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Stefano Carelli[1], Alfredo Passaretti[2], Giulia Petroni[3], Alessio Zanza[3], Luca Testarelli[3] * and Andrea Cicconetti[3]

Five Years Follow-up of Short Implants Placed in Atrophic Maxilla with Simultaneous Sinus Floor Transcrestal Elevation

Petogodišnje praćenje kratkih implantata ugrađenih u atrofičnu maksilu s istodobnim transkrestalnim podizanjem dna sinusa

[1] Private Practice, Rome, Italy
Privatna ordinacija, Rim, Italija
[2] Private Practice, Rome, Italy
Privatna ordinacija, Rim, Italija
[3] Department of Oral and Maxillo-Facial Sciences, "Sapienza" University of Rome, Italy
Odjel za oralne i maksilofacijalne znanosti, Sveučilište Sapienza, Rim, Italija

Abstract
Objective: Many authors have tried to face the anatomical limitations resulting from maxillary bone atrophy. Up to five millimeters bone height, the lateral sinus floor elevation is the most commonly used and validated strategy to achieve the prosthetic rehabilitation. However, the disadvantages of this technique are its invasiveness and delayed rehabilitation. The aim of this paper was to assess 5 years clinical outcome of implants placed with a technique that allows the percrestal sinus floor elevation and the immediate implant placement. **Materials and Methods** 30 transcrestal sinus floor elevations with immediate implant placement were performed in severely atrophic maxillae. Implant survival, marginal bone level variation, harvested bone height variation and periodontal indices were assessed. **Results:** After a five year follow up none of the thirty implants were lost. The mean value of vertical harvested bone loss was 5%. The mean crestal bone loss was -0.33 mm (Standard Deviation (SD) 0.11 mm). The mean value of periodontal indices was respectively: PD 1.22 mm (SD 0.72 mm), PI 17.47% (SD 15.01 mm), BOP 9, 87 %.,(SD 19.17 mm). **Conclusion:** The results obtained are comparable with success criteria in implant rehabilitation. The reported technique proved to be successful in the population observed, with minimal trauma and reduced invasiveness.

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Address for correspondence
Prof. Luca Testarelli, PhD
"Sapienza" University of Rome
Department of Oral and Maxillo-Facial Sciences
Via Caserta 6, Rome 00161, Italy
luca.testarelli@uniroma1.it

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Introduction

The prosthetic rehabilitation in atrophic posterior maxilla is a current topic in dentistry. The biological and mechanical improvements of dental implants and reconstructive surgery have allowed surgeons to rehabilitate increasingly complex cases. Up to date, many techniques have been described in the literature to face the anatomical limitations and create the conditions for implants insertion (1). As shown by several studies, the sinus floor elevation has been demonstrated to be a predictable and well-documented strategy to overcome the maxillary atrophy (2). Nearly half of the studies present in the literature have been published in the last five years, thus showing the relevance and actuality of the current topic. Two techniques of sinus lift are largely used: the lateral sinus floor elevation (LSFE) and the osteotome sinus floor elevation (OSFE) (3, 4). The LSFE was reported firstly by Tatum in 1997 and modified over the years by various authors, using different materials, instruments or access designs (5-10). Despite its highly predictable and successful rate, the indications

Uvod

Protetička rehabilitacija atrofične stražnje maksile aktualna je tema u dentalnoj medicini. Biološko i mehaničko poboljšanje dentalnih implantata i napredak rekonstrukcijske kirurgije omogućili su kirurzima rehabilitaciju sve složenijih slučajeva. Do danas su u literaturi opisane mnoge tehnike za suočavanje s anatomskim ograničenjima i stvaranje uvjeta za ugradnju implantata (1). Kao što su istaknuli autori nekoliko istraživanja, podizanje dna sinusa pokazalo se predvidljivom i dobro dokumentiranom strategijom za prevladavanje maksilarne atrofije (2). Gotovo polovina svih istraživanja u literaturi objavljena je u posljednjih pet godina, što pokazuje relevantnost i aktualnost teme. Uglavnom se upotrebljavaju dvije tehnike podizanja dna sinusa – lateralno podizanje dna sinusa (LSFE) i osteotomijsko podizanje dna sinusa (OSFE) (3, 4). O LSFE-u je prvi put izvijestio Tatum 1997., a tijekom godina su ga modificirali drugi autori koristeći se različitim materijalima, instrumentima ili pristupima (5 – 10). Unatoč predvidljivosti i uspješnosti, indikacije LSFE-a ograničene su

of LSFE are limited to the severe cases of atrophy (<5 mm residual vertical bone) because of its invasiveness and risks of complications (11).

The OSFE, described by Summers in 1994, is able to create the condition to place standard-length screw-implants and regenerate bone at the same time without a second surgical stage (12, 13). The success rate of this technique is comparable to LSFE procedure but with a more conservative approach which is less burdened by complications (14).

However, the use of this technique is limited by the availability of at least 5 mm of residual bone height (RBH) to ensure the stabilization of standard-length screw-implants (15, 16).

On the contrary, when RBH is less than 5 mm the lateral approach is a suggested option, but according to Smiler DG et al. the delayed implant placement is recommended (17). Although new bone could be obtained with this technique, it is difficult to assess the position and the total amount of graft material needed for the future implant placement in the first surgical stage. Furthermore, a longer treatment time is required. However, Peleg et al. (2006) concluded that the bone graft in LSFE and simultaneous implant placement is predictable even in case of 1-2 mm RBH, if "careful case planning and meticulous surgical techniques" are used (18).

In line with the abovementioned, and in order to reduce the treatment duration and the risks of complications, it could be auspicious to use the technique that simultaneously combines the safeness of crestal approach and the possibility of immediate positioning of implant even in case of RBH <5 mm.

