Review Article

Indirect sinus lift techniques: A literature review

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ABSTRACT

The most common anatomic limitation found in the maxillary posterior region is lack of vertical bone due to pneumatization of the maxillary sinus and close proximation of the sinus to the crestal bone. To increase the amount of bone in the posterior maxilla, the sinus lift procedure, or subantral augmentation has been developed. Bone volume can be increased by augmentation; however, augmenting the vertical bone dimension is technique sensitive. The elevation of the sinus membrane is an option to create space for augmenting the vertical bone height.

KEY WORDS: Augmentation, Maxillary sinus, Sinus lift

INTRODUCTION

Maxillary sinuses are air-filled cavities present bilaterally in the maxillae in the posterior region. The maxillary sinus is superior to the maxillary posterior teeth, inferior to the orbital floors, and anterior to the infratemporal fossa. These are the largest of the four paranasal sinuses.[1] The lining on the maxillary sinus is bilaminar mucoperiosteal membrane known as the Schneiderian membrane, which comprises ciliated pseudostratified columnar epithelium (respiratory epithelium) on the lumen side and a single-cell osteogenic periosteal layer (cambium layer) on the bone side. In a posteroanterior direction, in the middle of maxillary roof, the infraorbital nerve passes through.[1]

Dental implants are the most preferred prosthetic modalities for replacing missing teeth in edentulous patients. To place an implant, the minimum amount of vertical bone to be available is 10–14 mm or at least 2 mm more than the length of the implant to be placed. The most common anatomic limitation found in the maxillary posterior region is lack of vertical bone due to pneumatized maxillary sinus and close proximation of the sinus to the crestal bone.[2] To increase the amount of bone in the posterior maxilla, the sinus lift procedure, or subantral augmentation, has been developed in the mid-1970s.

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The sinus lift technique was firstly described by Boyne and James. Grafting of the maxillary sinus floor with autogenous marrow and bone. With the advances in implantology, there have been various systems and techniques invented and modified to perform sinus lift procedures.

However, there is no consolidated evidence on the various augmentative techniques. A thorough knowledge of the contemporary augmentation procedures assisted by proper patient selection can lead to effective long-term solutions in the management of the deficient posterior maxilla. Hence, we decided to perform a review on the evidence available in literature on the direct and indirect sinus lift techniques for implant placement in the pneumatized posterior maxilla.

There are different techniques for the sinus augmentation; the factors that contribute to the survival rate of sinus augmentation. They can be broadly classified into the two different ways of sinus floor elevation: (a) Lateral antrostomy as a one or two-step procedure as direct method and (b) osteotome technique with a crestal approach as indirect method.

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The transcrestal approach is considered the more conservative one, and it has several advantages compared to the lateral osteotomy.[3] Even though the transcrestal sinus lifting procedure is blindly performed, the frequency of sinus membrane perforation has been reported as less frequent than the lateral approach.

The lateral approach technique documented a 5-year survival rate more to 92.7% for implants placed in <4–5 mm ridge height and 94.9% for implants inserted with a ridge height of more than 5 mm.[4]

SUMMERS OSTEOTOME TECHNIQUE

In 1986, Tatum Jr. proposed a transcrestal, more conservative, approach later modified by Summers that first described the use of osteotomes to elevate the membrane and eliminate hammering, making the technique more comfortable for the patient. It was also called bone-added osteotome sinus floor elevation technique. The crestal technique is nowadays a reliable method allowing contextual implant insertion with good survival rates. However, the necessary height of >5 mm of residual bone height due to the risk of membrane perforation and a low implant stability were the main limitations of this technique. In the present retrospective study, the 45 implants later inserted in a 2-mm crest showed excellent survival rates (99.5%), calculated in a significant follow-up period (60 months). This higher result, if compared to other retrospective reports, can be explained thanks to a reduced risk of membrane perforation thanks to the use of piezoelectric device. This outcome has evidently shown bone height gain (7.8 mm ± 0.86 mm) which is greater than the average of the osteotome technique. This outcome may also be related to the non-smoker selection of patients due to the evidence of the negative impact on bone healing of the nicotine.

