CASE REPORT
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Application of piezosurgery for transcrestal sinus lift during simultaneous implant placement – case report

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SUMMARY

Introduction Implant placement is often complicated in the posterior maxilla by post-extraction bone resorption, pneumatization of maxillary sinuses, and poor quality of alveolar bone. In these situations, elevation of the maxillary sinus floor is one possible solution, which requires surgical maxillary sinus augmentation techniques that can convert part of the sinus cavity into bone suitable for implant placement.

Case outline A 34-year-old female patient was referred for implant treatment of the posterior left maxilla. A radiographic assessment revealed an atrophied posterior maxilla in the region of 25, 26, and 27, with a residual alveolar ridge height of 6 mm. At site 26, a transcrestal sinus lift was performed using a piezoelectric-surgery technique. A xenograft mixed with hyaluronic acid was used as the graft material. After graft application, a two-stage endosseous implant (Bio3, Pforzheim, Germany) with dimensions 8 × 4.2 mm was placed in the prepared site.

Conclusion Piezosurgery is an optimal option in all cases where sinus membrane elevation via the transcrestal approach is required, with the possibility of simultaneous implant placement when the residual alveolar ridge height is > 5 mm.

Keywords: sinus lift; transcrestal approach; piezoelectric surgery; endosseous dental implants

INTRODUCTION

The maxillary sinus is the largest of the paranasal sinuses and in adults contains roughly 12–15 mL of air [1]. It is a pyramidal structure with its base close to the nasal cavity, the superior portion forming the floor of the orbit, and the apex directed toward the zygomatic bone [2]. The floor of the sinus extends anteriorly to the premolar or canine region and posteriorly to the maxillary tuberosity, with its lowest part in many cases being close to the area of the first molar. The floor of the maxillary sinus is the thickest wall in dentate adults and is at about the same level as the nasal floor. In ø edentulous patients it is 1 cm below the nasal floor [3].

The rising demand for implant treatment corresponds with a growing need for their placement in various anatomical sites. Implant placement is often complicated in the posterior maxilla by post-extraction bone resorption, pneumatization of maxillary sinuses, and poor alveolar-bone quality, leading to a faster rate of bone loss compared with other areas of the mouth [4]. In these situations, elevation of the maxillary sinus floor is one possible solution, which requires surgical maxillary-sinus-augmentation techniques that can convert part of the sinus cavity into bone suitable for implant placement [5].

The most widely used technique for maxillary-sinus-floor elevation is the classic lateral antrostomy introduced by Tatum in 1976 and later published by Boyne and James in 1980. This technique is based on the lateral-window method, a modification of the well-known Caldwell–Luc sinus-revision procedure, in which grafted bone may be added in excess of 10–16 mm through a lateral-wall quadrilateral osteotomy [6]. According to traditional protocols, in cases of good-quality bone and subantral bone height of 5–6 mm the implant is placed simultaneously with the sinus-floor elevation, with or without adding bone-graft material [7]. In contrast, in situations of poor-quality bone or of subantral bone height < 5 mm, lateral antrostomy is performed and the space under the elevated Schneiderian membrane is filled with bone-graft material [6].

The most common intraoperative complication with these surgical approaches is perforation of the Schneiderian membrane [8]. Although no evidence suggests that perforation of the Schneiderian membrane reduces the survival rate of the implants, perforation may cause the grafting materials to enter the sinus cavity, leading to inflammation [9].

A crestal approach for sinus-floor elevation was initially suggested by Tatum, while Summers later proposed the osteotome technique to place implants in a simpler, more conservative, and less invasive manner than the lateral approach [10]. In Summers' technique, an osteotome is inserted through the edentulous alveolar crest at the

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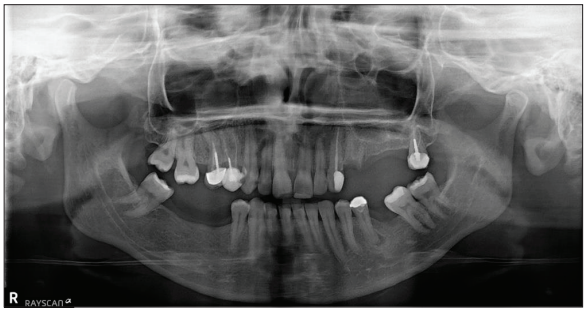

Figure 1. Panoramic X-ray of the initial situation
Slika 1. Ortopantomografski snimak početne situacije

Figure 2. Placed implant at site 24 and preparation of implant site 26
Slika 2. Postavljeni implantat u regiji 24 i priprema implantnog ležišta 26

Figure 3. Piezoelectric extension with a rounded tip
Slika 3. Piezoelektrični nastavak sa zaobljenim vrhom

