Masterclass in Clinical Practice

Dental Implants
with
Dr Vladimir S Todorovic[1]
Dr Andre W van Zyl[2]

Transcrestal Sinus Floor Elevation

[1] Vladimir S Todorovic, PhD
Research Associate, School of Dental Medicine,
University of Belgrade, Serbia
Private practice, Belgrade, Serbia

[2] Andre W. van Zyl
MChD (Oral Medicine & Periodontics)
Private Practice, Hermanus, South Africa

Introduction

Sinus floor elevation (SFE) has become the standard of care for increasing bone depth in the posterior maxilla when sinus pneumatization or ridge loss has decreased available bone for implant placement. The technique for placing bone in the sinus after mobilising the Schneiderian membrane to increase the available bone depth in the posterior maxilla was first described by Boyne and James (1980) and Tatum (1986).[1, 2]

The lateral window technique for sinus floor elevation (LSFE) was described in our Masterclass of February / March of 2023.[3] The LSFE is a procedure which is difficult to perform, is invasive surgery with a high morbidity and requires postgraduate surgical training.

Summers introduced the transcrestal SFE (TSFE) using osteotomes to simplify the process.[4]

The objective of this Masterclass is to describe the transcrestal SFE following the Summers' technique but allowing for modifications introduced over the years.

The advantage of this technique is that the procedure is through the implant osteotomy site, requiring no additional flap elevation over and above the implant placement flap. The procedure can be halted at any stage if a membrane perforation is detected, and primary closure achieved by simply closing the access site.

Technique

Unlike LSFE, where buccal bone plate osteotomy must be done, the TSFE implies the approach to the sinus membrane through the implant-osteotomy drilled in the residual alveolar ridge. The sinus floor elevation procedure was first proposed by Tatum in 1986[2] and afterwards modified by Summers in 1994[4] with a set of osteotomes of increasing diameter used to elevate the floor of the sinus introduced. Undoubtfully, the TSFE has some advantage over the LSFE, such as less invasiveness, shorter surgery time and less postoperative discomfort. Furthermore, most TSFE procedures are done simultaneously with implant placement, reducing the overall treatment time. However, some shortcomings are obvious – as this procedure is predominantly used for single tooth gaps, sinus floor should be flat and sub antral bone height sufficient (at least 4-6 mm). Also, TSFE is considered a blinded surgery, as surgeon is not being able to visualise the Schneiderian membrane, nor to easily solve possible membrane perforation complications.

Surgical procedure

The surgical procedure is done under local anaesthesia, with mid-crestal incision and full thickness mucoperiosteal flap elevation. A flapless approach can be considered.[5] After the exposure of the crest, preparation of the implant site starts according to the conventional drilling protocol and either is completed at the level of sinus floor or 1-2 millimetres below, allowing the use of osteotomes to fracture the sinus floor upwards. Afterwards, the membrane is gently elevated with osteotome or blunt instrument. It is possible to assess for a possible tear in the membrane by allowing the osteotomy site to fill with blood or use saline and ask the patient to breathe deeply through nose. If the membrane is perforated- the blood or saline will disappear into sinus, alternatively if intact you may notice a fluctuation in the fluid level. At this stage, grafting material could be placed under the membrane if intact and implant simultaneously installed. Depending on several factors, such as: primary implant stability, sub antral bone height and bone quality, a decision on healing period before loading is decided.[6]

It remains controversial whether TSFE should be done with or without grafting material. It has been suggested that grafting materials should be used in cases where the desired elevation of the sinus exceeds 2 mm.[6] The main advantage of not using a graft is less chair-side time, lower treatment cost, and in case of undetected membrane perforation – less probability for displacement of graft material into sinus. If indicated, bone grafting is performed using autogenous bone material, xenografts, or mixture of both. However, it has been speculated that bone regeneration is slower for bone substitutes than for autogenous bone or blood clot alone.[7] Therefore, some authors advocated the use of blood clots (platelet-rich plasma (PRP), platelet-rich fibrin (PRF) or platelet-rich growth factor (PRGF)). However, this has questionable impact on bone regeneration.[8]

Different modification techniques available

As mentioned above, TSFE technique was originally presented as an osteotome procedure. However, over the past few decades some modifications to the original technique were introduced, focusing on more convenient patient experience and reduced risk for complications.

