

Literature Review

Implant-Guided Tenting of the Schneiderian Membrane by the Osteotome Technique without Grafting Materials: Literature Review

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Abstract

Rehabilitation of the atrophied edentulous maxilla is complicated. Often the residual bone height is insufficient for implant placement due to crestal bone resorption and pneumatization of the sinus. The meticulous management of the available residual bone, the atraumatic sinus lifting procedure, and the proper selection of the implants are the keys to successful dental implantation in resorbed alveolar bone. Today, one of the most common ways to compensate for inadequate vertical bone height is to elevate the sinus floor by tenting of the schneiderian membrane by the implant which is guided by itself eliminating the need for bone graft. The Osteotome sinus-floor elevation in conjunction with implant placement is also possible in severely resorbed alveolar bone. Extensive and traumatic conventional lateral approach for the sinus lifting and the grafting procedures can be avoided even in the highly resorbed alveolar bone by using Osteotome technique. This paper consists of a review of the literature available on sinus membrane elevation with simultaneous implant placement without the use of grafting materials. This review shows that grafting materials are not necessary to achieve a high implant survival rate. Some advantages with the less invasive non-grafting method are a decreased patient discomfort and a shorter treatment time.

ABBREVIATIONS

CCARD: Cologne Classification of Alveolar Ridge Defects; RBH: Residual Bone Height; OSFE: Osteotome Sinus Floor Elevation; SLA: Sandblasted, Larg-grit, Acid etched; LASFE: Lateral Approach Sinus Floor Elevation; MBL: Marginal Bone Loss; RBH: Residual Bone Height; SRRB: Severely-Resorbed Residual Bone

INTRODUCTION

Residual ridge resorption following tooth loss, pneumatization of the maxillary sinus and poor quality of the residual alveolar bone are the possible reasons mandating elevation of the maxillary sinus prior to implant placement [1-3]. Different methods have been practiced to reconstruct the edentulous maxilla with a severely resorbed crestal bone height with implant therapy. One treatment method is to increase the volume of the bone by either grafting the area with synthetic or allogeneic bone, or to use an autogenous transplant. This is a two-stage method and was introduced by Tatum [4] and Boyne et al., [5] among

others. The graft is, after surgery, left to heal and controlled by radiographs before replacing lost teeth with implants. Unfortunately, harvesting autogenous bone often causes much discomfort for the patient and is also related to several risks. One risk is morbidity in the area where the graft is harvested. Other risks are postoperative bleeding and increased risk for infection [6]. Furthermore, cases of acute maxillary sinusitis have been reported [7] and also cases of hematomas, disturbed wound healing and sequestration of bone in the sinus [8]. A disadvantage using non-autogenous grafting materials such as BioOss; derived bovine bone, which is very similar to human bone, is the cost. Since the rehabilitation of the edentulous maxilla with implants is already an expensive treatment, using grafting materials will add to the cost resulting in a greater financial burden for the patient [9]. Treating the edentulous maxilla without bone grafting would have certain benefits such as a shorter overall treatment time, more cost efficiency and a less invasive procedure. Some studies have shown that placement of the implant in to the sinus without grafting materials can stimulate new bone formation in the sinus

cavity [10]. This is possible when a blood clot is isolated in an enclosed space, where the grafting materials usually are placed. The blood cells induce new bone formation by stimulating the bone precursor cells to evolve to osteoclasts. The activated osteoclasts in their turn activate the bone forming osteoblasts to start producing bone [11].

One of the widely practiced techniques for improving the bone density and the quality of the implant site in the posterior maxilla is the osteotome technique [12-16].