Fugazzotto (1998) described a crestal window approach and bone graft in case of RBH ranging from 1 to 2 mm. However, the implants were still positioned in the second stage (19). The same author described a crestal sinus augmentation using a trephine bur to design the window. In this case, the minimal RBH had to be 4-5 mm for technical reasons (the use of trephine bur) and the implants were delayed as well (20).

A recent systematic review supports the use of short implants as alternative solution to bone augmentation procedures (21). The survival rate of a short implant placed in atrophic bone is comparable to the procedure that involved bone manipulation to place standard length implants (22).

A great majority of authors believe that a short implant is a fixture long 8 millimeters or less, whilst an implant with a length of < 6.5 mm has been considered an extra-short implant (23). The use of a short implant could limit the amount of bone graft, thus reducing the invasiveness of the technique.

Therefore the bone rebuilder should be functionalized and preserved by adequate bone stimulation according to the laws of Wolff and Frost (24, 25).

The aim of this study was to describe and evaluate a technique that allows a sinus lift via crestal window and immediate positioning of extra-short implant in case of RBH ranging from 1 to 3 mm.

Material and Methods

The study was conducted in accordance with the World Medical Association Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of "Sa-

na teške slučajeve atrofije (rezidualna vertikalna kost < 5 mm) zbog invazivnosti i rizika od komplikacija (11).

OSFE, koji je opisao Summers 1994. godine, omogućuje stvaranje uvjeta za istodobnu ugradnju implantata standardne duljine i regeneraciju kosti bez druge kirurške faze (12, 13). Uspješnost te tehnike usporediva je s LSFE postupkom, ali s konzervativnijim pristupom koji je manje sklon komplikacijama (14).

No uporaba te tehnike ograničena je na najmanje 5 mm visine rezidualne kosti (RBH) kako bi se osigurala stabilizacija implantata standardne duljine (15, 16).

Suprotno tomu, kada je RBH kraći od 5 mm predložen je lateralni pristup, ali prema Smileru i suradnicima, preporučuje se odgođena ugradnja implantata (17). Iako bi se tom tehnikom mogla dobiti nova kost, teško je procijeniti položaj i ukupnu količinu grafta potrebnog za buduću ugradnju implantata u prvoj kirurškoj fazi. Nadalje, potrebno je dulje liječenje. No Peleg i suradnici (2006.) zaključili su da je koštani graft u LSFE-u i simultano postavljanje implantata predvidljivo čak i u slučaju od 1 do 2 mm RBH-a, no potrebno je *pomno planiranje slučaja i precizna kirurška tehnika* (18).

U skladu s gore spomenutim, i kako bi se skratilo liječenje i rizik od komplikacija, moglo bi biti povoljno primijeniti tehniku koja istodobno kombinira sigurnost krestalnog pristupa i mogućnost imedijatne ugradnje implantata čak i u slučaju RBH-a < 5 mm.

Fugazzotto (1998.) je opisao pristup kroz krestalni prozor i koštani graft u slučaju RBH-a u rasponu od 1 do 2 mm. No implantati su se i dalje ugrađivali u drugoj fazi (19). Isti je autor opisao augmentaciju krestalnoga sinusa trepanacijskim svrdlom za oblikovanje prozora. U ovom slučaju je minimalni RBH morao biti od 4 do 5 mm iz tehničkih razloga (upotreba trepanacijskoga svrdla), a ugradnja implantata također je odgođena (20).

Autor nedavno objavljenoga sistematiziranoga preglednoga rada ističe korist pri upotrebi kratkih implantata kao alternativnog rješenja u slučaju augmentacije kosti (21). Stopa preživljavanja kratkih implantata postavljenih u atrofiranu kost usporediva je s postupkom koji je uključivao augmentaciju kosti radi postavljanja implantata standardne duljine (22).

Velika većina autora vjeruje da je kratki implantatni vijak dužine 8 mm ili manje, a implantat dužine < 6,5 mm smatra se ekstra kratkim (23). Korištenje kratkog implantata moglo bi ograničiti količinu koštanoga grafta i tako smanjiti invazivnost tehnike.

Stoga bi se obnavljanje kosti moglo potaknuti i očuvati odgovarajućom stimulacijom prema zakonima Wolffa i Frosta (24, 25).

Cilj ovog istraživanja bio je opisati i procijeniti tehniku koja omogućuje podizanje dna sinusa kroz krestalni prozor i imedijatnu ugradnju iznimno kratkog implantata u slučaju RBH-a u rasponu od 1 do 3 mm.

Materijali i metode

Istraživanje je provedeno u skladu s Deklaracijom Svjetskoga liječničkog udruženja iz Helsinkija, a odobrio ga je Institucionalni etički odbor Sveučilišta Sapienza u Rimu

pienza" University of Rome (protocol code 27/13.06.2013). All participants gave their informed consent. Implant-prosthetic treatments were carried out at the Oral Surgery Unit of the Department of Oral and Maxillofacial Sciences, "Sapienza" University of Rome.

Patients with posterior maxillary atrophy (Class Ch Misch-Judy) (26), were the target population. Consecutive enrolment was used to select the patients between 2013 and 2014, and a total of 102 patients were enrolled for the first stage. Clinical visit and radiographic analysis (orthopantomography and intraoral periapical Rx) were prescribed. If vertical atrophies were considered eligible for the treatment, a Cone Beam CT scan was prescribed (27).

The inclusion criteria were: single or multiple posterior maxillary edentulism, stabilized post-extraction alveolus (at least 6 months after extraction) (28); space available for prosthetic rehabilitation; residual bone height from 1 to 3 mm; horizontal residual bone at least 5 mm (intra-cortical).

The exclusion criteria were: uncontrolled oral diseases, maxillary sinus disease, uncontrolled systemic diseases and ASA classes III, IV and V, chemo/radio tumoral therapy, immunosuppressed and patients being treated with corticosteroid or bisphosphonates, smokers who smoked more than 10 cigarettes a day.

Before surgery, clinical examination was carried on evaluating soft tissues and the adjacent teeth condition.