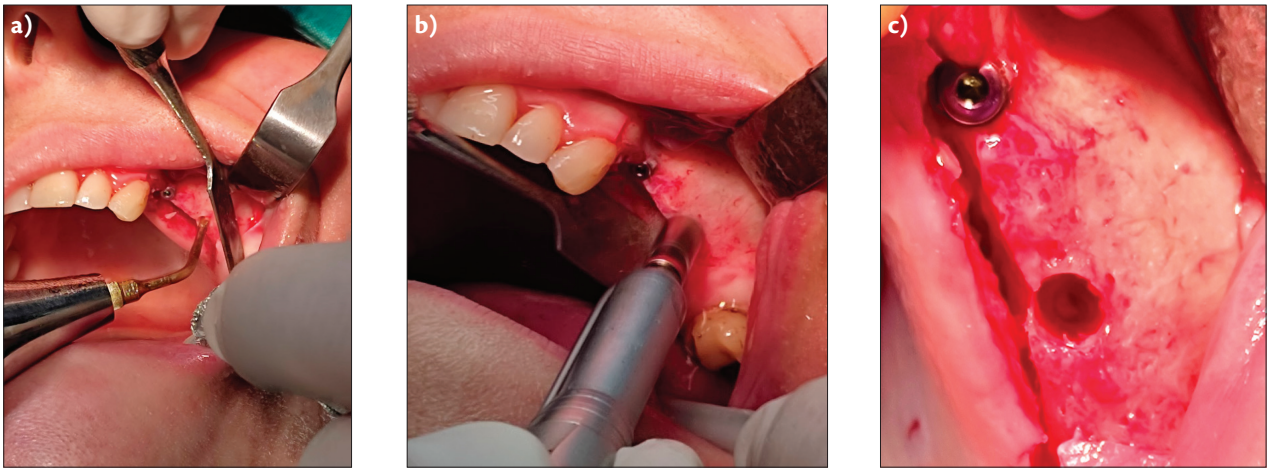

Figura 4. a) Maxillary-sinus-floor elevation using piezoelectric surgery; b) Expansion of implant site 26; c) Prepared implant site 26
Slika 4. a) Podizanje dna maksilarnog sinusa pomoću piezohirurgije; b) Proširenje implantnog ležišta 26; c) Pripremljeno implantno ležište 26

inferior border of the maxillary-sinus floor. This intrusion procedure produces a fracture in the least traumatic way possible and the sinus floor is moved upward, creating a space for bone graft placement and simultaneous implant insertion [11].

Over the past decade, various modifications of the osteotome technique for sinus lifting have been introduced, including hydraulic, crestal-core, and infracture methods. These techniques fall under osteotome-mediated sinus-floor elevation, which allows for localized sinus-floor elevation via a crestal approach, the placement of grafting materials beneath it, and the subsequent insertion of implants. One of the many described techniques uses piezoelectric ultrasonic vibration (25–30 kHz). The piezosurgery device precisely cuts only mineralized structures (bone) without cutting soft tissues, which remain undamaged even in case of accidental contact. The typical cavitation effect induces hydropneumatic pressure in the physiological saline solution that contributes to atraumatic sinus membrane elevation [12].

The aim of this article is to present a case report on the transcrestal sinus-lift technique using piezosurgery, with simultaneous placement of a dental implant in the posterior maxilla.

CASE REPORT

A 34-year-old female patient, a non-smoker, denied the presence of systemic diseases or the use of chronic therapy. Clinical examination and radiographic assessment revealed an atrophied posterior maxilla in the region of teeth 25, 26, and 27, with a residual alveolar-ridge height of 6 mm (Figure 1). After discussing the current condition and the necessity of a surgical approach for sinus-membrane elevation, the patient agreed to undergo the procedure.

Following the administration of local infiltrative anesthesia at the surgical site and elevation of a full-thickness flap, the first implant site was prepared at the level of tooth 24, and a two-stage implant (Bio3, Pforzheim, Germany) with dimensions 11.5 × 3.3 mm was placed. Once the first implant was positioned, preparation of the implant site for the second implant in the region of tooth 26 continued

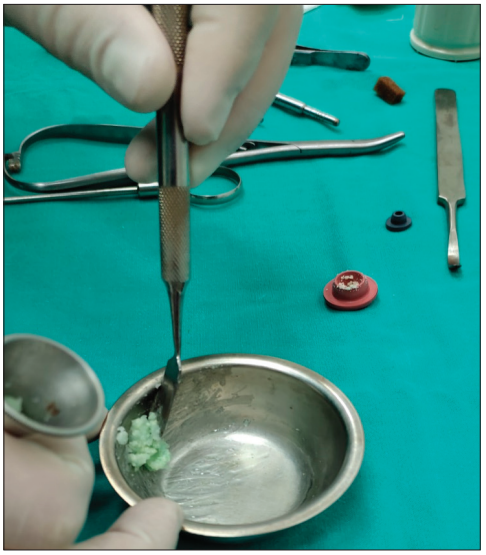

Figure 5. Mixing graft material with hyaluronic acid
Slika 5. Mešanje graft materijala sa hijaluronskom kiselinom

