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PRETHODNO PRIOPĆENJE
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Mjerenje stabilnosti implantata nakon podizanja dna sinusa: kliničko pilot istraživanje

Measurements of Implant Stability Following Sinus Lift: A Pilot Clinical Study

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Sažetak

Svrha: U ovom se istraživanju željela procijeniti stabilnost implantata Bredent Sky Blue različitih promjera nakon podizanja dna sinusa. **Materijali i metode:** U istraživanju su sudjelovala devetorica pacijenata s indikacijama za jednostrano ili obostrano podizanje dna sinusa. Augmentacijski materijali korišteni u ovom postupku bili su MinerOss® Cortical - Cancellous te Ossceram nano. **Rezultati:** Svi su se implantati pokazali uspješnima. ISQ vrijednosti mjerene su mjeračem Osstell ISQ, a bile su između 68 i 84. Srednje vrijednosti stabilnosti implantata Bredent Sky Blue različitih promjera nakon podizanja dna sinusa iznosile su 77,73 ± 2,93 (MD) i 77,98 ± 2,72 (VO).

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Uvod

Anatomska ograničenja u lateralnom dijelu gornje čeljusti jesu: ravni svod nepca, nedovoljna visina alveolarnog grebena, neadekvatna posteriorna alveola, povećana pneumatizacija maksilarnih sinusa te sinusi relativno blizu krestalne kosti. Maksilarna kost zbog više spongioze i trabekula manje je gusta i kvalitetna u usporedbi s premaksilom i mandibulom. Nasuprotni kortikalisi kompakte obično su vrlo tanki i zato minimalno pridonose čvrstoći (1).

Često je implantoprotetska rehabilitacija u gornjoj čeljusti iznimno teška zbog znatne resorpcije kosti koja nastaje zbog pneumatizacije maksilarnih sinusa nakon gubitka zuba. Kirurška tehnika podizanja dna sinusa uključuje podizanje dna sinusa kranijalno i očvršćivanje koštanog defekta kako bi se postigla zadovoljavajuća visina i debljina alveolarnog grebena za naknadnu implantaciju (2). Augmentacija se može obavljati različitim materijalima: autogenom kosti s ilijačne kosti ili tubera mandibule, demineraliziranom suho smrznutom kosti, hidroksiapatitom (HA), beta-trikalcijevim fosfatom (ß-TCP), anorganskom deproteiniziranom kravljom kosti te kombinacijama navedenoga (3, 4). Kad je riječ o upotrebi navedenih materijala u području augmentiranog sinusa, u području apeksa implantata autologna kost i ksenogeni materijal djeluju vrlo slično. U usporedbi s na-

Introduction

Anatomic limitations often associated with the posterior maxilla are flat palatal vault, deficient alveolar height, inadequate posterior alveolus, increased pneumatization of the maxillary sinus, and close approximation of the sinus to the crestal bone. Maxillary bone, primarily medullary and trabecular, has less quantity and bone density than the premaxilla or mandible. Adjacent cortices of compact bone are generally very thin, providing minimal strength (1).

In a great number of cases, implant prosthetic rehabilitation in the upper jaw is difficult, since extensive resorption of bone occurs as a consequence of pneumatization of the maxillary sinus following the loss of teeth. The surgical technique of lifting the sinus floor consists of the elevation of the sinus floor cranially and reinforcement of the bone defect in order to create sufficient height and width of the alveolar ridge for implant insertion (2). Various grafting materials have been proposed for the grafting procedure: autogenous bone from the iliac crest or maxillary tuberosity, demineralized freeze-dried bone, hydroxyapatite (HA), beta-tricalcium phosphate (ß-TCP), inorganic deproteinized bovine bone and combination of these and others (3, 4). Regarding remodeling in augmented sinus areas, the behavior of the autologous bone from the iliac crest and the xenogenic material was ultimate-

vedenim materijalima najsporije se resorbirala kravlja kost (5). Ponašanje autologne kosti s područja brade bilo je slično kao i pri uporabi ksenogenog materijala, najvjerojatnije zbog njihova gustoga kortikalnog sastava (5). Idealni materijal za augmentaciju maksilarnih sinusa trebao bi biti biološki stabilan, osigurati dovoljan volumen i dopustiti infiltraciju nove kosti te naknadno modeliranje. Materijali za augmentaciju implantata trebali bi s vremenom postići oseointegraciju. Nakon protetske nadoknade implantata ne bi trebao nastati gubitak kosti i materijal bi trebao biti stabilan. Također bi morala postojati predvidiva stopa uspješnosti (6).