Two different examiners measured the vertical and horizontal residual bone using Horos™ software (The Horos Project, 64-bit medical image viewer, GNU Lesser General Public Licence, version 3.0) for each Cone Beam CT scan. The calibration of measure was obtained using the CT software and CT scans were analyzed using the paraxial cross section at the center of the area selected for implant placement and mesial/distal of it. The three measures were used to achieve the mean residual bone height (mRBH). (Figure 1)

Surgical procedures

All patients received 2g Amoxicillin with Clavulanic Acid 1 hour before treatment and 1g capsule every 12 hours for 6 days after the surgery. The surgery was performed under local anesthesia. A mid-crestal incision was designed, and releasing was made only if strictly necessary. Using the calibrated bone chisel, a window was designed smaller than the chosen implant, horizontally. The window was mobilized starting from the corners using the concave calibrated hand-osteotome of the same diameter of the chisel used. When mobilized, the window was displaced apically towards the Schneider's membrane up to 8 mm from the bone crest. If necessary, gentle dissection of membrane was carried on with the sinus floor surgical detangler. The allograft material, synthetic Beta-Tricalcium Phosphate (Synthograft™, Bicon Implants LLC, Boston MA, USA) was inserted into the sinus and gentle compacted using the calibrated osteotomes till reaching the expected vertical dimension. The filling was checked by a periapical Rx.

The implant used, a short titanium biphasic implant, conometric-connected (Bicon Im-plants LLC, Boston MA, USA) was joined to the "sinus-lift abutment" (SLA) (Bicon Implants LLC, Boston MA, USA). The SLA is a healing sub-

(protokolarni kod 27/13.06.2013). Svi su sudionici dali informirani pristanak. Implantoprotetička terapija provedena je na Odjelu za oralnu kirurgiju Zavoda za oralne i maksilofacijalne znanosti Sveučilišta Sapienza u Rimu.

Pacijenti s maksilarnom atrofijom u stražnjem segmentu (klasa Ch Misch-Judy) (26) bili su ciljana populacija. Uzastopni upis korišten je za odabir pacijenata između 2013. i 2014. godine, a ukupno su za prvu fazu upisana 102. Obavljeni su klinički pregled i radiološka analiza (ortopantomogram i intraoralni periapikalni RTG). Ako se vertikalna atrofija smatrala prihvatljivom za liječenje, propisana je CT snimka (27).

Kriteriji za uključivanje bili su nedostatak jednoga ili više zuba u stražnjem dijelu maksile, stabilizirana postekstrakcijska alveola (najmanje 6 mjeseci nakon vađenja) (28), raspoloživ prostor za protetičku rehabilitaciju, rezidualna visina kosti od 1 do 3 mm i horizontalna rezidualna kost najmanje 5 mm (intrakortikalna).

Kriteriji za isključivanje bili su nekontrolirane bolesti usne šupljine, bolest maksilarnoga sinusa, nekontrolirane sistemske bolesti i ASA klase III, IV i V, zatim kemo/radioterapija, imunosupresivi i bolesnici koji se liječe kortikosteroidima ili bisfosfonatima te pušači koji puše više od 10 cigareta na dan.

Prije operacije obavljen je klinički pregled radi procjene mekih tkiva i stanja susjednih zuba.

Dva različita ispitivača izmjerila su vertikalnu i horizontalnu rezidualnu kost s pomoću softvera Horos™ (The Horos Project, 64-bitni preglednik medicinskih slika, GNU Lesser General Public License, verzija 3.0) na svakom CBCT-u. Mjere su kalibrirane s pomoću CT softvera, a CT skenovi su analizirani u paraksijalnom presjeku središta područja odabranog za ugradnju implantata i mezijalno/distalno od njega. Te tri mjere korištene su za izračun srednje rezidualne visine kosti (mRBH) (slika 1.).

Kirurški postupak

Svi pacijenti primili su jedan sat prije zahvata 2 g amoksicilina s klavulanskom kiselinom, a po 1 g morali su uzimati svakih 12 sati šest dana poslije operacije. Operacija je obavljena u lokalnoj anesteziji. Učinjen je krestalni rez po sredini, a oslobađanje je provedeno samo ako je bilo potrebno. Kalibriranim dlijetom horizontalno je oblikovan prozor manji od odabranog implantata. Prozor je mobiliziran počevši od uglova konkavnim kalibriranim ručnim osteotomom istog promjera kao korišteno dlijeto. Kada se prozor mobilizira, pomiče se apikalno prema Schneiderovoj membrani do 8 mm od krestalne kosti. Ako je potrebno obavlja se nježna disekcija membrane. Alogeni materijal, sintetički beta-trikalcijev fosfat (Synthograft ™, Bicon Implants LLC, Boston MA, SAD), umetnut je u sinus i lagano zbijen kalibriranim osteotomom do postizanja očekivane vertikalne dimenzije. Punjenje je provjereno periapikalnim RTG-om.

Upotrijebljeni implantat, kratki dvofazni titanijev implantat (Bicon Implants LLC, Boston MA, SAD), povezan je s nadogradnjom SLA (*sinus-lift abutment*) (Bicon Implants LLC, Boston MA, SAD). SLA je nadogradnja za cijeljenje veća od antrostomije koja sprječava pomicanje implantata u si-

