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Implantati širokog promjera u transplantiranoj homolognoj kosti

Wide Diameter Implants Inserted in Jaws Grafted with Homologue Bone

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Sažetak

Svrha rada: Posljednjih deset godina povećala se uporaba implantata širokog promjera (WDI-a), posebice u lateralnim dijelovima čeljusti, uglavnom zbog dobrih kliničkih rezultata. No, malo je opisanih postupaka te objavljenih radova i ni jedan se ne bavi WDI-ma ugrađenima u transplantate homologne svježe zamrznute kosti (FFB-e). Zato smo obavili i retrospektivno istraživanje na nizu WDI-a postavljenih u homologne FFB-e, kako bismo ispitali kliničke rezultate. **Materijal i metode**: Ukupnom broju od 49 pacijenata ugrađeno je 126 WDI-a. Njih 35 imalo je dvostruko jetkanu površinu, 5 SLA_1 površinu, 9 je bilo poprečno pjeskareno i jetkano kiselinom, 44 anodno oksidirano, 19 pjeskareno s $CaPO_4$, 10 SLA_2 površinu, a 4 su usatka imala neku drugu površinu. **Rezultati:** Samo jedan implantat bio je izgubljen (tj. SVR = 99,2%), a nije bilo razlike ni u ispitivanim varijablama. S druge strane, Coxova regresija pokazala je da su vrsta implantata (tj. dvostruko jetkana površina, površina pjeskarena $CaPO_4$ i SLA_2 površina) te njegova dužina (manja od 13 mm) u statistički znatnoj korelaciji s manjim gubitkom krestalne kosti, a time se omogućuje i bolji klinički ishod. **Zaključak:** Upotreba WDI-a u homolognom FFB-u može biti prihvatljiv način liječenja te može osigurati i neka poboljšanja, posebice u lateralnim dijelovima čeljusti za različita protetska rješenja poduprta usadcima.

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Uvod

Posljednjih deset godina povećala se uporaba implantata širokog promjera (engl. wide diameter implants - WDI, tj. implantata promjera većeg od 3,75 mm) i to osobito u posteriornim dijelovima čeljusti zbog toga što je općenito prihvaćeno da WDI-i:

1) poboljšavaju mogućnost distalnih implantata tolerancije okluzalnih sila;
2) stvaraju širu bazu za odgovarajući protetski rad i

Introduction

In the last decade the use of wide diameter implants (WDI, i.e. diameter › 3.75 mm) has increased especially in posterior jaws because it is generally accepted that WDI: 1- improve the ability of posterior implants to tollerate occlusal forces, 2- create a wider base for proper prosthesis, and 3– avoid placing two standard-size implants (SSI = 3.75 mm) at one site to obtain a double-root prosthetic tooth (1-15).

3) izbjegava se postavljanje dvaju implantata standardne veličine (3,75 mm) na mjesto jednog zuba kako bi se dobila protetska jedinica s dvama korijenima. (1-15).

Klinički ishod WDI-a ispitivan je prema stopi preživljavanja (engl. survival rate - SVR, tj. implantati u kosti na kraju razdoblja praćenja), ili kada je SVR bio previsok da bi se mogla otkriti statistička razlika među ispitivanim varijablama prema stopi uspjeha (engl. success rate - SCR) koja analizira varijable kao gubitak periimplantatne kosti, dubinu džepa, vrijednosti indeksa plaka i indeksa krvarenja (1-10).

Iako su dobri klinički rezultati opisani (15), nisu još ispitani WDI-i postavljeni u homolognu svježe smrznutu kost (engl. fresh frozen bone - FFB).

FFB ima nekoliko prednosti - ne zahtijeva drugi kirurški zahvat za uzimanje transplantata, ima ga u dovoljnoj količini i jeftiniji je od biomaterijala (16,17).

Alotransplantacija kosti na ljudima obavlja se već više od stotinu godina, a sve se češće koristi u ortopediji (18) za rekonstrukciju ligamenata i artikulacijskih površina (19).

Danas su dostupni mnogobrojni oblici koštanih alotransplantata, ponajprije FFB-a, suho zamrznute kosti (engl. freeze-dried bone - FDB) te demineralizirane svježe zamrznute kosti (engl. demineralized fresh frozen bone - DFDB). Svako od tih tkiva rizično je te ima jedinstvena ograničenja, postupke i načine uporabe. Njihova pravilna uporaba zahtijeva znanje o svojstvu materijala, ali i jamstvo da banka kostiju daje siguran i sterilan materijal (20).

Kad je riječ o upotrebi FFB-a u oralnoj i maksilofacijalnoj kirurgiji, postoji samo nekoliko radova o toj temi. Perrot (21) se njime godine 1992. koristio u kombinaciji s autolognom kosti s creste iliaca radi nadomještanja atrofične čeljusti, te samostalno u dvama slučajevima odontogenih tumora donje čeljusti. Ishod je bio - nakon protetske opskrbe - stopa preživljavanja od 95,8% (1 implantat od njih 29 bio je izgubljen). Rochanawutanon (22) je godine 2002. opisao uporabu FFB-a nakon velikih resekcija donje čeljusti u četirima slučajevima praćenima više od 12 godina.

D'Aloja i suradnici (2008.) pisali su o uporabi FFB-a kod nekoliko pacijenata kod kojih su postignuti dobri klinički rezultati.

Budući da nema radova koji specifično opisuju klinički ishod WDI-a postavljenih u FFB, odlučili smo se na retrospektivno istraživanje 126 WDI-a postavljenih u FFB transplantate.