Mjerenje stabilnosti implantata tijekom implantacije te naknadna promjena stabilnosti cijeljenja korisni su zbog informacija potrebnih tijekom praćenja procesa oseointegracije na implantatu i kod domaćina (7 – 11). Stabilnost implantata i uspješna oseoinetgacija preduvjeti su za preživljavanje usatka (12). Meredith i suradnici te Sennerby i njegovi kolege prvi su predložili analizu rezonantne frekvencije (Resonance Frequency Analysis – RFA) kao učinkovitu i kvalitativnu metodu za procjenu stabilnosti implantata (13, 14).

Ostell® ISQ (Osstellab, Göteborg, Švedska) ručni je instrument za mjerenje stabilnosti dentalnih implantata koji funkcionira na principu neinvazivne tehnike. Nedir i suradnici (15) koristili su se njime kao dijagnostičkim sredstvom tijekom implantacije te zaključili da se implantat može smatrati stabilnim ako je ISQ ≥ 47. ISQ jedinice temelje se na rezonantnoj frekvenciji u rasponu od 1 (najmanja stabilnost) do 100 (najveća stabilnost) (16).

Svrha ovog istraživanja bila je procijeniti stabilnost implantata Bredent Sky Blue različitih promjera nakon podizanja dna sinusa (9 mjeseci nakon kirurškog zahvata).

Materijali i metode

U ovom istraživanju sudjelovala su devetorica pacijenata s jednostranim i dvostranim podizanjem dna sinusa. Srednja dob bila je 49,89, a raspon godina od 45 do 66. Svi uključeni bili su zdravi, bez sistemskih bolesti. Isključeni su oni sa sistemskim bolestima kao što su dijabetes, osteoporoza, psihološke bolesti, loša oralna higijena te prethodna radioterapija.

Prije kirurškog zahvata svi su pacijenti ispunili FDI-jev upitnik o zdravlju.

Ukupno je implantirano 30 implantata. Dužine su bile 10, 12 ili 14 milimetara, što je određeno prema dostupnom mjestu. Širine implantata bile su 3,5, 4,0 4,5 ili 5,5 milimetara, a određene su prema dostupnoj širini.

Jedan sat prije zahvata svaki je pacijent popio ibuprofen od 600 mg. Kirurški zahvat (pristup lateralnom prozoru, jedna faza) obavljen je u lokalnoj anesteziji. Kod svakog sudionika sinus je augmentiran uporabom kombinacije alogenog materijala MinerOss® Cortical-Cancellous (BioHorisons) – 2,5 ml³ i Ossceram nano (Bredent, 40 % β-trikalcijev fosfat i 60 % hidroksiapatita, veličine granula 0,8 – 1.5 mm) u omjeru 1:1. Bukalni prozor prekriven je kolagenom membranom (Mem-Lok, Biohorizons). Implantati su nakon toga imedijatno postavljeni u pripremljena mjesta. CBCT snimka

ly very similar at the implant apex, although for bovine bone material the resorption was much slower than that of this autogenous graft (5). The behavior of autologous bone from the chin seemed similar to that of xenogenic material, probably because of the dense cortical composition of such grafts (5). An ideal maxillary sinus bone-grafting material should provide biological stability, ensure volume maintenance, and allow the occurrence of new bone infiltration and bone remodeling. Over time, bone-grafting materials and implants should achieve osseointegration. After the restoration of the upper part of the implant has been completed, there should be no bone loss and the materials should be stable; there should be a predictable success rate (6).

Measuring implant stability at placement and its subsequent change during healing provides useful information for monitoring the process of osseointegration, planning a loading protocol, and evaluating various conditions of osseointegration on implant and host sides (7-11). Implant stability and successful osseointegration are prerequisites for implant survival (12). Meredith et al. and Sennerby et al. were first to propose Resonance Frequency Analysis (RFA) as a highly effective qualitative method to assess implant stability (13, 14).