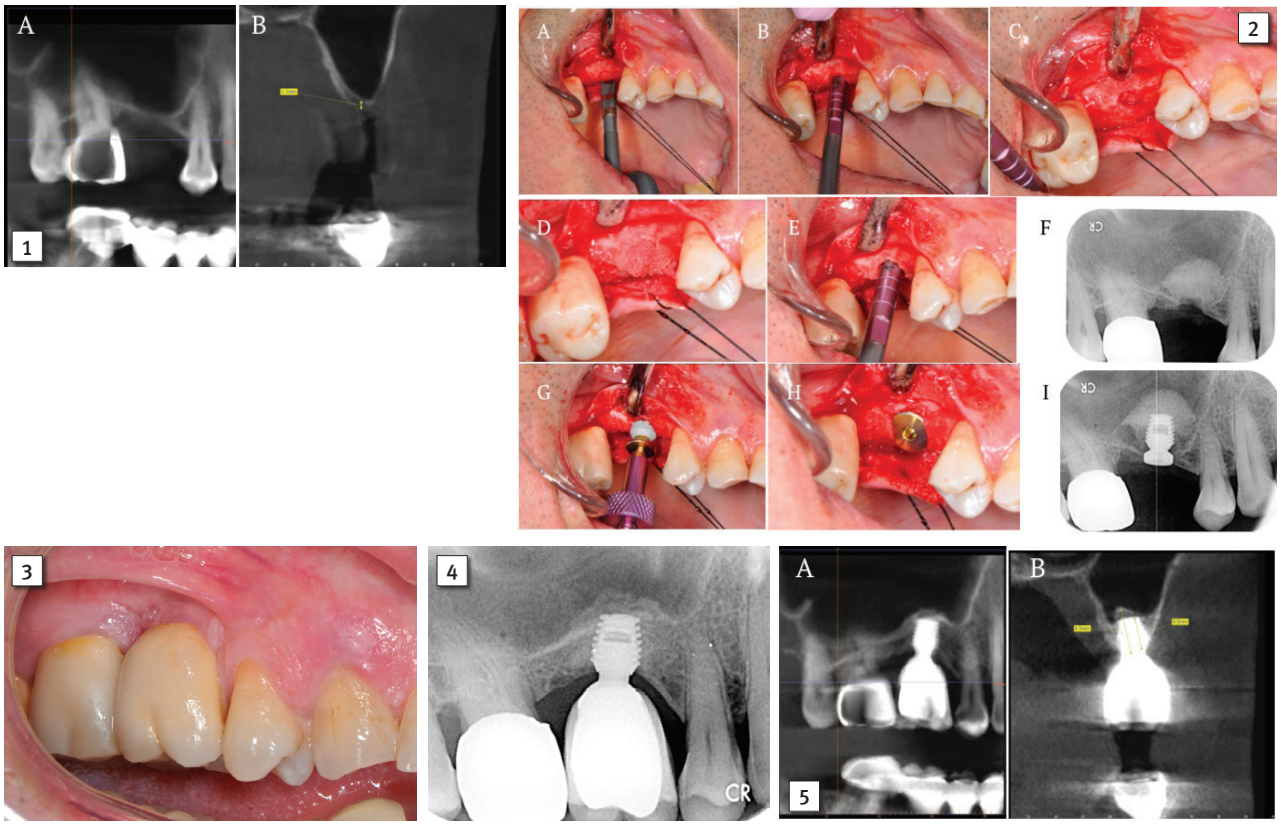

Figure 1 Vertical and horizontal residual bone on CT scan.
Slika 1. Vertikalna i horizontalne rezidualna kost na CT snimci
Figure 2 Illustration of surgical technique.
Slika 2. Ilustracija kirurške tehnike
Figure 3 Integrated Abutment Crown (IACTM).
Slika 3. Integrirana jednodijelna implantatna krunica (IACTM).
Figure 4 Intraoral x-ray showing the osteointegrated implant with its prosthetic rehabilitation..
Slika 4. Intraoralna rendgenska snimka prikazuje osteointegrirani implantat s protetičkom opskrbom
Figure 5 Five Years CT cone beam scan.
Slika 5. CBCT poslije 5 godina

merged abutment larger than the antrostomy that prevents the displacing of the implant into the sinus. The SLA-Implant complex was positioned in the site tapping the abutment on the crestal bone. Primary stability was thus obtained by the friction between SLA and antrostomy. In order to obtain a primary closure of the flap, the wound edges were everted and simple knots were made, (Figure 2).

Patients were instructed to take analgesic treatment (Paracetamol 1g) only if required. Oral and written postoperative instructions were given to all patients. It was recommended to avoid increasing the pression between the mouth and nose. Oral hygiene was performed as normal, except for toothbrushing around the implants site for 7 days. Sutures were daily deterged at home with chlorhexidine 0,20% and removed 7-10 days after surgery.

Prosthetic rehabilitation

After 6 months the implant was uncovered, and the SLA was removed rotating the abutment with forceps. Subsequently, the healing abutment was transgingivally connected to the implant.

After two weeks an impression was made and the implant was restored with a prosthesis called Integrated Abutment

nus. Kompleks SLA – implantat smješten je u ležište tapkanjem o nosač u krestalnu kost. Tako je primarna stabilnost postignuta trenjem između SLA i antrostomije. Da bi se postiglo primarno zatvaranje režnja, izvrnuti su rubovi rane i napravljeni jednostavni šavovi (slika 2.).

Pacijentima je prema potrebi preporučena analgetska terapija (1 g paracetamola). Svi su dobili usmene i pisane postoperativne upute. Preporučeno je izbjegavanje povećanja pritiska između usta i nosa. Oralna higijena obavljala se normalno, osim četkanja zuba oko mjesta implantacije tijekom sedam dana. Šavovi su svaki dan čišćeni kod kuće s 0,2-postotnom klorheksidinom i uklonjeni sedam do deset dana nakon operacije.

Protetička rehabilitacija

Nakon šest mjeseci implantat je otvoren, a SLA uklonjen rotirajući nadogradnju pincetom. Nakon toga je nadogradnja za cijeljenje transgingivno povezana s implantatom.

Nakon dva tjedna uzet je otisak i implantat je protetički opskrbljen jednodijelnom krunicom s nadogradnjom (IACTM). Restauracija je izrađena od Morseove konične na-

Crown (IACTM). The restoration was made of the Morse taper abutment and a composite crown fused together, one piece, for direct application on the implant. The abutment was made of Titanium alloy (Ti V6 A14) and the resin material used for the crown was a highly filled polyceramic resin composite (Shofu Inc. Kyoto Japan) (Figure 3). Intraoral x-ray was performed (Figure 4).