WDI clinical outcome has been studied in terms of survival rate (SVR i.e. implants still inserted at the end of the follow-up) or, when the SVR was too high to detect any statistical differences among the studied variables, in terms of success rate (SCR) by analyzing variables like peri-implant bone loss, pocket depth, Plaque Index values and Bleeding Index values (1-10).

Although good clinical outcomes have been reported (15), especially years, there are no studies on WDI inserted in homologuous fresh frozen bone (i.e. FFB).

FFB has several advantages: it does not need secondary surgery for graft retrieval, it is available in the required amount, and it is cheaper with respect to biomaterials (16, 17).

Bone allograft transplantation has been performed in humans for more than one hundred years and is being used in increasing numbers by orthopedic surgeons (18) also for ligament reconstruction, meniscal transplantation, and articular surface reconstruction (19).

Many forms of banked bone allograft are available to the surgeon. Among the grafts available are fresh-frozen bone (FFB), freeze-dried bone (FDB), and demineralized fresh dried bone (DFDB). Each one of these grafts carries risks and has unique limitations and handling properties. In order to use these materials appropriately, the surgeon must be familiar with the properties of each and must feel confident that the bone bank providing the graft is supplying a safe and sterile graft (20).

Regarding the use of FFB in Oral and Maxillo-Facial surgery, only few articles are available in literature: in 1992 Perrot (21) used it in combination with autologous bone from the iliac crest to restore atrophic jaws and alone in two cases of odontogenic tumors of the mandible: his outcome was, after prosthetic restoration, a survival rate of 95,8% (1 implant lost over 29). In 2002 Rochanawutanon (22) demonstrated that even after the resectioning of big portions of the mandible the FFB can be used: he reported 4 cases with a follow-up of over 12 years.

In 2008, D'Aloja e coll. (23) reported some patients tretaed with FFB which achieved good clinical results.

Since no report specifically focus on the clinical outcome of WDI inserted in FFB, we therefore decided to perform a retrospective study on 126 WDI placed in FFB grafts.

Materijal i metode

Pacijenti

U razdoblju od prosinca 2003. do prosinca 2006., u Općoj bolnici u Castelvenetu u Italiji, kod 184 pacijenta provedena je augmentacija kosti FFB-om. Od toga broja 81 pacijent (52 žene i 29 muškaraca) prosječne dobi od 52 godine, bio je određen za retrospektivno istraživanje, uglavnom zbog nedostatka kompletnih podataka. Od toga je 49 njih (33 žene i 19 muškaraca) prosječne dobi od 52 godine uključeno u istraživanje, budući da su im postavljeni WDI-i. Informirani pristanak odobrilo je lokalno Etičko povjerenstvo, a potpisali su ga i svi pacijenti kako bi se njihovi podaci mogli koristiti u znanstvene svrhe. Posljednji pregledi obavljeni su u studenome godine 2007. Prosječno vrijeme praćenja iznosilo je 26 mjeseci, u razmaku od 2 do 47 mjeseci.

Homologni FFB-i bili su postavljeni u općoj anesteziji. Prosječno razdoblje od augmentacije do postavljanja usadaka iznosilo je 6 mjeseci, a definitivni protetski rad stavljen je nakon dodatnih 6 mjeseci.

Ispitanici su izabrani na temelju sljedećih kriterija: kontrolirana oralna higijena; odsutnost bilo kakvih lezija u usnoj šupljini; zadovoljavajući rezidualni volumen kosti (autologna i FFB) koji može primiti implantate promjera od 4,0 mm i više te dužine od 7,0 mm i duže.

Pacijenti su dodatno morali pristati na to da sudjeluju u postoperativnom programu praćenja.

Kriteriji za isključivanje bili su: nedovoljan volumen kosti; teški bruksizam; pušenje više od 20 cigareta na dan; pretjerano pijenje alkohola; lokalizirano zračenje područja usne šupljine; antitumorska kemoterapija; bolesti jetre, bubrega ili krvi; imunosuprimirani pacijenti i pacijenti na kortikosteroidnoj terapiji; trudnice; upale i autoimune bolesti usne šupljine te loša oralna higijena.

Augmentacijski materijal

FFB je dobiven iz Tkivne banke u Venetu (Italija), a riječ je o mineraliziranoj, neozračenoj, samo dezinficiranoj zamrznutoj homolognoj kosti. Bilo kakvi rizični čimbenici, kao što su zarazne bolesti, neoplazme, reumatske i/ili degenerativne bolesti te sepse, kod donora nisu prihvatljivi. Kost se uzima s prednjeg ili stražnjeg ilijačnog grebena, tijekom prvih 12 sati nakon smrti. Kost se zatim dezinficira najmanje 72 sata na temperaturi od -4°C u polikemoterapeutskoj otopini vakomicina, polimiksina, glazidina i linkomicina, a zatim se uzorak uranja

Materials and Methods

A) Patients

In the period between December 2003 and December 2006, 184 patients were grafted with homologuous FFB at the Civil Hospital, Castelfranco Veneto, Italy. Out of them, 81 patients (52 females and 29 males) with a median age of 52 years were eligible for a retrospective study because of a lack in the data set. Among them, 49 patients (33 females and 16 males) with a median age of 52 years are included in the present study because they had WDI inserted. Informed written consent approved by the local Ethics Committee was obtained from all patients to use their data for research purpose. The last check-up was performed in November 2007, with a mean follow-up of 26 months ranging from 2 to 47 months.

Homologuous FFB were grafted in patient's jaws under general anesthesia. Usually the mean post-grafting period was 6 months before implant surgery and the final prosthetic restoration was delivered after an additional 6 months.