The Osteotome technique is based on a crestal approach which is described in a report by Bruschi et al., [17]. The incision is made on the alveolar crest and the implant preparation in the bone is made with a regular implant drill. Different osteotome are then used to elevate the Schneiderian membrane on the sinus floor through the prepared entrance. When the implant is placed, it lifts the membrane and holds it up with the aim to keep the membrane intact. All implants have a flat-top design which reduces the risk of perforating the Schneiderian membrane when placing the implant. However, perforations can be caused while dissecting the membrane from the bone wall in the sinus if the surgeon is incautious. In events where the membrane is perforated the size of the perforation decides whether it needs to be repaired or can be left to heal [9]. Some studies have shown that sinus membrane perforations have no impact on the implant survival rate if treated appropriately. Apart from the membrane perforation, there is no other evidence of long term implant or sinus-related complications after sinus elevation with simultaneous implant placement when using either the Osteotome or the lateral technique [18]. All the variations of the Osteotome-guided sinus-lifting carry considerable risk of penetrating the sinus membrane while condensing, removing, dissipating, and/or imploding the alveolar bone. Compared to other sinus lifting procedures, the Osteotome technique is less invasive and reduces the need for more traumatic and expensive procedures with less risk of damaging the Schneiderian membrane. The implant is inserted simultaneously with a sinus lift procedure only when sufficient primary stabilization can be expected [4, 19].

Classification of the pre-existing available bone height for maxillary sinus

In 1987, Misch classified the subantral (SA) region of the posterior maxilla in four categories for the treatment of the posterior maxilla (termed subantral [SA]): as SA-1 through SA-4 [20]. SA-1 has adequate vertical bone for endosteal implants (>12 mm), however the SA-1 posterior maxilla allows implant placement inferior to the sinus cavity without sinus manipulation, thus not altering the sinus floor or membrane. SA-2 has 0 to 2 mm less than ideal height of bone (10 to 12 mm), SA-3 has 5 to 10 mm of bone below the antrum, and SA-4 has less than 5 mm of vertical bone below the maxillary sinus [21]. Jensen has proposed a classification of sinus morphology (A through E) to help suggest the appropriate grafting material or grafting technique to use, based on a specific site, Class A: 10 mm or more of residual bone present (100% of a 10-mm implant in native bone); Class B: 7 to 9 mm of residual bone present (70% to 90% of a 10-mm implant in native bone); Class C: 4 to 6 mm of residual bone present (40%

to 60% of a 10-mm implant in native bone); Class D: 1 to 3 mm of residual bone present (10% to 30% of a 10-mm implant in native bone); Class E: Absent or ablated sinus [22]. In 2013 European Association of dental implantologists introduced guideline for the Cologne Classification of Alveolar Ridge Defects (CCARD) which classifies volume deficiencies of the alveolar process regardless of their aetiology as vertical, horizontal and combined defects (H, V, C), possibly in conjunction with a sinus area defect (+S). It takes into account the extent of the augmentation needed (1: < 4 mm, 2: 4-8 mm, 3: > 8 mm) and the relation of graft to surrounding morphology (i: intern, inside the ridge contour vs. e: extern, outside the ridge contour) and makes recommendations on possible treatment approaches based on the current literature [23].

Advantages of osteotome technique

The Osteotome technique is, by nature, a less-invasive surgery with smaller flap design and a less extensive osteotomy. Therefore, there is less chance of postoperative complications and morbidity, and patient acceptance for surgery is greatly increased and bone still forms as long as space is maintained beneath an intact sinus lining to form a closed wound environment [15, 22, 24]. This technique also reduces the need for more traumatic and expensive procedures with less risk of damaging the Schneiderian membrane. In 1996, the report of the Sinus Consensus showed that 48% of failed sinus grafts could be attributed to preoperative complications, and 38% of these were related to sinus-membrane perforation. Ferrigno and Toffler recorded that the rate of Osteotome sinus-membrane perforation using the osteotome technique was 2.2% to 4.7% [25, 26]. Therefore, the chance of postsurgical complications and infection associated with membrane perforation was greatly reduced using an expansion Osteotome instead of drills to avoid ovalization of the osteotomy site and to condense the surrounding bone [27]. More cost-effective and more time-efficient when comparing with an achievement the success rate of 94% to 98% with the lateral-window approach, a resorbable or non-resorbable membrane was needed to cover the osseous lateral window [28]. This increased the cost when compared with internal sinus-lift procedures, which did not require the use of any membrane. Even though there is still concern among clinicians about the amount of the bone height that can be elevated without membrane perforation or implant placement. There is lower rate of membrane perforation and a less complicated surgery, because Osteotome surgery involves a crestal approach, which is common to standard implant surgery.