Follow ups

After prosthetic rehabilitation, follow-up visits were scheduled at 1, 6 and 12 months during the first year of function, and annually thereafter. At each recall, clinical and radiographical (periapical) examination was carried out to evaluate the following: implant survival; marginal bone level; periodontal indices. Evaluations made at one month of follow-up were considered the baseline values.

In the follow-up evaluations, only the patients, who in the period of one year and five years from the implant placement needed a 3-dimensional investigation for other reason not linked to this study, were considered. In line to this, only 26 out of 102 patients (30 implants) were considered for the follow-ups evaluations. CBCT scans were evaluated in order to assess the mean bone height after prosthetic restoration (mARBH), (Figure 5).

Implant survival was defined as being symptom free and stable without mobility or radiographic evidence of severe bone loss (more than 2 mm). No inflammation or infection should affect hard and soft tissues. Two different examiners analyzed the implants using a blind analysis technique, and by giving univocal (yes/not) responses.

Marginal Bone Lost (MBL) is defined as the maximum distance from the implant-abutment junction (IAJ) to the marginal bone. Digital periapical radiographs were taken at each follow up and images were analyzed using the software (Dentsply, Sirona). Calibration was achieved using the software tools and using the implant length as control. Mesial and distal values (expressed in millimeters) were recorded for each implant. A positive value was assigned if the bone was over the IAJ, while a negative value was assigned if bone was below IAJ. The zero score was given when bone level was at IAJ. Mean value of the two measurements was obtained for each implant. Two different examiners, who were independent of the surgeons, were enrolled to evaluate radiograms. The mean value of mesial and distal measurement was obtained.

The mean values of MBL at baseline (1 month) were compared with values at the last follow up (five years) obtaining the marginal bone level variation (MBLv).

At each follow-up visit, a clinical evaluation was carried out in order to record the pocket depth (PD), the O'Leary plaque index (PI), and bleeding on probing (BOP) around implants.

PD was measured with a CP12 probe on six sites: three vestibular (mesial, vestibular, and distal) and three lingual (mesial, lingual, distal). The values, expressed in millimeters, were used to achieve the mean PD value for each implant and finally for all the implants.

PI was measured on six sites (three vestibular and three lingual) around each implant. Data were collected for all im-

dogradnje i kompozitne krunice koje su spojene u jedan dio za izravno pričvršćivanje na implantat. Nadogradnja je izrađena od titanijeve legure (Ti V6 A14), a materijal koji je korišten za krunicu bio je kompozitna smola s visokim udjelom punila (Shofu Inc. Kyoto Japan) (slika 3.). Snimljen je intraoralni rendgen (slika 4.).

Praćenje

Nakon protetičke rehabilitacije kontrolni pregledi bili su dogovoreni jedan, šest i dvanaest mjeseci tijekom prve godine, a nakon toga jedanput svake godine. Pri svakom posjetu obavljen je klinički i radiološki (periapikalni) pregled kako bi se procijenilo sljedeće: preživljavanje implantata, razina marginalne kosti i parodontološki indeksi. Vrijednosti dobivene nakon jednog mjeseca smatrane su osnovnim vrijednostima.

U naknadnim evaluacijama razmatrani su samo pacijenti kojima je u razdoblju jedne i pet godina od postavljanja implantata bilo potrebno trodimenzionalno istraživanje iz drugih razloga koji nisu povezani s ovim istraživanjem. U skladu s tim, samo je 26 od 102 pacijenta (30 implantata) uključeno u naknadne procjene. CBCT snimke analizirane su da bi se procijenila srednja visina kosti nakon protetičke restauracije (mARBH) (slika 5.).

Preživljavanje implantata definirano je kao stabilno stanje bez simptoma i bez pokretljivosti ili radioloških dokaza o ozbiljnom gubitku kosti (više od 2 mm). Upala ili infekcija ne bi smjele utjecati na tvrda i meka tkiva. Dvoje različitih ispitivača analiziralo je implantate tehnikom slijepe analize i davanjem jednoznačnih (da/ne) odgovora.

Gubitak marginalne kosti (MBL) definiran je kao maksimalna udaljenost od spoja implantata i implantatne nadogradnje (IAJ) do marginalne kosti. Digitalne periapikalne snimke snimljene su tijekom svakog praćenja i analizirane s pomoću softvera (Dentsply, Sirona). Kalibracija je postignuta softverskim alatima i korištenjem dužine implantata kao kontrole. Mezijalne i distalne vrijednosti (izražene u milimetrima) zabilježene su za svaki implantat. Pozitivna vrijednost dodijeljena je ako je kost bila iznad IAJ-a, a negativna ako je bila ispod IAJ-a. Ocjena nula dana je kada je razina kosti bila na IAJ-u. Prosječna vrijednost dviju mjera dobivena je za svaki implantat. Dvoje različitih ispitivača, koji su bili neovisni o kirurgu, uključeni su u procjenu rendgenske snimke. Dobivena je srednja vrijednost mezijalne i distalne mjere.

Prosječne vrijednosti MBL-a na početku (1 mjesec) uspoređivane su s vrijednostima u posljednjem praćenju (pet godina) te se tako dobila varijacija razine marginalne kosti (MBLv).

Pri svakom naknadnom posjetu učinjena je klinička procjena da bi se zabilježila dubina džepa (PD), indeks plaka prema O'Learyiju (PI) i krvarenje na sondiranje (BOP) oko implantata.

PD je izmjeren sondom CP12 na šest mjesta – tri vestibularno (mezijalna, vestibularna i distalna) i tri lingvalno (mezijalno, lingvalno, distalno). Vrijednosti izražene u milimetrima korištene su za izračun srednje vrijednosti PD-a za svaki implantat i na kraju za sve implantate.