INTRALIFT TECHNIQUE

An important contribution to oral surgery for direct sinus lift osteotomy was the introduction of piezoelectric surgery. Torrella *et al*. proposed the use of piezoelectric surgery for lateral osteotomies.[5] They are performed with a bone-preserving incision, so they are less traumatic and reduce the risk of perforation of the Schneiderian membrane and achieve a better view during surgery. Based on the use of piezoelectric surgery, attempts have been made to simplify the sinus lift technique to offer patients an intervention as atraumatic as possible, with milder post-operative discomfort. Troedhan *et al*. in conjunction with the Acteon Group (France) have developed the Intralif™ (Acteon Satelec, France) technique. A minimally invasive technique for lifting the maxillary sinus floor using piezoelectric surgery based on a specific set of tips for the application of ultrasound. This technique opens a wide range of possibilities in terms of reducing the complexity and morbidity of open sinus lift.[6]

HYDRAULIC SINUS LIFT (HySiLift) TECHNIQUE

Some authors have recently proposed crestal lifting techniques that use hydraulic pressure for the displacement of the sinus membrane with alternative methodologies to those currently in use.[7] The proposed methods provide a preliminary detachment of the Schneiderian membrane through injection of a liquid followed by its spontaneous expulsion or aspiration, to then pass on at the insertion of the graft material in the sub-Schneiderian space created this way. These methods, while effective, involve a prolongation of the operating procedure since it is conceptually simpler to use a graft material in a liquid state that when injected hydraulically raises the mucosa and fills the sub-Schneiderian space at once. Furthermore, the method described above used conventional single-use syringes in which it is not possible to finely check on the progression of the piston since this is connected with individual sensitivity. Other authors also have proposed, in the past, direct injection of fluid graft materials in the subantral space but always through conventional single-use syringes activated manually.

In 2010, Andreasi *et al*. proposed a new method that takes advantage of the hydraulic pressure exercised on a graft material of a pasty consistency to detach the antral mucosa and simultaneously fill the subantral space created this way.[8] The authors called the technique HySiLift. The instruments made for this purpose consist of three components: a titanium syringe (Hydromab, FMD, Rome, Italy) equipped with a micrometric control piston on which it is possible to assemble single-use plastic syringes of various volumes, possibly equipped with a Luer lock attachment; a dispenser in threaded surgical steel (ML Injector, FMD, Rome, Italy) available in two forms (conical and cylindrical) and four measurements (two cylindrical of ø 3.2 and 4.0 mm and two conical of ø 2.8–4.0 and 3.5–4.6 mm) and a needle in surgical steel, also equipped with a Luer lock attachment, complementary to that of the single-use syringe, that allows connecting of the two instruments described above.[9] The single-use syringes can be pre-loaded with a desired amount of graft material that, in our experience, was represented by nanocrystalline hydroxyapatite in an aqueous medium (Ostim, Heraeus Kulzer, Hanau, Germany), or it is possible to directly use the syringe containing the graft material as provided by the manufacturer. The semi-spherical tip of the ML injector allows this instrument to penetrate barely 3 mm in the sub-Schneiderian space without

damaging the overlying mucosa while the lateral openings allow uniform distribution of the Ostim that, due to its paste-like consistency, forms a dome precisely in correspondence to the future implant site. The threaded portion of the dispenser extends for a length of 6 mm, thus making its use indicated for ridges of thickness between 3 mm and 6 mm to ensure sufficient stability of the tool during the injection maneuver.

SINU-LIFT SYSTEM

The present study shows a minimally invasive two-staged procedure for maxillary bone augmentation using the "Sinu-Lift system" utilizing beta-tricalcium phosphate in conjunction with platelet-rich plasma. The Sinu-Lift system disposable kit consisting of a 3.2-mm Sinu start drill that drills the path to the sinus membrane which disengages upon contact with the membrane to avoid rupture is used in the study.[3] The 3-mm yellow curette is used to gently separate the sinus membrane from the bone. The 4.2-mm blue curette is used for additional elevation. It also consists of a bone packer, a multifunction handle to help turn wheels and provide additional reach. The front part of handle, pointed tip couples with the holes in the Sinu-Drill provides leverage while drilling through the bone with Sinu-Drill, whereas the rear part of handle snaps the curette (or) bone packer into the open end of the handle.

The Sinu-Lift system with the Sinu-Drill, an intelligent self-regulating mechanical hand device, and the curettes with color codings allow the accurate control of the working length providing the desired membrane elevation, minimizing the risk for membrane perforation and post-surgery infections.

DISCUSSION

The sinus augmentation procedure has been demonstrated as being a reliable and sometimes a mandatory technique when rehabilitating a maxillary atrophic ridge with pneumatized sinuses. The lateral approach proposed by Boyne and James in 1980 allowed a remarkable bone increasing >10 mm, even in atrophic ridges, however, resulting in a significant higher post-surgical morbidity and an increased risk of membrane perforation. Crestal approach, osteotome-mediated sinus lift surgery, may be performed with different bone-grafting materials, such as allograft, autogenous bone or heterologous materials, and platelet derivatives themselves or combined with grafting materials, in order to combine the properties of the growth factor to the mechanical presence of soft platelet derivate that allows a better force control during the sinus floor elevation.

The two augmentation techniques are designed for different clinical situation; Rosen *et al*. showed how the survival rates for the Summers' technique are strictly linked to the residual bone height, starting from 96% when 5 mm or more of bone is present, dropping to 85% when 4 mm or less is present; however, these results may be more linked to the primary stability of the implant than to more biological reasons.