Subjects were screened according to the following inclusion criteria: controlled oral hygiene, the absence of any lesions in the oral cavity, sufficient residual bone volume (autologous plus FFB graft) in order to receive implants of at least 4.0 mm in diameter and 7.0 mm in length; in addition, the patients had to agree to participate in a post-operative check-up program.

The exclusion criteria were as follows: insufficient bone volume, a high degree of bruxism, smoking more than 20 cigarettes/day and excessive consumption of alcohol, localized radiation therapy of the oral cavity, antitumor chemotherapy, liver, blood and kidney diseases, immunosupressed patients, patients taking corticosteroids, pregnant women, inflammatory and autoimmune diseases of the oral cavity, poor oral hygiene.

B) Graft material

The FFB - obtained from the Veneto Tissue Bank in Treviso (Italy) - is a mineralized, non-irradiated (only disinfected), and frozen homologuous bone. The presence of risk factors such as contagious disease, neoplasm, rheumatical and/or degenerative disease and sepsis necessarily disqualifies the donor. The bone harvesting is obtained from the anterior and posterior iliac crest, in the first 12 hours after donor death. The bone is then disinfected, for at least 72 hours at -4°C, in a polychemotherapeutic solution of vancomycine, polymyxine, glazidine

u sterilnu fiziološku otopinu. Nakon toga se reže u kortiko-medularne blokove, stavlja u dvostruko sterilno pakiranje i zamrzava na -80°C.

Prikupljanje podataka

Prije operativnog zahvata bio je obavljen radiološki pregled ortopantomogramom i CT-skenerom.

Kod svakog su se pacijenta kalibriranim ortopantomogramom procjenjivale razine grebena periimplantne kosti. Mjerenja su obavljena prije operativnog zahvata, nakon njega te na kraju razdoblja praćenja i to mezijalno i distalno od svakog implantata. Izračunana je udaljenost od ruba implantata do najkoronalnije točke kontakta implantata i kosti. Razina kosti, zabilježena odmah nakon postavljanja implantata, bila je referentna za svako sljedeće mjerenje. Mjerenja su se zaokruživala na najbližih 0,1 mm, a koristilo se povećalo sa sedmerostrukim povećanjem i mjerilom stupnjevanim na 0,1 mm.

Periimplantatno sondiranje nije bilo obavljeno zbog kontroverzija u vezi s korelacijom dubine sondiranja i stope uspješnosti implantata (24,25).

Stopa uspješnosti implantata (SCR) određivala se na temelju sljedećih kriterija:

1) odsutnosti boli ili disestezije,
2) odsutnosti periimplantatne infekcije sa supuracijom;
3) odsutnosti mobilnosti implantata;
4) odsutnosti stalne resorpcije periimplantatne kosti veće od 1,5 mm tijekom prve godine opterećenja te manje od 0,2 mm tijekom sljedećih godina (26).

Implantati

Ukupno je ugrađeno 126 WDI-a u čeljusti 49 pacijenata – u gornju 24 (19%), a u donju 102 (81%). Od toga je 35 implantata (27,8%) bilo dvostruko jetkano (3i Implants, Biomet Inc., SAD), 5 (4%) s površinom SLA_1 (Astra Implants, Astratech Inc., Švedska), 9 (7,1%) poprečno pjeskareno i jetkano kiselinom (Frialit, Friadent, Dentsply Inc., SAD), 44 (34,9%) anodno oksidirano (Nobel Biocare Implants, Nobelbiocare Inc., Švedska), 19 (15,1%) pjeskareno s $CaPO_4$ (RBM Implants, Lifecore Biomedical Inc., SAD), 10 (7,9%) s površinom SLA_2 (Sweden & Martina, Sweden & Martina SpA, Italija), a 4 (3,2%) neke druge vrste. Promjer i dužina usadaka varirali su od 4 do 5 milimetara, te od 7 do 16 milimetara. Implantati su nadomještali 13 inciziva (10,3%), 4 kanina (3,2%), 46 premolara (36,5%) i 63 molara (50%).

and lincomycine, following this the sample is irrigated with a sterile saline solution. The sample is then subdivided into cortico-medullary blocks, packed in double sterile casing and frozen at -80°C.

C) Data collection

Before surgery, radiographic examinations were done with the use of orthopantomograph and CT scan.

In each patient, peri-implant crestal bone levels were evaluated by a calibrated examination of orthopantomograph x-rays. Measurements were recorded before surgery, after surgery and at the end of the follow-up period. The measurements were carried out mesially and distally to each implant, calculating the distance between the edge of the implant and the most coronal point of contact between the bone and the implant. The bone level recorded just after the surgical insertion of the implant was the reference point for the following measurements. The measurement was rounded off to the nearest 0.1 mm. A peak Scale Loupe with a magnifying factor of seven times and a scale graduated in 0.1 mm was used.

Peri-implant probing was not performed because controversy still exists regarding the correlation between probing depth and implant success rates (24,25).

The implant success rate (SCR) was evaluated according to the following criteria: 1- absence of persisting pain or dysesthesia; 2- absence of peri-implant infection with suppuration; 3- absence of mobility; and 4- absence of persisting peri-implant bone resorption greater than 1,5 mm during the first year of loading and 0,2 mm/years during the following years (26).

D) Implants

In 49 patients a total of 126 WDIs were inserted: 24 (19%) in the mandible and 102 (81%) in the maxilla. There were 35 (27,8%) Double etched (3i implants, Biomet Inc.,US), 5 (4,0%) SLA_1 (Astra implants, Astratech Inc., US), 9 (7,1%) Grit blasted and acid etched (Frialit implants, Friadent, Dentsply Inc., US), 44 (34,9%) Anodic Oxidized (Nobel Biocare implants, TiUnite, Nobelbiocare Inc., US), 19 (15,1%) $CaPo_4$ ceramic-blasted (RBM implants, Lifecore Biomedical Inc., US), 10 (7,9%) SLA_2 (Sweden & Martina, Sweden & Martina Spa, IT), and 4 (3,2%) of other types. Implant diameter and length ranged from 4.0 to 5.0 mm and from 7.0 to 16 mm, respectively. Implants were inserted to replace 13 incisor (10.3%), 4 cuspids (3.2%), 46 premolars (36.5%) and 63 molars (50.0%).