PI je izmjeren na šest mjesta (tri vestibularno i tri lingvalno) oko svakog implantata. Podatci su prikupljeni za sve im-

plants and were expressed as percentage of plaque sites (% PI) (number of surfaces with plaque/total number of sites examined x100).

BOP was also measured on six sites (three vestibular and three lingual) around each implant and evaluated altogether. Data are expressed as percentage of bleeding sites (% BOP) (Number of bleeding sites/total number of sites examined x100).

Two different examiners, independent of the surgeons, were enrolled to value implants.

ARBH is defined as the distance from the crest to the top of grafted bone after the surgery. It is achieved in the same way as mRBH using the CT scan software tools. Calibration was achieved using the software tools and using the implant length as control. The mean value (mARBH) was obtained for each implant by three measurements, one at the implant center and two mesially and distally of 2 mm on paraxial sections. The value of mARBH measured at 1 year of follow-up was compared to data at 5 years follow-up. The difference between the two values was the objective of this study and it has been called mARBH variation (mARBHv).

Some adverse events were recorded.

Results

A total of 30 implants were inserted in 26 patients. The population sample included 20 female and 6 male subjects. The average age of participants was 50.5 years (min 35 years and max 65 years). The dental sites treated were: 10 second upper premolar; 15 first upper molar; 5 second upper molar. Three implant measures were used (diameter X length in mm): 5x6 (13); 5x5 (7); 6x5 (7); 6x6 (3). The mean RBH of population was 2.13 mm with a minimum of 1.1 mm and a maximum value of 3 mm.

- Implant survival:

  All the implants survived until the last follow-up.

- Marginal bone level variation:

  The difference of the mean bone level measured at each implant at 1-month follow-up and the mean value at 60 months of follow up (five years) resulted on average -0.33 mm (Standard Deviation (SD) 0.11) in the population observed (minimum -0.12 and maximum -0.52).

- Mean Bone Height After Prosthetic Restoration (mARBHv):

  The mean value registered at 1 year was compared to the mean value registered at 60 months. The bone harvested resorption was on average -0.4 mm (DS 0.26) in the population observed, with a minimum loss of -0.06 mm and the maximum loss of -1.11 mm. The bone loss could be expressed as percentage, mean 5% of vertical harvested bone loss (max -11%; min - 1%).

- Periodontal indices at the last follow up (5 years):

  The probing depth measured in the six sites for each implant was used to achieve the mean PD for the entire population. The mean value was 1.22 mm (DS 0.72) with values ranging from 0 and 3 mm.

plantate i izraženi kao postotak mjesta s plakom (% PI) (broj površina s plakom / ukupan broj pregledanih mjesta x 100).

BOP je također izmjeren na šest mjesta (tri vestibularno i tri lingvalno) oko svakog implantata i procijenjen ukupno. Podatci su izraženi kao postotak mjesta krvarenja (% BOP) (broj mjesta krvarenja / ukupan broj pregledanih mjesta x 100).

Dvoje različitih ispitivača, neovisno o kirurgu, bilo je uključeno u procjenu implantata.

ARBH se definira kao udaljenost od grebena do vrha augmentirane kosti nakon operacije. Mjeri se na isti način kao i mRBH s pomoću softverskih alata za CT skenove. Kalibracija je postignuta softverskim alatima i upotrebom dužine implantata kao kontrole. Srednja vrijednost (mARBH) dobivena je za svaki implantat trima mjerenjima – jedno u središtu implantata i dva mezijalno i distalno od 2 mm na paraksijalnim presjecima. Vrijednost mARBH izmjerena nakon jedne godine uspoređena je s podatcima tijekom petogodišnjeg praćenja. Cilj ovog istraživanja bio je dobiti razliku između dviju vrijednosti koja se naziva mARBH varijacija (mARBHv).

Zabilježeni su neki neželjeni događaji.

Rezultati

Dvadeset i šestero pacijenata dobilo je ukupno 30 implantata. Uzorak populacije obuhvaćao je 20 žena i 6 muškaraca. Prosječna dob sudionika bila je 50,5 godina (najmanje 35 godina i najviše 65 godina). Regije liječenja obuhvaćale su: 10 gornjih pretkutnjaka, 15 prvih gornjih kutnjaka, 5 drugih gornjih kutnjaka. Korištene su tri dimenzije implantata (promjer x dužina u mm): 5 x 6 (13); 5 x 5 (7); 6 x 5 (7); 6 x 6 (3). Prosječni RBH populacije bio je 2,13 mm s minimalnom vrijednošću od 1,1 mm i maksimalnom vrijednošću od 3 mm.

- Preživljavanje implantata:

  svi implantati preživjeli su do posljednjeg praćenja.

- Varijacija razine marginalne kosti

  Razlika srednje razine kosti izmjerene na svakom implantatu tijekom jednomjesečnog praćenja i srednje vrijednosti nakon 60 mjeseci (pet godina) rezultirala je u prosjeku gubitkom od 0,33 mm [standardna devijacija (SD) 0,11] u promatranoj populaciji (minimalno -0,12, a maksimalno -0,52).

- Srednja visina kosti nakon protetičke opskrbe (mARBHv)

  Prosječna vrijednost zabilježena poslije jedne godine uspoređena je sa srednjom vrijednošću registriranom nakon 60 mjeseci. Resorpcija kosti iznosila je u prosjeku -0,4 mm (DS 0,26) u praćenoj populaciji, s minimalnim gubitkom od -0,06 mm i maksimalnim gubitkom od -1,11 mm. Gubitak kosti može se izraziti kao postotak, što znači 5 % vertikalnoga gubitka kosti (maks. -11 %; min. -1 %).