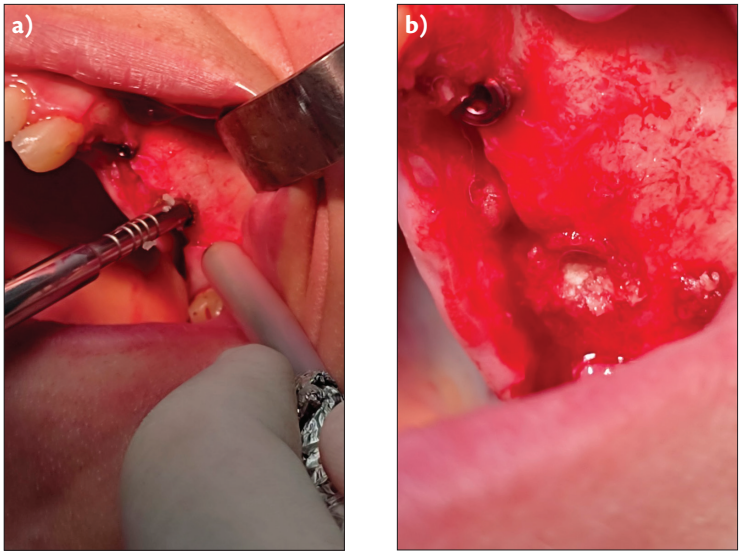

Figure 6. Filling the prepared site with graft material (a and b)
Slika 6. Popunjavanje pripremljenog ležišta graft materijalom (a i b)

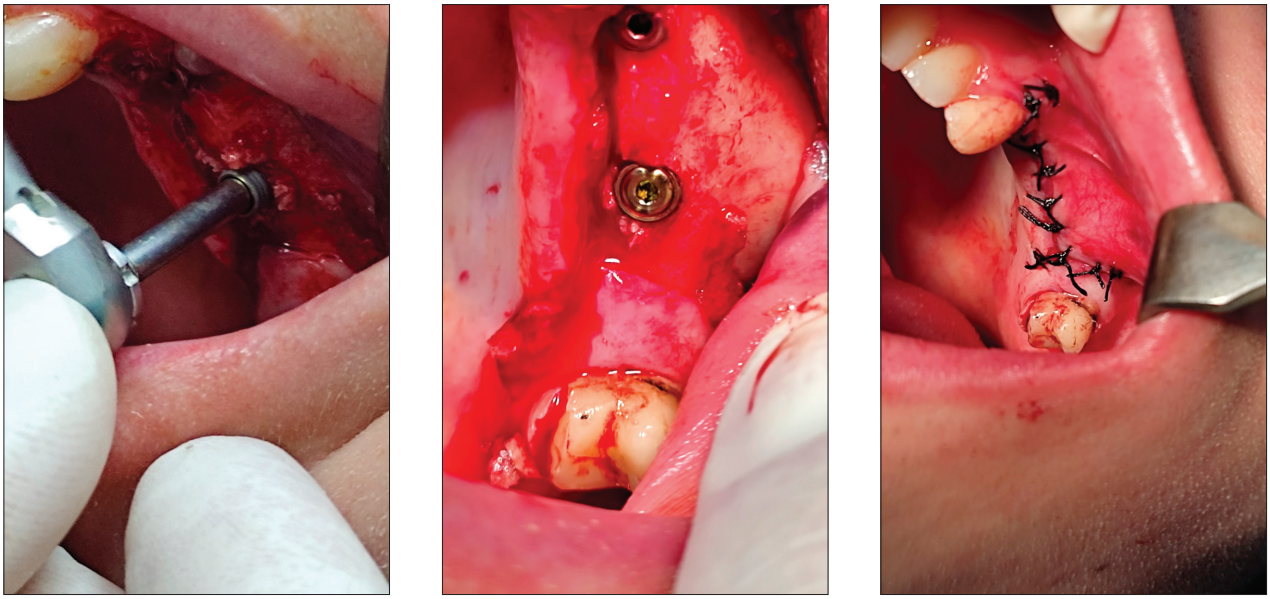

Figure 7. a) Implant placement at prepared site 26; b) Both implants at sites 24 and 26; c) Closed surgical site with simple interrupted sutures
Slika 7. a) Postavljanje implantata u pripremljeno ležište 26; b) Postavljeni implantati u regijama 24 i 26; c) Zatvorena hirurška regija pojedinačnim šavovima

using standard drills from the surgical set, where the residual alveolar-ridge height was limited (Figure 2).