Kirurški i protetski postupak

Svi pacijenti operirani su prema istom protokolu. Antimikrobna profilaksa provedena je s 500 mg amoksicilina dva puta na dan tijekom pet dana, a počela je jedan sat prije operacije. Lokalna anestezija bila je obavljena inflitracijom artikaina/epinefrina, a poslijeoperativna analgezija sa 100 mg nimesulida dva puta na dan tijekom tri dana. Osigurana je bila i pravilna oralna higijena.

Nakon incizije bio je po vrhu grebena odignut mukoperiostalni režanj, a implantat je postavljen u razinu kosti. Šavovi su uklonjeni 14 dana nakon operacije. Nakon 24 tjedna od ugradnje implantata izrađen je privremeni protetski nadomjestak, a konačni u sklopu dodatnih 8 tjedana. Broj protetskih jedinica (odnos krunica i implantata) iznosio je oko 0,75. Svi pacijenti bili su uključeni u strogi program kontrolnih higijenskih pregleda.

Statistička analiza

Budući da je bio izgubljen samo jedan implantat od 126 (SVR = 99,2%) te kako nije bilo statistički znatnih razlika među ispitivanim varijablama, smatra se da je izostanak ili smanjena resorpcija kosti indikator SCR-a za procjenu učinka nekoliko čimbenika u vezi s domaćinom, implantatima i okluzijom.

Razlike u nadogradnjama i implantatima te u razini kosti definirane su kao spoj implantata i nadogradnje (engl. Implant Abutment Junction - IAJ), a računale su se u trenutku operacije te tijekom praćenja. Delta IAJ je razlika između vrijednosti IAJ-a na posljednjoj kontroli i u trenutku kad se postavljaju implantati. Delta IAJ medijani su stratificirani prema varijablama od interesa.

Krivulje preživljavanja specifične za bolest računale su se prema Kaplan-Meierovu algoritmu, prema metodi limita produkta (27). Nulta točka bio je dan kada je implantat postavljen. Usadci koji su još bili na svojim mjestima uključeni su u zbirni broj za rizik od gubitka samo do posljednjeg kontrolnog pregleda. Zato se stopa preživljavanja mijenjala samo ako se dogodio gubitak implantata. Izračunana stopa preživljavanja bila je maksimum procjene stvarne krivulje preživljavanja. Testiranje prema rangu korišteno je za usporedbu krivulja preživljavanja, a generirano je stratifikacijom prema varijablama od interesa.

Coxova regresijska analiza primijenjena je da bi se odredio pojedinačni doprinos suvarijanti na stopu

E) Surgical and prosthetic technique

All patients underwent the same surgical protocol. An antimicrobial prophylaxis was administered with 500 mg Amoxycillin twice daily for 5 days starting 1 hour before surgery. Local anesthesia was induced by infiltration with articaine/epinephrine and post-surgical analgesic treatment was performed with 100 mg Nimesulid twice daily for 3 days. Oral hygiene instructions were provided.

After making a crestal incision a mucoperiosteal flap was elevated. Implants were inserted according to the procedures recommended. The implant platform was positioned at the alveolar crest level. Sutures were removed 14 days after surgery. After 24 weeks from implant insertion, the provisional prosthesis was provided and the final restoration was usually delivered within an additional 8 weeks. The number of prosthetic units (i.e. implant/crown ratio) was about 0.75. All patients were included in a strict hygiene recall.

F) Statistical Analysis

Since only 1 in 126 implants were lost (i.e. SVR = 99.2%) and no statistical differences were detected among the studied variables, no or reduced crestal bone resorption was considered as an indicator of SCR to evaluate the effect of several host-, implants-, and occlusion-related factors.

The differences between the implant abutment junction and the bone crestal level was defined as Implant Abutment Junction (IAJ) and calculated at the time of operation and during follow-up. Delta IAJ is the difference between IAJ at the last check-up and IAJ recorded just after the operation. Delta IAJ medians were stratified according to the variables of interest.

Disease-specific survival curves were calculated according to the product-limit method (Kaplan-Meier algorithm) (27). Time zero was defined as the date of the insertion of the implant. Implants which are still in place were included in the total number at risk of loss only up to the time of their last follow-up. Therefore, the survival rate only changed when implant loss occurred. The calculated survival rate was the maximum estimate of the true survival curve. Log rank testing was used to compare survival curves, generated by stratifications for a variable of interest.

Cox regression analysis was then applied to determine the single contribution of covariates on survival rate. Cox regression analysis compares survival data while taking into account the statistical value

preživljavanja. Ona uspoređuje podatke o preživljavanju i uključuje statističke vrijednosti nezavisnih varijabli, kao što su dob i spol te činjenicu hoće li se ili neće dogoditi gubitak implantata. Ako je povezana vjerojatnost manja od 5% (p<0,05), razlika se smatra statistički znatnom. U procesu regresijske analize izračunani su omjer rizika i 95-postotni interval pouzdanosti, no nije morao uključivati vrijednost „1“ (28). Postupna Coxova analiza omogućila nam je otkrivanje varijabli najpovezanijih s preživljavanjem i/ili uspjehom implantata.

Rezultati

Tablice od 1. do 7. opisuju medijane delta IAJ-a prema ispitivanim varijablama.