- Parodontološki indeksi u posljednjem praćenju (5 godina)

  Dubina sondiranja izmjerena na šest mjesta za svaki implantat korištena je za izračun srednje vrijednosti PD-a za ci-

Plaque and bleeding were recorded among the implant group at the last follow up. Thirty-two sites were positive to plaque and eighteen sites were positive to bleeding among the 180 sites analyzed. The relative mean percentage of Plaque Index was 17.47% (DS 15.01), while the mean percentage of Bleeding on Probing was 9.87% (DS 19.17).

The principal data on the five years follow-up are listed in Table 1.

jelu populaciju. Srednja vrijednost iznosila je 1,22 mm (DS 0,72) s vrijednostima u rasponu od 0 do 3 mm.

Plak i krvarenje zabilježeni su među implantacijskom skupinom na posljednjem kontrolnom pregledu. Trideset i dva mjesta bila su pozitivna na plak, a osamnaest na krvarenje među 180 analiziranih mjesta. Relativni srednji postotak indeksa plaka bio je 17,47 % (DS 15,01), a srednji postotak krvarenja na sondiranje iznosio je 9,87 % (DS 19,17).

Glavni podatci o petogodišnjem praćenju navedeni su u tablici 1.

Table 1 Schematic representation of the principal final data with respective mean values and standard deviations (SD).
Tablica 1. Prikaz glavnih konačnih podataka s odgovarajućim srednjim vrijednostima i standardnim devijacijama (SD)

Principal final data • Glavni konačni podatci	
Implant survival • Preživljavanje implantata	100 %
Mean MBLv • Prosječni MBLv	-0.33 mm (SD 0.11)
Mean PD • Prosječni PD	1.22 mm (SD 0.72)
Mean PI • Prosječni PI	17.47 % (SD 15.01)
Mean BOP • Prosječni BOP	9.87 % (SD 19.17)
Adverse events • Neželjeni događaji	0
ARBHv	-0.4 mm (SD 0.26) on average (5 %)

Discussion

The maxillary atrophy is a challenge for prosthetic rehabilitation. Over the years, many techniques were recommended to gain the adequate bone volume to place dental implants (1). The sinus floor elevation is the most documented treatment option and various techniques have been described. Many authors have questioned the best approach for each condition (2). The vertical residual bone height has been considered the crucial parameter in choosing the best strategy. When the amount of residual bone is at least 5 mm vertically, the immediate implant positioning is allowed (11), while the lateral approach for sinus floor elevation and delayed implant positioning is suggested in case of 4mm or less of residual vertical bone (17).

The objective of this study was to evaluate the long-term performance of a sinus floor elevation technique that allows immediate implant positioning in case of residual bone height less than 3 mm.

The population observed showed a good maintenance of crestal bone after the prosthetic restoration (mean -0.33 mm of crestal loss after 5 years). The stability of crestal bone could be explained by the subcrestal placement of the conometric implant-abutment junction. The mechanical and biological seal joined to the epicrestal stimuli carried by the abutment could be considered the key factor. The good health condition is confirmed by good values of periodontal indices registered.

The findings of this paper could be considered satisfactory according to the results presented in the literature (29).

As previously reported, socio-economic status and patients' compliance are crucial in order to achieve implant success (30). All patients in care at Oral Surgery Unit of the Department of Oral and Maxillofacial Sciences of "Sapienza" University of Rome have been regularly followed over the years. In our study, after 5 year of function, we noted a reduction of grafted bone of 5% (mean value) in the interval between one year and five year follow up. The value is con-

Rasprava

Atrofija maksile izazov je za protetičku rehabilitaciju. Tijekom godina preporučivale su se mnoge tehnike kako bi se dobio dovoljan volumen kosti za postavljanje dentalnih implantata (1). Podizanje dna sinusa najdokumentiraniji je oblik, pa su opisane razne tehnike. Mnogi su autori doveli u pitanje najbolji pristup za svako stanje (2). Rezidualna visina kosti smatrala se presudnim parametrom pri odabiru najbolje strategije. Kada je rezidualna vertikalna kost debela najmanje 5 mm, moguća je imedijatna ugradnja implantata (11), a lateralni pristup za podizanje dna sinusa i odgođena ugradnja implantata preporučuju se u slučaju rezidualne vertikalne kosti od 4 mm ili manje (17) .

Cilj ovog istraživanja bio je procijeniti dugoročne rezultate tehnike podizanja dna sinusa koja omogućuje imedijatnu ugradnju implantata u slučaju rezidualne visine kosti manje od 3 mm.

Promatrana populacija pokazala je dobro održavanje krestalne kosti nakon protetičke restauracije (prosjek -0,33 mm gubitka krestalne kosti nakon pet godina). Stabilnost krestalne kosti mogla bi se objasniti supkrestalnim postavljanjem koničnoga spoja implantata i nadogradnje. Mehanički i biološki pečat spojen u kombinaciji s epikrestalnom stimulacijom preko nadogradnje mogli bi se smatrati ključnim čimbenikom. Povoljno stanje potvrđuju dobre vrijednosti registriranih parodontoloških indeksa.

Rezultati ovoga rada mogli bi se smatrati zadovoljavajućima prema rezultatima koji se nalaze u literaturi (29).

Kao što je već istaknuto, socioekonomski status i suradnja pacijenata presudni su za postizanje uspjeha u implantološkoj terapiji (30). Tijekom godina redovito su praćeni svi pacijenti na Odjelu za oralnu kirurgiju Sveučilišta Sapienza u Rimu. U našem istraživanju, nakon pet godina u funkciji, primijetili smo smanjenje augmentirane kosti za 5 % (srednja vrijednost) u intervalu između jedne i pet godina praćenja. Vrijednost se smatra prihvatljivom prema rezultatima u literaturi (29, 31).

sidered acceptable according to the results present in the literature (29, 31).

In authors' opinion, the substantial stability of grafted bone volume depends not only on the osteoconductivity of the bone allograft but also on the formation of haversian bone following the functional stimulation carried out by the implant design. As reported by histological studies, the plateau macrodesign of those implants allows a direct bone formation (32). The healing chamber is filled by the blood clot, promoting the contact with fibrin and osteogenic cells, leading to bone formation (33).