In such cases of atrophied posterior maxilla, characterized by low supportive capacity, the implant site is prepared with reduced dimensions to enhance primary implant stability. The preparation was carried out up to 1 mm from the bony floor of the maxillary sinus. Upon reaching the appropriate depth, piezoelectric extensions with a rounded (ball-shaped) tip were used to perforate the bony floor, allowing contact with the sinus membrane (Figure 3). The ultrasonic vibrations facilitated elevation of the sinus membrane. This was followed by expansion of the implant site using a stopper sleeve with smaller dimensions than the planned implant size and by filling the created subantral space with graft material (Figure 4).

A xenograft from the same manufacturer (Bio3), combined with hyaluronic acid, was used (Figure 5). The graft was applied into the sinus cavity with a specialized applicator until the prepared site was completely filled (Figure 6). After graft application, a two-stage endosseous implant (Bio3) with dimensions 8 × 4.2 mm was placed in the prepared site. The surgical site was then closed with simple interrupted sutures (Figure 7). Antibiotics (amoxicillin 875 mg + clavulanic acid 125 mg, twice a day) were prescribed for seven days and analgesics as required.

A follow-up radiographic examination at six months showed successfully osseointegrated implants, with no changes in the sinus cavity and no clinical signs of postoperative complications (Figure 8). After successful implant therapy, the patient proceeded with prosthetic rehabilitation involving fabrication of a fixed prosthetic restoration.

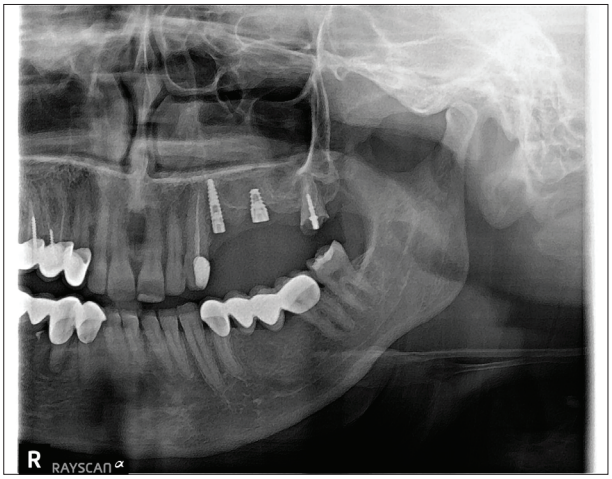

Figure 8. Follow-up panoramic X-ray after six months
Slika 8. Kontrolni ortopantomografski snimak nakon šest meseci

DISCUSSION

According to the literature, if implants are installed at the time of a sinus-lifting procedure, many investigators agree that there should be a minimum of 5 mm or more of initial subantral bone height and bone of sufficient density to provide good initial dental implant stability [13, 14].

Patients presenting < 5 mm of residual subantral bone are usually treated using the lateral antrostomy technique and two-stage surgery, with sinus lifting performed in one stage and implant placement later in the second stage [15].

According to Toffler [16], the primary determinant of implant survival with osteotome-mediated sinus-floor elevation procedures is the height of the residual alveolar ridge.

In a multicenter retrospective study, Rosen et al. evaluated the outcome of the Summers' technique in the placement of implants below the maxillary sinus floor: the success rate was 96% when the residual bone height was 5 mm or more, but dropped to 85% when crestal bone height was 4 mm or less.

Existing literature suggests that residual bone height has a significant influence on the outcome of crestal procedures. Specifically, the success rate decreases with reduced residual bone height [17].

In general, studies comparing the lateral and transcrestal approaches for sinus lift show that the transcrestal technique allows for a maximum bone-height increase of 3–4 mm, whereas the lateral technique permits an increase of 10–12 mm [18].

In a study conducted by Baldi et al. [19], two transcrestal techniques – piezoelectric and osteotome-mediated sinus-floor elevation – were evaluated. The mean sinus-floor elevation (6.78 mm) was equal to or greater than the augmentation reported in previous studies using osteotome-mediated sinus-floor elevation [19].

In the retrospective study by Bernardello et al. [20], a one-stage crestal approach for sinus lift was performed using a specific sequence of drills (Cosci's technique). The shape of the drill tip prevents perforation of the sinus membrane and permits gentle abrasive removal of the cortical bone without fracture.

Out of 134 implants immediately inserted into sites with a residual bone height of less than 5 mm (average height 3.46 ± 0.91 mm), an excellent survival rate (96.3%) was observed over a 48-month follow-up. The average bone-height gain was 6.48 ± 2.38 mm, greater than the increase typically achieved using the osteotome technique (3–4 mm) [20].

Marchetti et al. [21] concluded that the average volume augmentation after the piezoelectric transcrestal approach was 4.2 mm, as assessed at the 12-month X-ray check-up.

Many authors suggest that in cases of low supportive capacity (e.g. an atrophic posterior maxilla), the diameter of the implant-site preparation should be reduced compared with standard protocols to optimize primary stability [19].