Jedan je implantat izgubljen tijekom poslijeoperativnog razdoblja (u sklopu tri mjeseca), a u Tablici 7. dane su njegove karakteristike.

Kaplan-Meierov algoritam pokazuje da su duljina implantata (rang = 7,09, df=2, p=0,03) i vrsta implantata (rang=14,88, df=6, p=0,02) bili statistički različiti.

Tablica 8. pokazuje da su vrsta implantata (dvostruko jetkani, pjeskareni $CaPO_4$ te SLA_2) i njegova dužina (dužina < 13 mm, Tablica 3.) u korelaciji sa statistički znatno nižim delta IAJ-om (tj. smanjenim gubitkom krestalne kosti), a time i boljim kliničkim ishodom. Nije bilo razlika između fiksnih i mobilnih protetskih nadomjestaka, ali s neopterećenim usadcima postižu se bolji rezultati (Tablica 6.).

of independent variables, such as age and sex, on whether or not an event (i.e. implant loss) is likely to occur. If the associated probability was less then 5% (p<.05), the difference was considered statistically significant. In the process of doing the regression analysis, odds ratio and 95% confidence bounds were calculated. Confidence bounds did not have to include the value «1» (28). Stepwise Cox analysis allowed us to detect the variables most associated with implant survival and/or success.

Results

Table 1 to 7 report the median delta IAJ according to the studied variables.

One implant was lost in the post-operative period (within 3 months) and Table 7 describes its characteristics.

Kaplan Meier algorithm demonstrates that implant length (Log rank=7.09 df=2 p=0.03) and implant type (Log rank=14.88 df=6 p=0.02) were statistically different.

Table 8 showed that implant type (i.e. double etched, $CaPo_4$ ceramic-blasted and SLA_2; Table 5) and implant length (i.e. length < 13 mm; Table 3) correlated with a statistically significant lower delta IAJ (i.e. reduced crestal bone loss) and thus a better clinical outcome. No differences were detected between fixed and removable prosthetic restoration but unloaded implants have a better outcome (Table 6).

Tablica 1. Distribucija s obzirom na mjesto augmentacije i delta IAJ
Table 1 Distribution of series as regards graft site and delta IAJ

Mjesto augmentacije • Graft Site	N	Medijan • Median
Mandibula • Mandible	24	2.2
Maksila • Maxilla	102	2.0

Tablica 2. Distibucija s obzirom na mjesto implantata i delta IAJ
Table 2 Distribution of series as regards implant site and delta IAJ

Mjesto implantacije • Implant Site	N	Medijan • Median
Sjekutići • Incisors	13	2.1
Očnjaci • Cuspids	4	1.4
Premolari • Premolars	46	1.9
Molari • Molars	63	2.3

Tablica 3. Distribucija s obzirom na dužinu implantata i delta IAJ
Table 3 Distribution of series as regards implant length and delta IAJ

Duljjina implantata • Implant Length	N	Medijan • Median
Kratki • Short (<13mm)	17	1.6
Standardni • Standard (13mm)	74	2.2
Dugi • Long (>13mm)	35	2.5

Tablica 4. Distribucija s obzirom na promjer implantata i delta IAJ
Table 4 Distribution of series as regards implant diameter and delta IAJ

Promjer implantata • Implant Diameter	N	Medijan • Median
4mm	83	2.1
4mm	43	2.1

Tablica 5. Distribucija s obzirom na tip implantata i delta IAJ
Table 5 Distribution of series as regards implant type and delta IAJ

Vrsta implantata • Implant Type	N	Median
Dvostruko jetkan • Double etched	35	1.8
SLA_1	5	2.9
Pjeskaren i jetkan • Grit blasted and acid etched	9	4.9
Anodno oksidiran • Anodic oxidized	44	2.0
Pjeskaren s kalcij-fosfatom • $CaPo_4$ ceramic-blasted	19	1.7
SLA_2	10	1.1
Druge vrste • Others	4	2.6

Tablica 6. Distribucija s obzirom na protetski nadomjestak i delta IAJ
Table 6 Distribution of series as regards prosthetic restoration and delta IAJ

Vrsta nadomjeska • Prosthetic Type	N	Median
Nema • None	11	1.4
Fiksne proteze • Fixed prosthesis	94	2.2
Mobilne proteze • Removable dentures	21	2.0

Tablica 7. Neoseointegrirani implantat
Table 7 Failed Implant

Promjer implantata • ImplantDiameter	Duljina implantata • Implant Length	Mjesto augmentacije • Grafted Site	Mjesto implantacije • Implant Site	Vrsta implantata • Implant Type	Mjeseci nakon implantacije • N° months post implant insertion	Proteza • Prosthesis
4,3	13	Maxilla	26	Anodic Oxidized	1	None

Tablica 8. Rezultat Coxove regresije koji prikazuje varijable povezane s delta IAJ-om tijekom izračuna delta IAJ-a (SCR-a).
Table 8 Output of the Cox regression reporting the variables associated statistically with delta IAJ by evaluating delta IAJ (i.e. SCR)

Varijabla • Variable	B	S.E.	Značajnost • Significance (P<0.05)	Interval pouzdanosti • 95% Confidence Interval	
				Donji • Lower	Gornji • Upper
Dob • Age	0.0319	0.0228	0.1617	0.9873	1.0796
Spol • Gender	-0.192	0.4173	0.9633	0.4330	2.2225
Mjesto augmentacije • Graft Site	0.6477	0.4952	0.1909	0.7240	5.0444
Mjesto implantacije • Implant Site	-0.2710	0.2351	0.2490	0.4811	1.2089
Duljina implantata • Implant Length	1.1180	0.3313	0.0007	1.5980	5.8549
Promjer implantata • Implant Diameter	0.0833	0.4238	0.8441	0.4737	2.4942
Vrsta implantata • Implant Type	-0.2904	0.1319	0.0277	0.5775	0.9686
Vrsta nadomjeska • Type of restoration	-1.3917	0.4887	0.0044	0.0954	0.6480