- Hydraulic TSFE or `balloon technique`- this modification differs from original technique by the method of lifting the membrane. Initial drilling sequence is the same and when the sinus membrane is reached through the osteotomy site a hydraulic lifter with light pressure is introduced. Usually, a tube connected to a balloon with a syringe filled with sterile saline solution is used and by pressing the plunger the balloon inflates and consequently elevates the membrane.[9] As saline will cause no harm if introduced into the sinus, the balloon is optional when using this technique. This is demonstrated in the case presentation below.
- Osseodensification approach – in this variant transcrestal osteotomy is done using burs of increasing diameter with many grooves in an anticlockwise direction. This approach is less traumatic than conventional drilling and tends to compress the bone instead of eliminating it, resulting in increased bone density around implant and less healing time.[10] This technique has become very popular with various bur systems available on the market.
- Hydrodynamic piezoelectric internal sinus elevation – refers to ultrasonic piezosurgery device used to make osteotomies with reduced risk of membrane perforation, as it does not interfere with soft tissues. The concept employs different inserting tips used initially for osteotomy and afterwards to lift the sinus membrane through hydrodynamic pressure by concurrent internal irrigation.[11]

Complications

The TSFE is regarded as a safe procedure with low incidence of intra- or post-operative complications. However, meticulous planing and patient selection is of utmost importance for favourable outcome. TSFE procedure requires a skilled surgeon, as any intraoperative complication (such as membrane perforation, ingress of graft material into sinus cavity etc.) must be managed with a possibly more demanding lateral window approach.

The most common complication of TSFE is Schneiderian membrane perforation. In the literature, the incidence of such events is reported to be 5.8%.[12] Though, such small occurrence might be due to inability of proper inspection of the membrane rupture intraoperatively, which may go undetected. If the perforation of Schneiderian membrane is detected, depending on the size of the defect, managing options might be different. In small perforation cases the placement of collagen membrane through the osteotomy is possible, while in cases with large membrane perforation, the procedure should be abandoned or changed to a LSFE procedure, with direct visualisation of the membrane. If the procedure is aborted, healing period of 3-6 months is suggested before the next attempt. Other complications are related to loss of primary implant stability and postoperative haematoma due to a injury of the posterior superior alveolar artery during the TSFE procedure.[13]

Case Report: Upper left TSFE with simultaneous bone graft and implant placement

A male patient presented with a reduced alveolar bone depth in position 26 after tooth extraction a few years prior. The available bone depth was 4mm (Figure 1), with a ridge width of 8mm as measured on CBCT. The patient did not want to undergo the LSFE and it was decided to perform a transcrestal approach and a simultaneous placement of the implant if primary stability could be achieved.

The preparation was done with a combination of the Surgident® TOCA kit (Figure 2) allowing for very careful

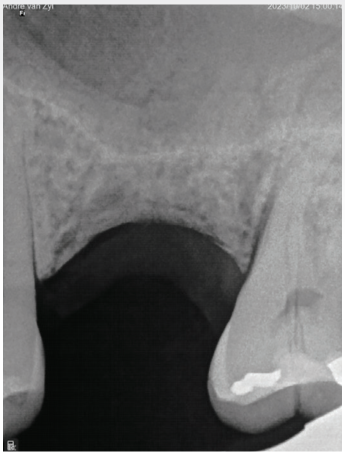

Figure 1: Pre-operative radiograph of 26 site with 4mm bone depth below sinus.

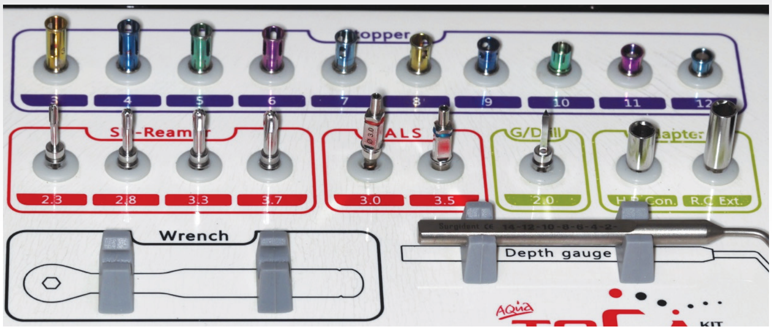

Figure 2: A transcrestal drilling kit with stoppers ranging from 3-12mm and drill sizes 2.3-3.7mm in diameter. It also contains the ALS instruments as described.

control of the depth of drilling and Summers' osteotome technique. The Surgident® drills do not cut apically which allows for careful perforation of the sinus floor without perforation of the Schneiderian membrane. By measuring the bone depth on CBCT, it was decided to start with a 3mm stop on the pilot drill before taking the first radiograph (Figure 3). The depth stop was then changed to 5mm to allow careful penetration of the sinus floor (Figure 4) before increasing the diameter to 2.8mm and then fracturing the sinus floor with the 2.8mm Summers' type osteotome (Figures 5 and 6). Care should be taken when breaking the sinus floor with Summers' osteotome technique, as it is a very unpleasant sensation when hammering the osteotomes through into the sinus and should not be done on any patient with neurological disorders of the brain. It is therefore advantageous to drill as close as possible to perforation or even perforate with the low trauma drills as this may enable lifting of membrane with the osteotomes by hand pressure and not using the mallet.