Moreover, in reference to our case, Daher S. (2019) reported a histological analysis of a human retrieved functioning implant which was placed using Beta-Tricalcium Phosphate (34). The specimen analyzed showed no discernable differences between the original host bone and a new bone in terms of lamellar and osteonic structure.

Eventually, the use of short implants could reduce the time of rehabilitation, thus providing faster prosthesis even in case of extreme atrophy, when compared to traditional bone graft procedures.

Conclusions

This technique is considered safe for the patient and less invasive if compared to LSFE. Incidents and compliances are inevitable in every surgical procedure, even more in these advanced cases. The worst complication is a displacement of the fixture into the sinus. Anyway, if the case is carefully selected and the procedure carefully performed, the main complications are avoided.

Although more casuistry is needed, with its limitations, this research validated the viability of the technique presented.

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Institutional Review Board Statement

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of "Sapienza" University of Rome (protocol code 27/13.06.2013).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest

The authors declare no conflict of interest.

Author's Contributions: Conceptualization, **A.C.** and **S.C.**; methodology, **A.C.**; software, **A.P.**; validation, **L.T.**; formal analysis, **G.P.**; investigation, **A.C.**; resources, **A.C.**; data curation, **A.P.**; writing—original draft preparation, **A.P.** and **G.P.**; writing—review and editing, **A.Z.** and **L.T.**; visualization, **S.C.**; supervision, **A.C.**; project administration, **A.C.**; All authors have read and agreed to the published version of the manuscript.

Prema mišljenju autora, stabilnost volumena augmentirane kosti ne ovisi samo o osteokonduktivnosti koštanoga alografta, nego i o formiranju kosti nakon funkcijske stimulacije zbog dizajna implantata. Kao što su pokazale histološke studije, makrodizajn tih implantata omogućuje izravno stvaranje kosti (32). Šupljina se puni krvnim ugruškom potičući kontakt s fibrinom i osteogenim stanicama, pa se počinje stvarati kost (33).

Štoviše, S. Daher (2019.) izvijestio je o histološkoj analizi ljudskoga funkcionalnog implantata koji je postavljen s pomoću beta-trikalcijeva fosfata (34). Analizirani uzorak nije pokazao uočljive razlike između izvorne kosti domaćina i novoformirane kosti kad je riječ o strukturi.

Na kraju, upotreba kratkih implantata mogla bi skratiti rehabilitaciju i tako omogućiti bržu protetičku opskrbu, čak i u slučaju ekstremne atrofije, u usporedbi s tradicionalnim postupcima augmentacije kosti.

Zaključci

Ova se tehnika smatra sigurnom za pacijenta i manje invazivnom u usporedbi s LSFE-om. Komplikacije su katkad neizbježne tijekom kirurškog zahvata, čak i češće u ovim složenim slučajevima. Najgore što se može dogoditi jest pomicanje implantata u sinus. U svakom slučaju, ako se pažljivo odabere slučaj i jednako tako obavi postupak, izbjegavaju se veće komplikacije.

Iako je potreban veći broj slučajeva, uzimajući u obzir ograničenja, ovo je istraživanje potvrdilo održivost predstavljene tehnike.

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Sukob interesa

Autori nisu bili u sukobu interesa.

Doprinos autora: Konceptualizacija, **A.C. i S.C.**; metodologija, **A.C.**; softver, **A.P.**; validacija, **L.T.**; formalna analiza, **G.P.**; istraga, **A.C.**; resursi, **A.C.**; obrada podataka, **A.P.**; pisanje – priprema izvornog nacrta, **A.P.** i **G.P.**; pisanje – pregled i uređivanje, **A.Z. i L.T.**; vizualizacija, **S.C.**; nadzor, **A.C.**; administracija projekta, **A.C.**; Svi su autori pročitali i složili se s objavljenom verzijom rukopisa. Svi su autori pročitali tekst i složili se s objavljenom verzijom.

Sažetak

Svrha rada: Mnogi su se autori pokušali suočiti s anatomskim ograničenjima koja nastaju zbog atrofije maksilarne kosti. Do visine kosti od pet milimetara lateralno podizanje dna sinusa najčešće je korištena i potvrđena strategija za protetičku rehabilitaciju. No nedostatci te tehnike su invazivnost i odgođena rehabilitacija. Cilj ovoga rada bio je procijeniti petogodišnji klinički ishod ugrađenih implantata tehnikom koja omogućuje perkrestalno podizanje dna sinusa i imedijatnu ugradnju implantata. **Materijali i metode:** Obavljeno je 30 transkrestalnih podizanja dna sinusa s imedijatnom ugradnjom implantata u vrlo atrofiranu maksilu. Procijenjeni su preživljavanje implantata, varijacija razine marginalne kosti te varijacija visine kosti i parodontoloških indeksa. **Rezultati:** Nakon petogodišnjeg praćenja ni jedan od trideset implantata nije bio izgubljen. Srednja vrijednost vertikalnog gubitka kosti iznosila je 5 %. Srednji gubitak krestalne kosti bio je -0,33 mm [standardna devijacija (SD) 0,11 mm]. Srednja vrijednost parodontoloških indeksa bila je: PD 1,22 mm (SD 0,72 mm), PI 17,47 % (SD 15,01 mm), BOP 9, 87 %, (SD 19,17 mm). **Zaključak:** Dobiveni rezultati usporedivi su s kriterijima uspješnosti u implantološkoj rehabilitaciji. Prikazana tehnika pokazala se uspješnom u promatranoj populaciji, uz minimalne traume i smanjenu invazivnost.

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Adresa za dopisivanje
Prof. Luca Testarelli, PhD
Sapienza University of Rome
Department of Oral and Maxillo-Facial Sciences
Via Caserta 6, Rome 00161, Italy
luca.testarelli@uniroma1.it

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