Rasprava

WDI su indicirani posebice u lateralnim dijelovima čeljusti zbog toga što je općenito prihvaćeno da oni:

1) poboljšavaju mogućnost distalnih implantata tolerancije okluzalnih sila,
2) stvaraju širu bazu za odgovarajući protetski rad i
3) izbjegava se postavljanje dvaju implantata standardne veličine (3,75 mm) na mjesto jednog zuba kako bi se dobila protetska jedinica s dvama korijenima.

WDI-i osiguravaju širu vezu s potpornom kosti koja je jača od one kod implantata standardnog promjera, smanjuju opasnosti od frakture vijka, a kod

Discussion

WDI are indicated especially in posterior jaws because it is generally accepted that WDI 1- improve the ability of posterior implants to tollerate occlusal forces, 2- create a wider base for proper prosthesis, and 3– avoid placing two standard-size implants (SSI = 3.75 mm) at one site to obtain a double-root prosthetic tooth. WDI provide a greater interface with supporting bone, that are stronger then SSI, reduce the risk of screw fracture, and when prosthetic components match the increased diameter of the implant, they may also lead to better esthetics, optimal emergence profiles, and improved oral hygiene. Initially used as rescue implants (1), WDI have become the first choice in clinical situa-

protetske komponente odgovaraju većem promjeru implantata. Oni također mogu poboljšati estetski izgled, osigurati optimalni izlazni profil i poboljšati obavljanje oralne higijene. Na početku korišteni za spašavanje kosti loše kvalitete (1), WDI-i su postali implantati prvog izbora u kliničkim situacijama kao što su ekstrakcijski slučajevi, kost loše kvalitete, ograničena visina, bruksizam te privjesci (2-10).

Dosad je tiskano nekoliko radova o istraživanju WDI-a u kojima je istaknuta povoljna stopa preživljavanja kod dvofaznih postupaka - više od 97% (2,7-10). No, nekoliko autora (3-5) objavilo je manje optimistične rezultate. Aparicio i Orozco (3) opisali su globalni SVR od oko 90% na 94 WDI-ja sa srednjim vremenom praćenja od 33 mjeseca nakon izrade protetskog rada. Slične rezultate dobili su Renouard i suradnici (4) – oni su analizirali 98 WDI-a s SVR-om od 91,8%, a Ivanoff i njegovi kolege (5) dobili su slabije rezultate (97 WDI-a tijekom petogodišnjeg praćenja i SVR od 82%). Branemark i suradnici opisali su 150 imedijatno opterećenih WDI-a sa SVR-om od 98%.

U ovom smo radu opisali rezultate 126 WDI-a postavljenih u FFB, s gubitkom samo jednog implantata tijekom srednjeg vremena praćenja od 26 mjeseci (SVR=99,2%).

Budući da nije bilo statistički većih razlika između ispitivanih varijabli kod korištenja SVR-a, izostanak ili smanjena resorpcija kosti smatrali su se indikatorom SCR-a u procjeni nekoliko varijabli.

Općenito, dužina (Tablica 3.), vrsta (Tablica 5.) i promjer (Tablica 4.) implantata smatraju se relevantnim čimbenicima. U našoj skupini koristili su se različiti SCR-i s obzirom na dužinu i vrstu (vidi Tablicu 8.), i to s boljim rezultatom s obzirom na smanjenu resorpciju krestalne kosti tijekom vremena za kraće implantate (tj. duljinu <13 mm u usporedbi s dužinom ≥13 mm) i specifične implantate (dvostruko jetkane, pjeskarene $CaPO_4$ i SLA_2). Općenito ne iznenađuje činjenica da se s kratkim WDI-om postiže dobar rezultat, s obzirom na to da su Griffin i Cheung opisali 100-postotni SVR (10). Branemark i suradnici (6) također su imali vrlo visok SVR (98%) u skupini od 150 imedijatno opterećenih WDI-a.

Kvaliteta kosti, čimbenik povezan s domaćinom, smatra se najjačim prediktorom ishoda kod imedijatnog opterećenja. Dobro je poznato da donja čeljust (osobito intraforaminalno područje) ima kost bolje kvalitete od gornje čeljusti, pa je to razlog zašto nekoliko dostupnih radova o temi presudne okluzalne procedure (imedijatnog opterećenja) implantata u donjoj čeljusti ima visok SVR (29-31). U ovom se istra-

tions such as extraction site, poor-quality bone, limited crestal height, bruxers, and cantilevers (2-10).

Several medium-term studies on WDI have been published, demonstrating favourable survival rates with two-stage procedures (over 97%) (2,7-10). However, several authors (3-5) have reported less optimistic results. Aparicio and Orozco (3) reported a global SVR of about 90% on 94 WDI with a mean post-loading follow-up of 33 months. Similar results were reported by Renouard and coll.(4) (which analyzed 98 WDI with a SVR = 91.8%) whereas lower values were reported by Ivanoff and al. (5) (who studied 97 WDI with a 5-year follow-up and a SVR = 82%). Branemark et al. (6) presented 150 immediate loaded WDI with a SVR = 98%.

In this article we have reported a series of 126 WDI inserted in FFB with only 1 implant lost during a mean follow-up of 26 months (SVR = 99.2%).