Ostell ® ISQ (Osstellab, Göteborg, Sweden) is a handheld instrument that involves the use of a noninvasive technique for measuring dental implant stability. Nedir et al. (15) evaluated the Osstell as a diagnostic tool at implant placement and concluded that implant stability could be reliably determined for implants with an ISQ≥47. The ISQ unit is based on the underlying resonance frequency ranging from 1 (lowest stability) to 100 (highest stability) (16).

The aim of this study was to evaluate the implant stability of Bredent Sky Blue implants of different diameters following sinus lift (9 months after the surgery).

Material and Methods

This study included 9 male patients with an existing indication for unilateral or bilateral sinus lift procedure. The mean age of patients was 49.89, ranging between 45 and 66 years. All patients included in this study were healthy, without any systemic diseases. Patients with systemically compromised conditions e.g. diabetes, osteoporosis, and those with mental disorders, poor oral hygiene, a history of radiotherapy were excluded.

Before the surgical procedure all patients had signed a questionnaire recommended by the World Dental Federation (FDI).

The total number of implants was 30. The length was 10 mm, 12 mm or 14 mm which was determined according to the available space. The implant diameter included 3.5 mm, 4.0 mm, 4.5 mm or 5.5 mm according to the available ridge width.

One hour prior to the surgery patients took ibuprofen 600mg. The surgical procedures (lateral window approach, single stage) were performed under local anesthesia. In all cases, the sinus cavity was grafted with a combination of allograft material MinerOss® cortical&cancellous (BioHorisons) 2.5 ml³ and Ossceram nano (Bredent, 40 %

napravljena je kako bi se kontrolirale moguće dislokacije augmentiranog materijala. Nakon operacije pacijentima je dan deksametazol 4 od ml. Dan nakon zahvata dobili su 80-miligramski metilprednizolon. Nekoliko dana poslije ordiniran im je amoksicilin s klavulanskom kiselinom 2 x 1000 mg i ibuprofen prema potrebi. Šavovi su izvađeni 7 do 10 dana nakon zahvata.

Pacijenti su zamoljeni da poštuju standardne postoperativne upute, kao što su hlađenje operiranog mjesta, mekana kalorična prehrana i ispiranje usta antiseptičkom otopinom (0,2-postotni klorheksidin glukonat). Također im je rečeno da ne kišu, ne ispuhuju nos i ne poduzimaju ništa što stvara intranazalni pritisak ili vakuum. Tijekom istraživanja nije zabilježen ni jedan gubitak implantata.

Nakon devet mjeseci izmjerene su ISQ vrijednosti uređajem Osstell ISQ tipa FW 7660M/05 sa SmartPeg abutmentom. Točnost ISQ-a je unutar +/- 0,5 jedinica za svaki SmartPeg. Za svaki implantat uzeta je srednja vrijednost ISQ jedinica izračunana na osnovi triju mjerenja iz raznih smjerova – meziodistalnoga i vestibulo-oralnoga.

Rezultati

Korišteno je osam implantata promjera 3,5 mm, 6 implantata promjera 4,0 mm, 10 implantata promjera 4,5 mm i 6 implantata promjera 5,5 mm. Bilo je 14 implantata dužine 10 mm, 14 implantata dužine 12 mm i 2 implantata dužine 14 mm. ISQ vrijednosti zabilježene su u rasponu od 68 do 84.

Srednja vrijednost /± standardne devijacije ISQ vrijednosti izmjerena je RFA metodom (Resonance frequency analysis) za implantate različitih promjera nakon podizanja dna sinusa i nalazi se u tablici 1.

β-tricalciumphosphate and 60% hydroxylapatite, granule size 0.8-1.5 mm) at a ratio 1:1. Buccal window was covered with collagen membrane (Mem-Lok, Biohorizons). The implants were then placed immediately in the prepared site. Control cone beam computed tomography (CBCT) scan was recorded to exclude dislocation of the bone grafting material. After the surgery, patients took dexamethason 4ml. Day after surgery, patients took methylprednisolone 80 mg. Following days after the surgery, patients took 2 x1000 mg amoxicillin/potassium clavulanate and ibuprofen if necessary. Sutures (interrupted) were removed 7-10 days after the surgery.