One of the most frequent causes of failure during maxillary-sinus-floor augmentation by the crestal approach is rupture of the Schneiderian membrane. Although the crestal approach is less invasive, the lack of a direct view of the membrane prevents assessment of a possible perforation, with subsequent dispersion of graft material in the maxillary sinus and failure of the regenerative treatment [21].

Wallace et al. [22] reported that the membrane-perforation rate fell from 30% with rotary instrumentation to 7% using the piezoelectric technique.

Apart from reducing the risk of membrane perforation, piezoelectric surgery offers several advantages over other techniques used for the transcrestal approach. Some of these advantages include the following: minimal movement of the piezosurgery extensions, which increases cutting precision and reduces patient discomfort; the absence of macrovibrations, making the instrument more manageable and allowing greater intra-operative control, resulting in a safer approach in anatomically challenging regions; and the ability to maintain a clear surgical site by keeping a blood-free field during bone cutting, due to the air–water cavitation effect of the ultrasonic instrument [23].

Different types of biomaterials have been used for sinus augmentation, including autograft, allograft, xenograft, alloplast, and growth factors, and the selection of the ideal graft material is controversial.

Autogenous grafts, harvested from intra- or extra-oral sources, are the gold standard owing to their osteogenic capacity, but increased morbidity, limited availability, and a high resorption rate (up to 40%) make them less desirable.

Allogenic bone grafts, or allografts, are obtained from cadavers of the same species as the recipient of the graft. They are osteoconductive space-maintaining scaffolds for bone regeneration.

Their osteoinductive capability can be enhanced by demineralization, although processing reduces growth-factor content.

Xenografts are obtained from different animal species and act as semi-permanent, slowly resorbing, osteoconductive grafts.

Alloplastic grafting materials are either synthetic (polymers, calcium sulphates, hydroxyapatite, calcium phosphates) or natural (coral- or algae-derived hydroxyapatite). Alloplastic grafting materials are generally osteoconductive only [24].

In the present study, a xenograft mixed with hyaluronic acid was used as graft material. According to numerous studies, the crucial factors for successful implant treatment after a sinus-lift procedure include thorough evaluation of the patient's systemic and oral health and precise radiographic measurement of the residual bone height. These factors directly influence the choice of sinus-lift approach and technique.

The ability to work in direct proximity to the sinus membrane without causing perforation makes piezosurgery an optimal option in all cases where sinus membrane elevation via the transcrestal approach is required, with the possibility of simultaneous implant placement when the height of the residual alveolar ridge is more than 5 mm.

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Primena piezohirurgije za transkrestalni pristup sinus liftu uz istovremeno postavljanje implantata – prikaz slučaja

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SAŽETAK

Uvod Postavljanje implantata u posteriornoj maksili često je otežano zbog postekstrakcione resorpcije kosti, pneumatizacije maksilarnih sinusa i lošeg kvaliteta alveolarne kosti. U takvim situacijama, podizanje dna maksilarnog sinusa predstavlja jedno od mogućih rešenja, koje zahteva hirurške tehnike augmentacije sinusa kako bi se deo sinusne šupljine pretvorio u kost pogodnu za postavljanje implantata.

Prikaz slučaja Pacijentkinja stara 34 godine upućena je na implantološki tretman posteriorne leve maksile. Radiografska procena pokazala je atrofičnu posteriornu maksilu u regiji zuba 25, 26 i 27, sa preostalom visinom alveolarnog grebena od 6 mm. Na mestu zuba 26 izvršeno je podizanje membrane sinusa transkrestalnim pristupom primenom piezoelektrične hirurške tehnike. Kao graft materijal korišćen je ksenograft pomešan sa hijaluronskom kiselinom. Nakon aplikacije grafta, u pripremljeno ležište postavljen je dvofazni endoosealni implantat (Bio3, Pforzheim, Nemačka) dimenzija 8,0 × 4,2 mm.

Zaključak Piezohirurgija predstavlja optimalno rešenje u slučajevima kada je potrebno transkrestalno podizanje membrane sinusa, uz mogućnost istovremene ugradnje implantata kada je visina preostalog alveolarnog grebena veća od 5 mm.

Ključne reči: sinus lift; transkrestalni pristup; piezoelektrična hirurgija; endoosealni dentalni implantati

UVOD

Maksilarni sinus je najveći paranazalni sinus i kod odraslih sadrži približno 12–15 ml vazduha [1]. To je piramidalna struktura sa bazom blizu nosne šupljine, gornjim delom koji formira dno orbite i vrhom usmerenim ka zigomatičnoj kosti [2]. Dno sinusa se proteže anteriorno do regije premolara ili očnjaka i posteriorno do maksilarnog tubera, pri čemu je njegov najniži deo u mnogim slučajevima blizu područja prvog molara. Dno maksilarnog sinusa je najdeblji zid kod pacijenata sa očuvanim zubima i nalazi se otprilike na istom nivou kao i dno nosne šupljine. Kod bezubih pacijenata ono se nalazi 1 cm ispod dna nosne šupljine [3].