The important roles for Implant surface and design

The type of implant surface and design appears to be an important variable in the Osteotome technique with simultaneous implant placement in severely-resorbed residual bone. In the atrophic maxilla, primary stability can readily be achieved with tapered implants, even when the mean residual bone height (RBH) is severely resorbed such as 3.8 mm. The use of the Osteotome sinus floor elevation (OSFE) technique without grafting material, combined with the placement of tapered implants, can reduce the need for direct sinus lift procedures. Implants were often placed deeper with the flared neck resting against the crestal

bone, which also increased the stability with high percentage of survival and success rates reached in some studies to 100% and 94.4%, respectively [27]. Buser et al., showed that the SL Active surface promotes earlier bone apposition and provides greater implant stability during the first critical weeks of osseointegration [29], which is more appropriate for osteotome technique with simultaneous implant placement in severely-resorbed residual bone. Bone formation between SLA and SLActive implants was also compared in a study in foxhounds by Bornstein et al. According to it, SLActive demonstrated statistically significantly higher newly formed bone-to-implant contact length than SLA [30]. The possibility of early loading of sandblasted/Acid-Etched Active surface implant (SLActive) inserted with simultaneous osteotome sinus floor elevation without the use of grafting material. There is growing interest in early and immediate loading and a reduction time between surgery and prosthetic rehabilitation, especially in areas with atrophic maxilla. However the use of an early loading protocol in the posterior maxilla is doubtful, as this region has always been considered particularly challenging for long-time successful implant survival because of its deficiency in bone quantity and quality [31-34]. In addition to thread engagement, the body design and surface roughness of the implants provided a frictional interface with the receptor site to assist in the mechanical retention by facilitating bone in growth during osseointegration [35]. According to ferrigno et al report in 2006, on the relationship of implant survival rate and the length of implants placed with the one-stage Osteotome sinus-lift technique (with a total of 588 implants placed in 323 patients with a mean follow-up time of 59.7 months), implants with a 12-mm length had a greater survival rate (93.4%) than 10-mm (90.5%) or 8-mm (88.9%) implants [25,36]. Therefore, it may be desirable to have implants longer than 12 mm when placing fixtures by using the atraumatic technique in the placement of the implant and round-shaped end of the implant, which limits the risks of damaging the sinus membrane during the sinus lift Osteotome procedure. The convex apex shape of the implant is designed to prevent the tearing of the sinus membrane and carefully can elevate the schneiderian membrane by inserting and placement the implant into the prepared implant bed [37].

Clinical recommendations

Care should be given, gentle hammering should be performed, and a careful approach should be taken during the osteotome technique to prevent any complication such as the symptoms of vertigo. The patients who were experiencing vertigo were asked to rest in the dental chair for another 15 to 30 minutes prior to discharge from the clinic. Multiple Valsalva tests were performed in all of the cases to check for the patency of the Schneiderian membrane immediately following the procedure. The symptoms of vertigo can require pharmacological management to reduce the spinning sensations and/or the accompanying nausea. The most commonly used drugs are anxiolytics, sedatives, and/or muscle relaxants, along with antihistamines. Antihistamines appear to have suppressive effects on the central emetic center, relieving the nausea and vomiting associated with motion sickness [38,39]. Patients should be informed regarding the possibility of post-operative vestibular symptoms, because these symptoms can be very unpleasant and may cause considerable stress if the patient

is unaware of this problem. If the symptoms are incapacitating, immediate referral to an otorhinolaryngologist is recommended [40-44]. One of the most clinical recommendations is avoiding cervical flaring at the preparation site for a placed dental implant even in low-density bone increases the initial implant stability. Nedir et al. reported that tapered implants with a reduced thread pitch were placed with good primary stability in the atrophic maxilla of 2 patients using an Osteotome sinus floor elevation procedure without grafting material [45]. Prior of implant insertion and placement into the appropriate position, a cortical wall was present at the apical end of the implant, which suggests the formation of a new sinus floor [46]. The regenerative properties of the bone beneath the sinus floor resulted in high endo-sinus bone gain. Some researchers have reported successful sinus elevation without bone grafting, and for all the studied implants, the Osteotome procedure without grafting material was effective in forming new bone beyond the original limits of the sinus [25,27,47].