Since no statistical differences were detected among the studied variables by using the SVR, no or reduced crestal bone resorption was considered as an indicator of SCR to evaluate the effect of several variables.

In general, length (Table 3), type (Table 5), and diameter (Table 4) are considered to be relevant implant-related factors. In our series, we found a different SCR according to length and type (see Table 8) with a better outcome as regards reduced crestal bone loss over time for shorter implants (i.e. length < 13 mm vs. length ≥ 13 mm) and specific implants (i.e. Double etched, $CaPo_4$ ceramic-blasted, and SLA_2). In general, the fact that short WDI have a good outcome is not surprising since Griffin and Cheung reported a 100% SVR (10). Also Branemark et al. (6) had a very high SVR (=98%) in a series of 150 immediate loaded WDI.

Bone quality, a host-related factor, is believed to be the strongest predictor of outcome in immediate loading. It is well known that the mandible (especially the interforaminal region) has a better bone quality than the maxilla, and this fact is probably the reason why several reports are available regarding a critical occlusal procedure (i.e. immediately loaded) of implants inserted in the mandible with a high SVR (29-31). In this study, FFB is a good recipient for dental implanting as only one fixture was lost. In addition no statistically significant differences were found among different graft sites (see Table 1) and implant sites (see Table 2).

The fact that WDIs can tollerate occlusal forces better than standard diameter implants was reported recently in finite element analysis and clinical studies (32-36).Our results also demonstrated that

živanju pokazalo da je FFB dobar primatelj implantata, budući da je bio izgubljen samo jedan usadak. Dodatno nije bilo nikakve statistički znatne razlike između različitih mjesta augmentacije (vidi Tablicu 1.) i lokalizacije implantata (vidi Tablicu 2.).

Činjenica da WDI-i mogu podnijeti okluzalno opterećenje bolje od implantata standardnog promjera, nedavno je potvrđena analizom konačnih elemenata i kliničkim istraživanjima (32-36). Naši rezultati također su pokazali da i fiksni i mobilni protetski radovi imaju slične kliničke ishode (vidi Tablicu 6.). Nije bilo razlika između fiksnih i mobilnih protetskih nadomjestaka, ali neopterećeni implantati imali su bolje rezultate (Tablica 6.).

Zaključak

Na kraju se može reći da su WDI-i u FFB-u predvidljivi kirurški postupak s visokim SVR-om i SCR-om i mogu se usporediti s onima opisanima za WDI –e postavljene u prirodnu kost.

Zahvale

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both fixed prostheses and removable dentures have a similar clinical outcome (see Table 6). No differences were detected between fixed and removable prosthetic restoration but unloaded implants have a better outcome (Table 6).

Conclusion

In conclusion, insertion of WDI in FFB is a predictable surgical procedure with high SVR and SCR which are comparable to those reported for WDI placed in native bone.

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Abstract

Objective of work: In the last decade the use of wide diameter implants (WDI) has increased especially in posterior jaws for their good clinical outcomes. However there are few reports on this topic and none on WDI inserted in homologue fresh frozen bone (FFB) grafts. Thus we planned a retrospective study on a series of WDI placed in homologuous FFB to evaluate the clinical outcome. **Materials and Methods**: 49 patients were operated on and 126 WDI inserted. There were 35 Double etched, 5 SLA_1, 9 Grit blasted and acid etched, 44 Anodic Oxidized, 19 $CaPo_4$ ceramic-blasted, 10 SLA_2, and 4 miscellaneous implants. **Results**: Only 1 over in 126 WDI was lost (i.e. SVR = 99.2%) and no differences were detected among the studied variables. On the contrary, the Cox regression showed that implant type (i.e. Double etched, $CaPo_4$ Ceramic-blasted, and SLA_2) and implant length (i.e. length < 13 mm) correlated with a statistically significant lower crestal bone loss and thus a better clinical outcome. **Conclusion**: The use of WDI inserted in homologuous FFB can be a viable treatment option and may provide benefits especially in posterior regions for the maintenance of various implant-supported prosthetic rehabilitations.

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References

1. Langer B, Langer L, Herrmann I, Jorneus L. The wide fixture: a solution for special bone situations and a rescue for the compromised implant. Part 1. Int J Oral Maxillofac Implants. 1993;8(4):400-8.
2. Bahat O, Handelsman M. Use of wide implants and double implants in the posterior jaw: a clinical report. Int J Oral Maxillofac Implants. 1996;11(3):379-86.
3. Aparicio C, Orozco P. Use of 5-mm-diameter implants: Periotest values related to a clinical and radiographic evaluation. Clin Oral Implants Res. 1998;9(6):398-406.
4. Renouard F, Arnoux JP, Sarment DP. Five-mm-diameter implants without a smooth surface collar: report on 98 consecutive placements. Int J Oral Maxillofac Implants. 1999;14(1):101-7.
5. Ivanoff CJ, Gröndahl K, Sennerby L, Bergström C, Lekholm U. Influence of variations in implant diameters: a 3- to 5-year retrospective clinical report. Int J Oral Maxillofac Implants. 1999;14(2):173-80.
6. Brånemark PI, Engstrand P, Ohrnell LO, Gröndahl K, Nilsson P, Hagberg K et al. Brånemark Novum: a new treatment concept for rehabilitation of the edentulous mandible. Preliminary results from a prospective clinical follow-up study. Clin Implant Dent Relat Res. 1999;1(1):2-16.