Povećani interes za terapiju implantatima dovodi do povećane potrebe za njihovim postavljanjem na različitim anatomskim lokacijama. Postavljanje implantata u posteriornoj maksili često je otežano postekstrakcionom resorpcijom kosti, pneumatizacijom maksilarnih sinusa i lošim kvalitetom alveolarne kosti, što dovodi do brže resorpcije kosti u poređenju sa drugim regijama usne duplje [4]. U ovim situacijama, podizanje dna maksilarnog sinusa predstavlja jedno od mogućih rešenja, koje zahteva hirurške tehnike augmentacije sinusa kako bi se deo sinusne šupljine pretvorio u kost pogodnu za postavljanje implantata [5].

Najčešće korišćena tehnika za podizanje dna maksilarnog sinusa je klasična lateralna antrostomija, koju je uveo Tatum 1976. godine, a kasnije objavili Boyne i James 1980. godine. Ova tehnika se zasniva na metodi lateralnog prozora, koja predstavlja modifikaciju dobro poznate Caldwell-Luc revizije sinusa, pri čemu se graftovana kost može dodati u količini većoj od 10 do 16 mm putem lateralnim zidom kvadrilateralne osteotomije [6]. Prema tradicionalnim protokolima, u slučajevima kada je kvalitet kosti dobar, a subantralna visina kosti 5–6 mm, implantat se postavlja istovremeno sa podizanjem dna sinusa, sa dodavanjem graft materijala ili bez njegovog dodavanja [7]. Nasuprot tome, u situacijama kada je kvalitet kosti loš ili kada je subantralna visina kosti manja od 5 mm, vrši se lateralna antrostomija i prostor ispod podignute Šnajderove membrane popunjava se graft materijalom [6]. Najčešća intraoperativna komplikacija ovih hirurških pristupa je perforacija Šnajderove membrane [8]. Iako ne postoje dovoljni dokazi da perforacija Šnajderove membrane smanjuje stopu preživljavanja implantata, može doći do ulaska graft materijala u sinusnu šupljinu, što dovodi do njene upale [9].

Krestalni pristup za podizanje dna sinusa prvobitno je predložio Tatum, dok je Summers kasnije razvio osteotomsku tehniku za postavljanje implantata na jednostavniji, konzervativniji i manje invazivan način u odnosu na lateralni pristup [10]. U Samersovoj tehnici, osteotom se uvodi kroz bezubi alveolarni greben na donjoj granici dna maksilarnog sinusa. Ova intruziona procedura izaziva frakturu na najmanje traumatičan način i omogućava pomeranje dna sinusa naviše. Time se stvara prostor za koštani graft i istovremeno postavljanje implantata [11].

Tokom poslednje decenije, uvedene su različite modifikacije osteotomske tehnike za podizanje sinusa, uključujući hidrauličnu metodu, krestalnu jezgro-tehniku i infrakturne metode. Ove tehnike spadaju u osteotomski posredovanu elevaciju dna sinusa (osteotome-mediated sinus floor elevation – OMSFE), koja omogućava lokalizovano podizanje dna sinusa krestalnim pristupom, postavljanje graft materijala ispod podignute membrane sinusa i naknadnu ugradnju implantata. Jedna od mnogih opisanih tehnika koristi piezoelektrične ultrazvučne vibracije (25–30 kHz). Piezohirurški aparat precizno seče samo mineralizovane strukture (kost) bez oštećenja mekih tkiva, koja ostaju netaknuta čak i u slučaju kontakta. Tipični efekat kavitacije stvara hidropneumatski pritisak u fiziološkom rastvoru, što doprinosi atraumatskom podizanju membrane sinusa [12].

Cilj ovog rada je prikaz slučaja transkrestalne tehnike podizanja sinusa pomoću piezohirurgije, sa istovremenim postavljanjem dentalnog implantata u posteriornoj maksili.

PRIKAZ SLUČAJA

Pacijentkinja stara 34 godine, nepušač, na osnovu dobijenih anamnestičkih podataka, negirala je prisustvo sistemskih bolesti ili upotrebu hronične terapije. Kliničkim pregledom i radiografskom procenom utvrđena je atrofija posteriorne maksile u regiji zuba 25, 26 i 27, sa preostalom visinom alveolarnog grebena od 6 mm (Slika 1). Nakon razgovora i objašnjenja trenutnog stanja i potrebe za hirurškim pristupom radi podizanja membrane sinusa, pacijentkinja je pristala na hirurški zahvat.

Nakon primene lokalne infiltracione anestezije u hirurškoj regiji i podizanja mukoperiostalnog režnja, pripremljeno je prvo implantno ležište u nivou zuba 24, gde je postavljen dvofazni implantat (Bio3, Pforzheim, Nemačka) dimenzija 11,5 mm × 3,3 mm. Nakon postavljanja prvog implantata, nastavilo se sa pripremom implantnog ležišta za drugi implantat u regiji zuba 26 korišćenjem standardnih drilova iz hirurškog seta, gde je preostala visina alveolarnog grebena bila ograničena (Slika 2).