Patients were advised to follow standard postoperative instructions, which included ice-pack, soft high nutrient diet, thorough rinsing with antiseptic mouthwash (chlorhexidine gluconate 0.2%). The patients were instructed to avoid sneezing, nose blowing, or other actions that might create high intranasal pressure or vacuum. No implant loss was observed during the study period.

After the time of 9 months, ISQ levels were measured by Osstell ISQ device Type FW 7660M/05 with SmartPeg abutment. ISQ accuracy is within +/- 0.5 units for a single SmartPeg. For each implant, a mean ISQ value was calculated on the basis 3 ISQ measurements recorded from different directions: mesiodistally and vestibulo-orally.

Results

There were 8 implants with 3.5 mm in diameter, 6 implants with 4.0 mm in diameter, 10 implants with 4.5 mm in diameter and 6 implants with 5.5 mm in diameter. There were 14 implants 10 mm long, 14 implants were 12 mm long and 2 implants were 14 mm long. The ISQ values were from 68 to 84.

The mean /± standard deviation of the stability values (ISQ) measured using Resonance Frequency Analysis for implants of different diameter following sinus lift are presented in Table 1.

Tablica 1. Srednja /± standardna devijacija ISQ vrijednosti za implantate različitog promjera (M-D meziodistalno, V-O vestibulo-oralno)
Table 1 The mean /± standard deviation of ISQ values for implants of different diameter (M-D mesiodistally, V-O vestibulo-orally)

		ISQ	
Diameter	**Number of implants**	**M-D Mean (SD)**	**V-O Mean (SD)**
3.5x12	6	78.5 (3.331)	79 (3.405)
3.5x14	2	80.5 (2.11)	80 (1.414)
4x10	4	74.25 (5.56)	74 (5.71)
4x12	2	82 (1.414)	82 (2.828)
4.5x10	4	77.25 (1.707)	78 (2.16)
4.5x12	6	74.16 (6.794)	75.3 (6.088)
5.5x10	6	77.5 (2.738)	77.6 (1.966)
Total	30	77.73 ± 2.93	77.98 ± 2.72

Rasprava

U ovom istraživanju stabilnost implantata procijenjena je devet mjeseci nakon podizanja dna sinusa. Mi smo obavili jednofazno podizanje dna sinusa pristupom kroz lateralni prozor. Nakon što je podizanje dna sinusa uvedeno u kliničk-

Discussion

In the present study, implant stability was assessed at 9 months after sinus lift surgery. We performed lateral window approach single-stage sinus floor elevations. Since their introduction into clinical practice, different sinus augmen-

ku praksu, prihvaćene su i razne metode augmentacije koje su dokazale učinkovitost u poboljšanju prirodne kosti u području atrofične i pneumatizirane maksile (17). Boyne i James predložili su 1980. godine lateralni pristup pri podizanju dna sinusa (18). Summers se koristio kliničkom tehnikom transkrestalnoga pristupa, a upotrebljavao je osteotome (19, 20). Pal i kolege proveli su istraživanje u kojem nisu zabilježili razliku u boli, oteklini, stabilnosti i gingivalnom statusu između transkrestalnoga i lateralnog pristupa, a koristili su se organskim kravljim transplantatom (Bio-Oss, Gaistlich biomaterials, Švicarska). Povećanje u visini kosti bilo je značajnije veće pri lateralnom pristupu negoli transkrestalnom (21).