7. Khayat PG, Hallage PG, Toledo RA. An investigation of 131 consecutively placed wide screw-vent implants. Int J Oral Maxillofac Implants. 2001;16(6):827-32.
8. Friberg B, Ekestubbe A, Sennerby L. Clinical outcome of Brånemark System implants of various diameters: a retrospective study. Int J Oral Maxillofac Implants. 2002;17(5):671-7.
9. Krennmair G, Waldenberger O. Clinical analysis of wide-diameter frialit-2 implants. Int J Oral Maxillofac Implants. 2004;19(5):710-5.
10. Griffin TJ, Cheung WS. The use of short, wide implants in posterior areas with reduced bone height: a retrospective investigation. J Prosthet Dent. 2004;92(2):139-44.
11. Sato Y, Shindoi N, Hosokawa R, Tsuga K, Akagawa Y. A biomechanical effect of wide implant placement and offset placement of three implants in the posterior partially edentulous region. J Oral Rehabil. 2000;27(1):15-21.
12. Sato Y, Shindoi N, Hosokawa R, Tsuga K, Akagawa Y. Biomechanical effects of double or wide implants for single molar replacement in the posterior mandibular region. J Oral Rehabil. 2000;27(10):842-5.
13. Moscovitch M. Molar restorations supported by 2 implants: an alternative to wide implants. J Can Dent Assoc. 2001;67(9):535-9.
14. Huang HL, Lin CL, Ko CC, Chang CH, Hsu JT, Huang JS. Stress analysis of implant-supported partial prostheses in anisotropic mandibular bone: in-line versus offset placements of implants. J Oral Rehabil. 2006;33(7):501-8.
15. Degidi M, Piattelli A, Iezzi G, Carinci F. Wide-diameter implants: analysis of clinical outcome of 304 fixtures. J Periodontol. 2007;78(1):52-8.
16. Vargel I, Tunçbilek G, Mavili E, Cila A, Ruacan S, Benli K et al. Solvent-dehydrated calvarial allografts in craniofacial surgery. Plast Reconstr Surg. 2004;114(2):298-306.
17. Gajiwala K, Lobo Gajiwala A. Use of banked tissue in plastic surgery. Cell Tissue Bank. 2003;4(2-4):141-6.
18. Tomford WW, Mankin HJ. Bone banking. Update on methods and materials. Orthop Clin North Am. 1999;30(4):565-70.
19. Vangsness CT Jr, Garcia IA, Mills CR, Kainer MA, Roberts MR, Moore TM. Allograft transplantation in the knee: tissue regulation, procurement, processing, and sterilization. Am J Sports Med. 2003;31(3):474-81.
20. Hardin CK. Banked bone. Otolaryngol Clin North Am. 1994;27(5):911-25.
21. Perrott DH, Smith RA, Kaban LB. The use of fresh frozen allogeneic bone for maxillary and mandibular reconstruction. Int J Oral Maxillofac Surg. 1992;21(5):260-5.
22. Rochanawutanon S, Suddhasthira T, Pairuchvej V, Vajaradul Y. Long term follow-up of reconstruction with allogeneic mandibular bone crib packed with autogenous particulate cancellous bone marrow. Cell Tissue Bank. 2002;3(3):183-97.
23. D'Aloja E, Santi E, Aprili G, Franchini M. Fresh frozen homologous bone in oral surgery: case reports. Cell Tissue Bank. 2008;9(1):41-6.
24. Quirynen M, van Steenberghe D, Jacobs R, Schotte A, Darius P. The reliability of pocket probing around screw-type implants. Clin Oral Implants Res. 1991;2(4):186-92.
25. Quirynen M, Naert I, van Steenberghe D, Teerlinck J, Dekeyser C, Theuniers G. Periodontal aspects of osseointegrated fixtures supporting an overdenture. A 4-year retrospective study. J Clin Periodontol. 1991;18(10):719-28.
26. Albrektsson T, Zarb GA. Determinants of correct clinical reporting. Int J Prosthodont. 1998;11(5):517-21.
27. Dawson-Saunders B, Trapp RG. Basic & Clinical Biostatistic. Norwalk: Appleton & Lange; 1994.
28. Cox DR, Oakes D. Analysis of survival data. New York: Chapman & Hall; 1984.
29. Balshi TJ, Wolfinger GJ. Immediate loading of Brånemark implants in edentulous mandibles: a preliminary report. Implant Dent. 1997;6(2):83-8.
30. Randow K, Ericsson I, Nilner K, Petersson A, Glantz PO. Immediate functional loading of Brånemark dental implants. An 18-month clinical follow-up study. Clin Oral Implants Res. 1999;10(1):8-15.
31. Chow J, Hui E, Liu J, Li D, Wat P, Li W et al. The Hong Kong Bridge Protocol. Immediate loading of mandibular Brånemark fixtures using a fixed provisional prosthesis: preliminary results. Clin Implant Dent Relat Res. 2001;3(3):166-74.
32. Petrie CS, Williams JL. Comparative evaluation of implant designs: influence of diameter, length, and taper on strains in the alveolar crest. A three-dimensional finite-element analysis. Clin Oral Implants Res. 2005;16(4):486-94.
33. Huang HL, Huang JS, Ko CC, Hsu JT, Chang CH, Chen MY. Effects of splinted prosthesis supported a wide implant or two implants: a three-dimensional finite element analysis. Clin Oral Implants Res. 2005;16(4):466-72.
34. Anner R, Better H, Chaushu G. The clinical effectiveness of 6 mm diameter implants. J Periodontol. 2005;76(6):1013-5.
35. Krennmair G, Waldenberger O. Clinical analysis of wide-diameter frialit-2 implants. Int J Oral Maxillofac Implants. 2004;19(5):710-5.
36. Cho SC, Small PN, Elian N, Tarnow D. Screw loosening for standard and wide diameter implants in partially edentulous cases: 3- to 7-year longitudinal data. Implant Dent. 2004;13(3):245-50.