Kod ovakvih slučajeva atrofične posteriorne maksile, karakterisane smanjenim kapacitetom potpore, implantno ležište se priprema sa smanjenim dimenzijama kako bi se poboljšala primarna stabilnost implantata. Preparacija implantnog ležišta drilovima završila se na 1 mm od koštanog dna maksilarnog sinusa. Po dostizanju odgovarajuće dubine, piezoelektrični nastavci sa zaobljenim (okruglim) vrhom korišćeni su za perforaciju koštanog dna, omogućavajući kontakt sa sinusnom membranom (Slika 3). Ultrazvučne vibracije olakšale su podizanje membrane sinusa. Nakon toga je usledilo proširenje implantnog ležišta pomoću upotrebe stopera (stopper sleeve) smanjene dimenzije u odnosu na planirani implantat, kao i popunjavanje formiranog subantralnog prostora graft materijalom (Slika 4).

Korišćen je ksenograft istog proizvođača (Bio3, Pforzheim, Nemačka), u kombinaciji sa hijaluronskom kiselinom (Slika 5). Graft materijal je apliciran u sinusnu šupljinu specijalnim aplikatorom sve dok pripremljeno ležište nije bilo potpuno ispunjeno (Slika 6). Nakon aplikacije grafta, u pripremljeno ležište postavljen je dvofazni endoosealni implantat (Bio3, Pforzheim, Nemačka) dimenzija 8,0 × 4,2 mm. Hirurška regija je zatvorena pojedinačnim šavovima (Slika 7). Prepisana je antibiotska terapija (amoksicilin 875 mg + klavulonska kiselina 125 mg, dva puta dnevno) u trajanju od sedam dana, uz analgetike po potrebi.

Kontrolnim radiografskim pregledom nakon šest meseci utvrđeni su uspešno oseointegrisani implantati, bez promena u sinusnoj šupljini i bez kliničkih znakova postoperativnih komplikacija (Slika 8). Nakon uspešne implantološke terapije, pacijentkinja je nastavila sa protetskom rehabilitacijom, koja je obuhvatala izradu fiksno-protetskog rada.

DISKUSIJA

Prema podacima iz literature, ukoliko se implantati postavljaju istovremeno sa procedurom podizanja sinusa, mnogi istraživači se slažu da bi minimalna visina preostale subantralne kosti trebalo da bude 5 mm ili više, uz dovoljnu gustinu kosti, kako bi se obezbedila dobra primarna stabilnost implantata [13, 14]. Kod pacijenata sa manje od 5 mm preostale subantralne kosti obično se preporučuje tehnika lateralne antrostomije i dvofazna hirurgija, gde se podizanje sinusa izvodi u prvoj fazi, dok se implantati postavljaju kasnije, u drugoj fazi [15]. Toffleru [16] navodi da je primarni faktor za uspeh implantata pri transkrestalnom osteotomski posredovanom podizanju dna maksilarnog sinusa visina preostalog alveolarnog grebena.

U multicentričnoj retrospektivnoj studiji, Rosen i saradnici analizirali su ishod Samersove tehnike prilikom postavljanja implantata ispod dna maksilarnog sinusa: stopa uspešnosti bila je 96% kada je preostala visina kosti bila 5 mm ili više, ali je drastično opala na 85% kada je visina krestalne kosti bila 4 mm ili manje. Postojeća literatura sugeriše da preostala visina kosti ima značajan uticaj na ishod sinus lifta transkrestalnim pristupom, pri čemu se stopa uspeha smanjuje sa smanjenjem preostale visine kosti [17]. Generalno, studije koje porede lateralni i transkrestalni pristup podizanja sinusa pokazuju da transkrestalna tehnika omogućava povećanje visine kosti za 3 do 4 mm, dok lateralna tehnika omogućava povećanje od 10 do 12 mm [18].

S druge strane, u studiji koju su sproveli Baldi i saradnici analizirane su dve transkrestalne tehnike — piezoelektrično i osteotomski posredovano podizanje dna maksilarnog sinusa. Utvrđeno je da prosečna visina podizanja sinusa (6,78 mm) odgovara ili premašuje povećanje zabeleženo u prethodnim studijama koje su koristile osteotomski posredovano podizanje dna sinusa [19].