Koštani presadci mogu utjecati na stopu opstanka implantata. Yoon i suradnici procijenili su visinu alveolarne kosti, tehniku pristupa sinusu, koštani materijal te kliničku stopu opstanka implantata Astra Tech u maksilarnoj molarnoj regiji. Ocijenjeno je 99 implantata Astra Tech (Osseospeed, Astra Tech AB, Mölndal, Švedska) implantiranih u molarnu regiju maksile uz podizanje dna sinusa u razdoblju od rujna 2009. do veljače 2012. godine te redovite preglede tijekom jedne godine. Korištena je autogena i alogena kost, ksenogeni koštani transplantati (Bio-Oss; Geistlich Pharma AG, Wolhusen, Švicarska), aloplastična kost (Osteon; Genoss, Suwon, Južna Koreja) i autogeni koštani transplantati. Autori nisu pronašli povezanost između metode pristupa maksilarnom sinusu, vrste transplantata i njegova gubitka (22). U ovom istraživanju korištena su dva materijala za augmentaciju – mineralizirani alograft i β-trikalcijev fosfat/hidroksiapatit. Tijekom istraživanja nije izgubljen ni jedan implantat, a ISQ vrijednosti bile su od 68 do 84, što se može smatrati uspjehom. Čini se da su materijali za augmentaciju tijekom podizanja dna sinusa korišteni u ovom istraživanju postigli zadovoljavajuću biološku stabilnost implantata.

Ghanbari i suradnici usporedili su radiološki i klinički algipore (karbonizirana crvena morska alga kemijski pretvorena u kidroksiapatit) s deklacificiranim suho smrznutim koštanim alograftom (DFDBA) u postupku augmentacije i podizanja dna sinusa, a pritom su se koristili piezo instrumentima. Nakon devet mjeseci nisu uočili značajne kliničke ili radiološke razlike između algipora i DFDBA te su oba materijala priznata kao prihvatljiv materijal za augmentaciju pri podizanju dna sinusa (23). Jelušić i suradnici procijenili su stabilnost implantata nakon podizanja dna sinusa koristeći se dvama materijalima (čisto-fazni ß-TCP ili HA/ß-TCP) i usporedili ih s implantatima ugrađenima u nedirnutu kost lateralnoga segmenta maksile. Njihovi rezultati pokazuju da je stabilnost implantata slična kod implantata implantiranih u nedirnutu kost i implantata u augmentiranom dnu sinusa, neovisno o augmentacijskom materijalu i tehnici podizanja dna sinusa. Ni ISQ vrijednosti nisu pokazivale značajnu razliku u mjerenju između dviju lokacija implantata. Srednja vrijednost ISQ-a na implantatima u lateralnom segmentu netaknute i augmentirane maksile iznosila je 78,9 ± 6,3 i 78,7 ± 6,1, a na implantatima ugrađenima u lateralni segment maksile augmentiran s β-TCP bila je 79,8, ± 6,8 (12). Te vrijednosti slične su našima – 77,73 ± 2,93 meziodistalno i 77,98 ± 2,72 vestibulo-oralno. Degidi i suradnici pronašli

tation procedures have demonstrated their effectiveness regarding the enhancement of native bone in maxillary areas with atrophic ridges and pneumatized sinuses (17). Boyne and James in 1980 proposed a lateral approach to sinus lifts (18). Summers introduced clinical practice techniques using a transcrestal approach, based on the use of osteotomes (19, 20). Pal et al. found no significant difference in pain, swelling, stability, and gingival status between both a transcrestal and lateral approach with an organic bovine bone graft (Bio-Oss, Geistlich biomaterials, Switzerland). Increase in bone height was significantly greater in the lateral approach than in the transcrestal approach (21).

Bone graft materials may affect implant survival rate. Yoon et al. evaluated the height of alveolar bone, sinus approach technique, bone material and the clinical survival rate of Astra Tech implants in the maxillary molar region performed with sinus lift and bone graft. Ninety-nine Astra Tech implants (Osseospeed, Astra Tech AB, Mölndal, Sweden) placed in the maxillary molar region using sinus lift from September 2009 to February 2012 were selected with a minimum follow-up period of 1 year. The bone graft materials used were autogenous bone and allogenic bone, xenogenic bone (Bio-Oss; Geistlich Pharma AG, Wolhusen, Switzerland), alloplastic bone (Osteon; Genoss, Suwon, Korea), and autogenous bone graft materials. They found no correlation between the approach methods to the maxillary sinus or bone graft materials used and implant failure (22). In the present study, we used two different grafting materials (mineralized allograft and β-tricalciumphosphate/ hydroxylapatite). No implant loss was observed during the study period and the ISQ values were from 68 to 84 after, which may be regarded as successful. It appears that sinus bone-grafting materials, which were used in our study, provided biological stability.

