomiješane prednje zube s namjerom da ih iskoriste kao restoracijske – za nosače kvačica – i tako odgode prelazak na potpune proteze. Retencija potpune proteze ovisi o čimbenicima kao što su gravitacija, viskoznost sline, anatomska i mehanički čimbenici, odnos rubova proteze prema mekim tkivima i o mišićnoj koordinaciji pacijenata (40 – 43). Uz očuvanje preostalih zuba, današnji doktori dentalne medicine imaju mogućnost ugradnje dentalnih implantata kako bi riješili probleme koji otežavaju nošenje proteze. MDI-jem se mogu koristiti i pacijenti koji bi za ugradnju implantata standardnih dimenzija morali proći postupak augmentacije, te je zato moguće uključiti i veći broj potencijalno implantoprotetičkih pacijenata u terapiji, uz manje troškove i manje invazivne terapijske postupke. Pacijentima u ovom istraživanju najprije bilo ponuđena ugradnja četiriju MDI-ja, bez troškova, jer bi se oni pokrili financiranjem projekta. Većina pacijenata koji su odbili tu terapiju objasnili su svoj postupak strahom od bolova ili mogućih komplikacija zbog dobi, a dio njih bio je zadovoljan do sadavanjem starih proteza. Svi pacijenti koji su odbili MDI bili su raspoređeni u skupine PP ili PP-D-P. Pokrovne proteze retinirane MDI-jem bile su rano opterećene, u skladu s podacima iz literature koji pokazuju da je to bolja opcija negli imedijatno opterećenje (15). Utjecaj rehabilitacijskih oralnih zahvata na individuelno doživljavanje rezultata terapije prepoznat je kao važna komponenta zdravlja (1, 2, 4, 13, 23, 24, 31 – 33, 36 – 38, 40 – 50, 53, 58 – 60). U skladu s tim u istraživanje smo uključili upitnike OHIP 14 i CFQ, kako bismo procijenili uspjehe terapije na temelju mišljenja samog pacijenta. Suvremena istraživanja pokazuju da samoprocjena
perceived chewing ability and objective mixing ability (chewing) have been significantly inter-related (42). Although recent studies showed that the OHRQoL comprises of four dimensions (33,34,36-48), only the summary scores of the OHIP14 questionnaire have been assessed in this study, as it is the most frequently used questionnaire in prospective oral health-related quality of life assessment (49). Although the OHIP14 shows lower sensitivity in the edentulous patients than the OHIP-EDENT (50), it was preferred in this study, because the CD-RPD group had some anterior teeth left in the mandible and were not suitable for the OHIP-EDENT questionnaire.

As expected, all treatment options elicited significant treatment effects, which were confirmed by a significant after-treatment score reduction. However, excellent benefits of the CD-MDI treatment considering both, chewing function, and OHRQoL, in comparison to the CD and the CD-RPD group, have been proven in the study. Despite the fact that the CD-RPD group had clasps to improve denture retention and stability, the CD-MDI group revealed significantly better after-treatment chewing scores, probably due to better retention and stability of dentures provided by MDI matrices with “O” rings than by clasps on the remaining teeth in the CD-RPD group, regardless of how many teeth had been present (three, four or five) or what was their position and/or condition. Significantly better OHIP14 after treatment scores in the CD-MDI group than in the CD-RPD group could additionally be attributed to aesthetic concerns (clasp visibility in the CD-RPD group), and not solely to the self-perceived chewing function in the CD-MDI group.

However, two years after denture insertion, both OHRQoL and the chewing function worsened (i.e. confirmed by increased questionnaires scores) in the CD patients and in the CD-RPD group, which we attributed to problems inherent to removable denture wearing, such as residual ridge resorption, mucosal inflammation and/or clasp loosening (50-59). Scores of the CFQ, as well as the OHIP14 were not dependent on the position and number of the remaining teeth in the CD-RPD group. On the contrary, the OHIP14 scores slightly decreased further and the CFQ scores significantly reduced in the CD-MDI patients (revealing further improvement), which we attributed to patient’s better adaptation to their dentures and subsequent increased confidence and stability while chewing at the 2-year observation stage. The results related to OHRQoL are in agreement with some recent studies showing that the OHRQoL comprises of four dimensions (33,34,36-48), only the summary scores of the OHIP14 questionnaire have been assessed in this study, as it is the most frequently used questionnaire in prospective oral health-related quality of life assessment (49). Although the OHIP14 shows lower sensitivity in the edentulous patients than the OHIP-EDENT (50), it was preferred in this study, because the CD-RPD group had some anterior teeth left in the mandible and were not suitable for the OHIP-EDENT questionnaire.