Radiological considerations

Radiological evaluation revealed sufficient lifting of the sinus floor by Osteotome technique and the presence of bone over the implant apex was proved by periapical x-rays and CT scans. Nevertheless, there has been no inconclusive clinical evidence to prove any advantage of bone over the implant apex directly affecting implant survival in any of the sinus lifting procedures [48, 49]. As a comparison between lateral and Osteotome approaches, conventional radiography proved bone/graft maturation around the implant apex in cases completed with the lateral approach, while for Osteotome sinus floor elevation (OSFE), no marked evidence was seen of bone formation between the lifted sinus membrane and the implant apex. In OSFE, because there is no marked bone formation around the implant apex, these tangential forces can apply more rotational force, with a fulcrum situated toward the crestal bone [49,50]. One of the most accurate radiographic assessment for the intact Schneiderian membrane is the reformatted fly-through image of the maxillary sinus floor showed an intact Schneiderian membrane over the projection of the apical border of the implant for all sinus floor elevation techniques which is very appropriate to be used in Osteotome technique with simultaneous implant placement in severely-resorbed residual bone and Syngo Siemens Software was used for the thin cut images in the navigation protocol—Flythrough Application for Osteotome technique and for lateral technique [18,37].

DISCUSSION & CONCLUSION

This systematic review, where sinus membrane elevation with simultaneous implant placement without the use of grafting materials has been studied, shows that a high implant survival rate can be achieved without grafting materials. When multiple missing teeth at same quadrant need to be replaced with multiple implant insertion on a severely resorbed alveolar in a staged manner in which the first implant is placed by tenting the sinus membrane using OSFE without a bone graft to prepare the adjacent resorbed sites for further implant placement in the sinus areas, which allows for better initial stability and early functional loading by using staged Osteotome technique [37]. Since the LASFE

technique requires a mucoperiosteal flap and is more invasive than the OSFE technique, the expected inflammation during healing is greater than the inflammation after implant placement with OSFE. This inflammation can cause a more pronounced bone resorption which may explain why the marginal bone loss (MBL) was greater in LASFE technique. The disadvantages with the OSFE technique could be a limited view of the operation field, which can lead to unnoticed accidental membrane perforations resulting in a lower survival rate. Also, the OSFE technique makes it difficult to repair eventual perforations of the sinus membrane. The study by Lai et al., [51] showed that the use of grafting materials had no significant impact on the implant survival rate compared to sinus elevation without grafting materials, but the grafting material could be used to maintain the space under the Schneiderian membrane. This review shows that there is no need for grafting materials to achieve a predictable result with good implant survival and new bone formation. Also, using the technique without grafting materials can reduce additional treatment cost and greater patient discomfort can be avoided. It seems to be more convenient to use OSFE when RBH is > 5 mm, but Nedir et al., [52,53] and Al-Almaie [37] have shown that OSFE is also applicable in cases where RBH < 5 mm. This implies that there is no correlation between RBH and choice of technique. If this is the case, LASFE technique should be used only in cases where a good view of the operation field is required, since this method is more invasive and causes more patient discomfort than OSFE. However, the surgeon should always consider his or hers experience and knowledge before choosing technique and also take into consideration the number of implants intended to be placed in the same sinus. The meticulous management of the available residual bone, the atraumatic sinus lifting procedure, and the proper selection of the implants are the keys to successful dental implantation for Osteotome technique. This review of literature proves that implant-guided tenting of the schneiderian embrane by the Osteotome technique are also possible in severely-resorbed residual bone (SRRB) and will be of great benefit to clinician in managing these kind of cases. Extensive and traumatic conventional lateral approach for the sinus lifting and the grafting procedures can be avoided even in highly resorbed alveolar bone by using these procedures. The attained initial stability favored the early functional loading of the placed implants.

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