Ghanbari et al. investigated radiographic and clinical comparison of Algipore (marine-derived carbonated red alga that is chemically converted into hydroxyapatite) with decalcified freeze-dried bone allograft (DFDBA) in the open maxillary sinus lift technique using piezoelectric instruments. After nine months there were no considerable clinical or radiological differences in outcome between Algipore and DFDBA and both of them were recognized as acceptable materials for sinus lift procedures (23). Jelušić et al. evaluated implant stability following sinus lift with two grafting materials (pure-phase ß-TCP or HA/ß-TCP material), and compared it with the implants placed in a pristine posterior maxilla. Their results clearly demonstrated that the examined implant stability is comparable among implants placed in the posterior maxilla regardless of sinus lift or grafting procedure. ISQ values were shown not to be influenced by a particular grafting material, because no significance was observed in comparison to ISQ values of corresponding implants in non-augmented sites. The mean values of stability of implants that were inserted in the posterior maxilla with or without augmentation procedure were 78.9±6.3 and 78.7±6.1, respectively. The mean value of stability of implants that were inserted in the posterior maxilla with β-tricalciumphosphate/hydroxylapatite was 79.8±6.8 (12).

su pozitivnu povezanost između ISQ vrijednosti za implantate različitih promjera i dužine (24). Zbog toga smo izračunali srednju ISQ vrijednost za implantate različitog promjera. Najviša je iznosila 82 (1,414) meziodistalno i 82 (2,828) vestibulo-oralno za implantate promjera 4 x 10 mm. Naše istraživanje pokazalo je da, kada se provode rekonstruktivne tehnike sinusa, najbolje istodobno obaviti i implantaciju.

Zaključak

Srednja vrijednost stabilnosti implantata Bredent Sky Blue različitih promjera nakon podizanja dna sinusa tehnikom lateralnog prozora, bila je 77,73 ± 2,93 i 77,98 ± 2,72.

Naši klinički rezultati pokazali su da kombinacija alografta MinerOss® Cortical-Cancellous i Ossceram nano (40 % β-trikalcijev fosfat i 60 % hidroksiapatit) omogućuje biološku stabilnost i visoku stopu oseointegracije.

Sukob interesa

Nije ga bilo.

These values were similar to ours: 77.73 ± 2.93 mesiodistally and 77.98 ± 2.72 vestibulo-orally. Degidi et al. found positive correlation between ISQ values and implant diameter and length (24). For that reason, we calculated mean ISQ values for implants of different diameter. The highest mean ISQ values were 82 (1.414) mesiodistally and 82 (2.828) vestibulo-orally for implant of diameter 4x12 mm. The lowest ISQ value was 74 (5.71) vestibulo-orally for implant of diameter 4x10 mm. It was observed in our study that it is reliable to insert dental implants during the same surgery during which the reconstructive technique is performed.

Conclusion

The mean values of stability of Bredent Sky Blue implants of different diameters following lateral window approach sinus lift procedure were 77.73 ± 2.93 and 77.98 ± 2.72, respectively.

Our clinical results demonstrated that a combination of allograft material MinerOss® Cortical and Cancellous and Ossceram nano (40 % β-tricalciumphosphate and 60% hydroxylapatite) provided biological stability and a high rate of osseointegration.

Conflict of interest

None declared

Abstract

Aim: The aim of this study was to evaluate the implant stability of Bredent Sky Blue implants of different diameters following one stage sinus lift procedure. **Material and methods:** This study included 9 male patients with an existing indication for unilateral or bilateral sinus lift procedure. As grafting materials, combination of allograft material MinerOss® cortical & cancellous and Ossceram nano were used. **Results:** All implants were considered successful and ISQ levels were measured by Osstell ISQ device. The ISQ values were from 68 to 84. The mean values of stability of Bredent Sky Blue implants of different diameters following one stage sinus lift procedure were 77.73 ± 2.93 (MD) and 77.98 ± 2.72 (VO).

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Key words
Dental Implantation; Sinus Floor Augmentation

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