At this stage it was decided to use the Surgident® Aqua Lift System (ALS) which allows for careful measured introduction of saline into the sinus to push the membrane up in a low trauma manner with low risk of perforation (Figure 7). The saline is directed through lateral openings at the tip of the drill using a sterile syringe and saline. The line is filled with saline before drawing 1cc of saline into the syringe. This will introduce 1cc of saline under the Schneiderian membrane. This is then removed and to test if the membrane is intact, the patient is asked to breathe deep in and out through the nose. The fluid level in the osteotomy site should fluctuate with the breathing and not disappear into the sinus, which would indicate a perforation. The particulate bone graft can be mixed with some blood from the surgical site, saline or I-PRF as described before and is slowly introduced into the sinus through the implant osteotomy opening. The graft can be pushed into the sinus using special instruments in the TOCA kit or the Osteotome used for the TSFE. The graft will show a smooth dome / egg-shape if the membrane stays intact, and this is verified on the radiograph (Figure 8).

It was decided to place an implant with increased thread depth to achieve a high primary stability in the soft bone (8.5 x 5mm, Megagen Anyridge® Korea). Primary stability of

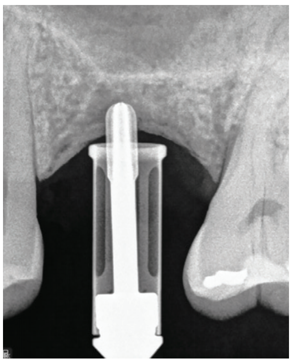

Figure 3: Transcrestal pilot drill with a 3mm stop used to perform 1st measurement.

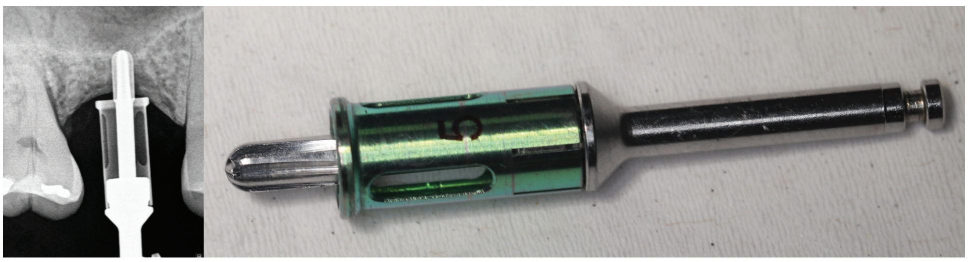

Figure 4: Transcrestal drill with 5mm stop for a controlled perforation of sinus floor.

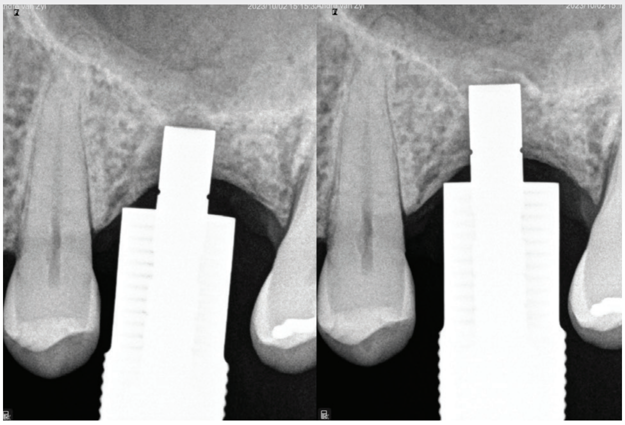

Figure 5: Summers' osteotome with depth stop increased in careful 1mm increments to in fracture the sinus floor 1-2 mm as seen on the right.

Figure 6: Summers' osteotomes with hollow tips to fracture sinus floor and the mallet for hammering if needed. The curved osteotomes shown here allow for easy access to posterior sites.