No dvije godine nakon predaje proteza, OHRQoL i žvačna funkcija pogošlali su se (potvrđeno povećanjem ukupnog zbroja bodova upitnika) kod PP pacijenata i u skupini PP-DP. To se može pripisati problemima povezanim uz nošenje proteza (kao što su resorpcija preostalog alveolnog grebena, upali sluznice i/ili popuštanje proteza, 50 – 59). Bođovi u upitnicima CFQ i OHIP 14 nisu ovisili o položaju i broju preostalih retencijskih zuba u skupini PP-DP. Nasuprot ovim skupinama, ukupan zbroj bodova u OHIP-u 14 smašnjo se tijekom vremena, a zbroj bodova u CFQ-u značajno se smanjio u skupini PP-MDI. Pošto se i očekivalo, sve vrste terapija pokazale su značajne poboljšanja u kvaliteti života u odnosu na prethodne obilježja u skupini PP-DP. Jedno avtorstvo istaklo je da je OHIP14 nakon terapije zabilježen u skupini PP-MDI, negoli u skupini PP-DP, što se dodatno može pripisati i estetskim razlozima (vidljivost kvačica u skupini PP-DP), a ne samo samoprocjeni žvačne funkcije u skupini PP-MDI.

Kako se i očekivalo, sve vrste terapija pokazale su značajne učinke koji su potvrđeni znatnim smanjenjem ukupnog zbroja bodova nakon terapije. No u ovom istraživanju dokazana je veća dobrobit PP-MDI terapije, uključujući i žvačnu funkciju i kvalitetu života, u usporedbi sa skupinama PP i PP-DP. Ustanovio se da je skupina PP-DP imala kvačice koje povećavaju retenciju i stabilizaciju proteza, a skupina PP-MDI pokazala je značajno bolju mogućnost žvakanja nakon terapije, vjerojatno zbog bolje retencije i stabilizacije donjih proteza koje su bile osigurane retencijskim matricama, tzv. O princeznom. Ova je retencija bolja negoli retencija i stabilizacija kvačica na preostalim zubima u skupini PP-DP, bez obzira na to koliko je bilo retencijskih zuba (tri, četiri ili pet) ili kako su bili raspoređeni u uljepšaju. Stanje preostalih zuba nisu utjecalo na rezultat. Značajno veći zbroj bodova u upitniku OHIP nakon terapije zabilježen je u skupini PP-MDI, negoli u skupini PP-DP, što se dodatno može pripisati i estetskim razlozima (vidljivost kvačica u skupini PP-DP), a ne samo samoprocjeni žvačne funkcije u skupini PP-MDI.

U ovom istraživanju dobiveni za OHRQoL slični su rezultatima drugih autora koji su ustanovili da zadovoljstvo pacijenata pokriva protezama retiniranim minimalnim implantatima postoji tijekom godina (2, 13, 22). U ovom istraživanju dokazana je veća dobrobit PP-MDI terapije, uključujući i žvačnu funkciju, kvalitetu života i samopouzdanje pacijenata. U ovom istraživanju, dokazana je veća dobrobit PP-MDI terapije, uključujući i žvačnu funkciju, kvalitetu života i samopouzdanje pacijenata.
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Conclusions

Patients receiving mandibular overdentures retained by mini dental implants showed the highest improvement of OHRQoL and chewing function, consistent and even improved over the period of 2 years in comparison to patients who received a complete mandibular denture or a long saddle clasp retained Kennedy class I partial removable denture on slightly mobile anterior teeth.

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Conflict of interest

The authors report no conflict of interest.
Sazetak
Srvoja: Željelo se procijeniti žvačnu funkciju i kvalitetu života ovisnu o oralnom zdravlju (OHRQoL) pacijenata nakon različitih vrsta protetičke terapije u mandibuli. Cilj: korištenje djelemičnih proteza dugogodišnjih sedala (skupina PP-DP), potpunih proteza (skupina PP) ili potpunih pokrovnih proteza retiniranih na minidentalnim implantatima (skupina PP-MDI). Na početku terapije svi su pacijenti imali pomoćno samo donje prednje zube (1 mm ili >), a stražnja regija donje čeljusti bila je bezuba. Pacijenti su bili potpuno bezbojni u gornjoj čeljusti. Nakon terapije svi su povrati na kontrolni pregled i to tri mjesece nakon protetičke rehabilitacije (razdoblje prilagodbe) a zato ispitivane u skupini PP. Nakon terapije, OHRQoL je bio značajno bolji u skupini PP-MDI u odnosu prema skupini PP (p < 0,01). Nakon dvije godine žvačna funkcija u skupini PP-MDI još se dodatno značajno poboljšala, a pogoršanje je utvrđeno u skupinama PP i PP-DP (p < 0,01). Isti rezultati zabilježeni su i za OHRQoL. Najveći broj reparatur proteza i dodatnih prilagodbi obavijen je u skupini PP-DP. Zaključak: U zaključku, protetička rehabilitacija pokrivenih protezama koje su retinirane minidentalnim implantatima može se smatrati boljom terapijskim opcijom, uz trajno poboljšanje OHRQoL-a i žvačne funkcije, u odnosu prema primerima donje pomalo pokrivenih protezama na preostalim pomoćnim prednjim zubima.

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