The bone height has a relevant influence on the survival rates of implant positioned on augmented bone, decreasing its value with reduced bone height.

A decreased bone height resorption rate might be influenced by the osteotomy technique that can maintain a better cellular vitality, especially when piezoelectric devices are used instead of rotating instruments.

A reduction of the grafted material has been reported over the first 3 months of bone remodeling and remained stable over the whole follow-up period (60 months). Other reports showed lower 5-year survival rates of the dental implants placed (97.83, 95.45). However, they consider a higher number of implants.

The results observed could be favorably compared with the observation from a similar study in which implants were placed into a severely resorbed ridge, with <4 mm of residual bone height.

Other studies reported lower implant survival rates from 96% to 85.7% when the residual bone height was 4 mm or less, considering the height of bone from the crest of the alveolar ridge to the sinus floor as the most important factor affecting the implant survival rate; this concept is strictly linked to the necessity to ensure a high primary stability, especially in severely atrophied ridge.

More recent studies from Gonzales underlined the good long-term predictability of this technique even in case of simultaneous implant placement in patients with residual bone height of 4 mm or less, confirming that the residual bone height did not increase crestal bone loss or reduce the success rate of the implants and associated prostheses.

In particular, Mazor *et al*. showed a 100% implant survival rate at 18-month follow-up, demonstrating the safety and predictability of this minimally invasive sinus lift elevation technique.

One of the main aspects that must be considered for a long-term success, especially observed in this study, is linked to the ability to elevate the Schneiderian membrane without any tearing, in addition to a correct anatomy evaluation, a low membrane detachment force, and elasticity and deformation capacity judgment. An increased number of insertion sites can

increase the membrane elevation height increasing the elastic properties of the Schneiderian membrane.

The use of grafting materials is, however, debated with several authors describing a consistent bone formation (6.51 mm ± 2.49 mm) even when no grafting material was used after a minimum of 1-year follow-up and others suggest their necessity as the use of a blood clot or platelet concentrates alone may lead to unpredictable results. When grafting materials were used the autologous bone representing nowadays the gold standard, however, might be subjected to extensive resorption and might be linked to endosinusal contamination due to intraoral pathogens.

Our data confirm that the crestal augmentation technique gives the surgeon the possibility of a big bone height augmentation with good long-term survival rates, allowing the insertion of adequate implants per length and diameter, as suggested in literature, even in extreme atrophic ridge.

Further clinical and *in vitro* investigations are needed to measure the mechanical properties of the Schneiderian membrane and minimum force needed for its detachment from the underlying bone and its elasticity and load limits.

CONCLUSION

The height of bone gain is comparable to the one achieved with lateral approach while maintaining the advantage of a less invasive approach with less post-operative morbidity.

REFERENCES

1. Stern A, Green J. Sinus lift procedures: An overview of current techniques. Dent Clin North Am 2012;56:219-33, 10.
2. Pal US, Sharma NK, Singh RK, Mahammad S, Mehrotra D, Singh N, *et al.* Direct vs. Indirect sinus lift procedure: A comparison. Natl J Maxillofac Surg 2012;3:31-7.
3. Parthasaradhi T. An alternative maxillary sinus lift technique sinu lift system. J Clin Diagn Res 2015;9:ZC33-7.
4. Lo Giudice G, Iannello G, Terranova A, Lo Giudice R, Pantaleo G, Cicciù M. Transcrestal sinus lift procedure approaching atrophic maxillary ridge: A 60-month clinical and radiological follow-up evaluation. Int J Dent 2015;2015:1-8.
5. Torrella F, Pitarch J, Cabanes G, Anitua E. Ultrasonic ostectomy for the surgical approach of the maxillary sinus: A technical note. Int J Oral Maxillofac Implants 1998;13:697-700.
6. Troedhan AC, Kurrek A, Wainwright M, Jank S. Hydrodynamic ultrasonic sinus floor elevation an experimental study in sheep. J Oral Maxillofac Surg 2010;68:1125-30.
7. Andreasi Bassi M, Lopez MA, Confalone L, Carinci F. Hydraulic sinus lift technique in future site development: Clinical and histomorphometric analysis of human biopsies. Implant Dent 2015;24:117-24.
8. Andreasi B, Lopez MA, Confalone L, Fanali S, Carinci F. Hydraulic sinus lift technique: Description of a clinical case. Ann Oral Maxillofac Surg 2013;1:18.
9. Tallarico M, Meloni SM, Xhanari E, Pisano M, Cochran DL. Minimally invasive sinus augmentation procedure using a dedicated hydraulic sinus lift implant device: A prospective case series study on clinical, radiologic, and patient-centered outcomes. Int J Periodontics Restorative Dent 2017;37:125-35.

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