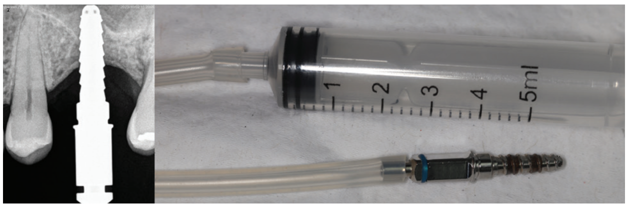

Figure 7: The ALS (Aqua Lift System) drill in position with the lateral openings visible at tip. This will force saline in a horizontal direction to gently lift the Schneiderian membrane. The syringe is used to fill the connecting line and in this case 1cc of saline was used to lift the membrane.

Figure 8: Bone particles are slowly pushed into the sinus using instruments in the TOCA kit or alternatively using the Summers' osteotome. This is done slowly and monitored by taking regular radiographs to see that membrane stays intact. This can be verified by the smooth egg-shaped graft within sinus.

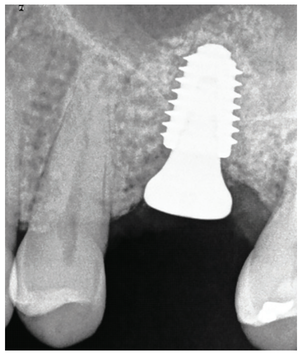

Figure 9: The implant is inserted at a very low speed not exceeding 15RPM to ensure it spreads the graft in a lateral manner, not pushing the particles too much against the membrane in upward manner thereby perforating at the apex.

45Ncm was achieved and a healing abutment was placed for a one stage protocol (Figure 9). The implant is turned in very slowly with a maximum RPM of 15, to push the bone graft in a lateral direction rather than apically which may stretch and perforate the membrane. Radiographs are taken to verify that the smooth dome shape of graft stays intact.

References

1. Boyne PJ, James RA. Grafting of the maxillary sinus floor with autogenous marrow and bone. J Oral Surg. 1980;38(8):613-6.
2. Tatum H, Jr. Maxillary and sinus implant reconstructions. Dent Clin North Am. 1986;30(2):207-29.
3. Todorovic VS, Snyman I, van Zyl AW. MC Implant Dentistry; Lateral window Sinus Floor Elevation technique. International Dentistry- African Edition. 2023;13(1):6-12.
4. Summers RB. A new concept in maxillary implant surgery: the osteotome technique. Compendium. 1994;15(2):152, 4-6, 8 passim; quiz 62.
5. Danesh-Sani SA, Loomer PM, Wallace SS. A comprehensive clinical review of maxillary sinus floor elevation: anatomy, techniques, biomaterials and complications. Br J Oral Maxillofac Surg. 2016;54(7):724-30.
6. Lundgren S, Cricchio G, Hallman M, Jungner M, Rasmusson L, Sennerby L. Sinus floor elevation procedures to enable implant placement and integration: techniques, biological aspects and clinical outcomes. Periodontol 2000. 2017;73(1):103-20.
7. Rammelsberg P, Kilian S, Busch C, Kappel S. The effect of transcrestal sinus-floor elevation without graft on the long-term prognosis of maxillary implants. J Clin Periodontol. 2020;47(5):640-8.
8. Guo T, Gulati K, Shen Z, Han P, Fan Z. Therapeutic outcomes of non-grafted and platelet concentrations-grafted transcrestal maxillary sinus elevation (TSFE): a systematic review and meta-analysis. Sci Rep. 2020;10(1):5935.
9. Cho YS, Chong D, Yang SM, Kang B. Hydraulic Transcrestal Sinus Lift: Different Patterns of Elevation in Pig Sinuses. Implant Dent. 2017;26(5):706-10.
10. Trisi P, Berardini M, Falco A, Podaliri Vulpiani M. New Osseodensification Implant Site Preparation Method to Increase Bone Density in Low-Density Bone: In Vivo Evaluation in Sheep. Implant Dent. 2016;25(1):24-31.
11. Kim JM, Sohn DS, Bae MS, Moon JW, Lee JH, Park IS. Flapless transcrestal sinus augmentation using hydrodynamic piezoelectric internal sinus elevation with autologous concentrated growth factors alone. Implant Dent. 2014;23(2):168-74.
12. Shi S, Han L, Su J, Guo J, Yu F, Zhang W. Clinical efficacy of transcrestal sinus floor augmentation, in comparison with lateral approach, in sites with residual bone height </=6 mm: A systematic review and meta-analysis. Clin Oral Implants Res. 2023.
13. Pjetursson BE, Lang NP. Sinus floor elevation utilizing the transalveolar approach. Periodontol 2000. 2014;66(1):59-71.