U retrospektivnoj studiji koju su sproveli Bernardello i saradnici, jednofazni krestalni pristup za podizanje sinusa sproveden je korišćenjem specifičnog niza drilova (Cosci tehnika). Oblik vrha drilova sprečava perforaciju membrane sinusa i omogućava blago abrazivno uklanjanje kortikalne kosti dna sinusa bez frakture. Od 134 implantata imedijatno postavljenih u mesta sa preostalom visinom kosti manjom od 5 mm (prosečna visina: 3,46 ± 0,91 mm), zabeležena je visoka stopa preživljavanja (96,3%) tokom perioda praćenja od 48 meseci. Prosečno povećanje visine kosti u ovoj studiji iznosilo je 6,48 ± 2,38 mm, što je više od povećanja koje se obično postiže osteotomskom tehnikom (3–4 mm) [20]. Marchetti i saradnici [21] u svojoj studiji su zaključili da je prosečno povećanje zapremine kosti nakon piezoelektrične tehnike za transkrestalni pristup bilo 4,2 mm, što je potvrđeno rendgenskim snimkom nakon 12 meseci.

Mnogi autori predlažu da se u slučaju niske potpore kosti vilice, kao što je atrofična posteriorna maksila, prečnik implantnog ležišta smanji u odnosu na standardne protokole kako bi se optimizovala primarna stabilnost implantata [19]. Jedan od najčešćih uzroka neuspeha pri augmentaciji poda maksilarnog sinusa krestalnim pristupom jeste ruptura Šnajderove membrane. Iako je krestalni pristup manje invazivan, nedostatak direktne vizuelizacije membrane sprečava procenu moguće perforacije, što može dovesti do disperzije graft materijala u maksilarni sinus i neuspeha regenerativnog tretmana [21]. Wallace i saradnici navode da je stopa perforacije membrane smanjena sa prosečnih 30%, koliko se beležilo pri korišćenju rotacionih instrumenata, na 7%, kada se koristi piezoelektrična tehnika [22].

Osim što smanjuje rizik od perforacije membrane, piezoelektrična hirurgija pruža brojne prednosti u odnosu na druge tehnike transkrestalnog pristupa. Neke od ovih prednosti uključuju minimalno pomeranje piezohirurških nastavaka, što povećava preciznost sečenja i smanjuje nelagodnost pacijenta; odsustvo makrovibracija, što čini instrument lakšim za rukovanje i omogućava bolju intraoperativnu kontrolu, rezultirajući sigurnijim pristupom u anatomski izazovnim regijama; sposobnost

održavanja jasnog hirurškog polja bez prisustva krvi tokom osteotomije, zahvaljujući efektu kavitacije vazdušno-vodenog mlaza ultrazvučnog instrumenta [23].

Za augmentaciju sinusa korišćeni su različiti biomaterijali, uključujući autograft, alograft, ksenograft, aloplast i faktore rasta. Izbor idealnog graft materijala je i dalje predmet rasprave. Autogeni graftovi, koji se mogu uzeti iz intraoralnih ili ekstraoralnih izvora, smatraju se zlatnim standardom za augmentaciju sinusa zbog svoje osteogene sposobnosti, ali su manje poželjni zbog povećane morbidnosti, ograničene dostupnosti i visoke stope resorpcije grafta (do 40%). Alogeni graftovi (alografti) dobijaju se od kadavera iste vrste kao i recipijent grafta i deluju kao osteokonduktivni materijali koji omogućavaju regeneraciju kosti. Njihova osteoinduktivna sposobnost može biti povećana uklanjanjem mineralizovanog dela grafta kako bi se dobio materijal sa većom koncentracijom koštanih morfogenetskih proteina (BMP) i drugih proteina specifičnih za kost. Treba imati na umu da eliminacija patogena i antigena tokom obrade graft materijala dovodi do značajnog smanjenja količine faktora rasta. Ksenografti, dobijeni od različitih vrsta životinja, deluju kao polutrajni ili sporo resorbujući osteokonduktivni graftovi. Aloplastični graft materijali su sintetskog porekla, kao što su polimeri, kalcijum-sulfati, hidroksiapatit i kalcijum-fosfati, ili prirodnog porekla, kao što je hidroksiapatit dobijen iz korala i algi. Aloplastični graft materijali se generalno smatraju isključivo osteokonduktivnim, bez osteoinduktivnih svojstava [24]. U ovoj studiji kao graft materijal korišćen je ksenograft pomešan sa hijaluronskom kiselinom. Prema brojnim istraživanjima sprovedenim na ovu temu, ključni faktori za uspešan tretman implantatima nakon podizanja sinusa uključuju adekvatnu procenu sistemskog i oralnog zdravlja pacijenta, kao i odgovarajuću radiografsku dijagnostiku sa preciznim merenjem preostale visine kosti. Ovi faktori direktno utiču na izbor pristupa i tehnike podizanja dna maksilarnog sinusa.

Mogućnost rada u neposrednoj blizini membrane sinusa bez izazivanja njene perforacije čini piezohirurgiju optimalnom opcijom u svim slučajevima gde je potrebno podizanje membrane sinusa transkrestalnim pristupom, uz mogućnost istovremene implantacije kada je visina preostalog alveolarnog grebena veća od 5 mm.