Sinus grafting using the lateral window approach was first described by Tatum and later by Boyne and James. It is currently considered one of the most predictable regenerative procedures. Research has shown that even with the use of multiple types of graft materials, implant survival in a grafted sinus is predictable. However, despite the improvements in CBCT imaging, clinicians may still have difficulty in locating and gaining precise access to the maxillary sinus cavity. Clinicians may be presented with challenges such as cone beam computed tomography (CBCT) have become essential in aiding the clinician in the diagnosis and treatment planning of sinus procedures.

ABSTRACT

Lateral approach sinus grafting has become a routine and predictable surgical method of augmenting the pneumatized sinus for implant placement. Outlining the lateral window access can be a challenging task for the clinician to envision and execute. Improper extension and access to the maxillary sinus can prevent proper placement of graft materials and lead to complications. The purpose of this report was to demonstrate a technique that will allow the precise planning of the lateral approach using radiographic information and 3-dimensional (3D) software to 3D-print a surgical guide. (J Prosthet Dent 2018;119:897-901)
as navigating around large sinus septa, large maxillary arterial branches, and adjacent teeth; and having adequate extension of the proposed window in relation to the planned implant positions. These challenges can result in sinus perforation, which has been reported to be the most common complication.

The purpose of this report was to demonstrate a technique that will allow the clinician to plan and precisely outline the lateral access using CBCT imaging and 3-dimensional (3D) software to 3D-print a guide. This allows the clinician to precisely outline the window intraoperatively, which can reduce surgical time and complications.

**TECHNIQUE**

1. Make a CBCT scan (NewTom VGi; NewTom Inc) for diagnosis and treatment planning. The CBCT cross section shows adequate bone for 1-stage sinus grafting with implant placement (Fig. 1).
2. Make an intraoral scan (Trios 3; 3Shape A/G) of the hard and soft tissues. Export the data set from the intraoral scan as a standard tessellation language (STL) file.
3. Transform the Digital Imaging and Communications in Medicine (DICOM) data set from the CBCT into a 3D bone model using DICOM reconstruction software (InVesalius 3.0; CTI). Export the bone model as an STL file.
4. Superimpose the STL file of the bone model on the STL file of the intraoral scan (Geomagic Control 2014; 3D Systems Inc) to create a bone model with accurate tooth surfaces. Export the newly merged tooth/bone model data set as an STL file.
5. Import the tooth/bone model STL file and superimpose it on the CBCT data using implant-planning software (BlueSky Plan; BlueSkyBio LLC). Plan the implant position. Design a tooth-supported surgical guide to include the implant position and cover the lateral wall of the sinus and zygomatic process of the maxilla (Fig. 2).
6. From an internal view of the maxillary sinus, and using the cut tool, outline the proposed lateral window location (Fig. 3A). Finalized surgical guide with lateral window outline in implant planning software (BlueSky Plan; BlueSkyBio LLC) (Fig. 3B).

**Figure 3.** A, Internal view of maxillary sinus with outlined window location. B, Finalized surgical guide with lateral window outline in implant planning software (BlueSky Plan; BlueSkyBio LLC).

**Figure 4.** Three-dimensional printed guide before final polymerization.

**Figure 5.** Three-dimensional printed guide on bone model after polymerization.
window with proper extension (Fig. 3A). The outline is cut through the tooth/bone model and the surgical guide (Fig. 3B). Export the surgical guide as an STL file.

7. Import the STL file of the surgical guide into design software (Meshmixer; Autodesk Inc) to contour and smooth the surgical guide. Export the surgical guide as a new STL file.

8. Import the STL file of the surgical guide into printing software (PreForm; Formlabs Inc) and 3D-print in dental resin (Dental SG Resin; Formlabs Inc) using a desktop printer (FormLabs 2; Formlabs Inc) (Figs. 4, 5). Light polymerize and autoclave the guide according to manufacturer guidelines before beginning the surgical procedure.

9. Make midcrestal, sulcular, and vertical releasing incisions. Reflect a full-thickness mucoperiosteal flap to expose the lateral wall of the maxillary sinus. Place the implant/sinus window guide intraorally (Fig. 6A).

10. Using a surgical pencil, trace an outline of the lateral window (Fig. 6B). Collect autogenous bone scrapings from the outlined area. Using a #8 tungsten carbide round bur, create an osteotomy, preserving the bony plate (Fig. 6C). Reflect and elevate the sinus membrane.

11. Place a mixture of 40% xenograft (Bioss; Geistlich Pharma Inc), 40% allograft (Puros Cortical; RTI Biologics, Inc), and 20% autogenous graft material in the sinus (Fig. 6D). Using the same implant/sinus window guide, prepare the osteotomy for the #3 implant site using the Straumann Guided Protocol (Fig. 6E). Place an implant (Straumann BL 4.8×12 mm, Bone Level; Institut Straumann AG) with 25 Ncm of insertion torque (Fig. 6F).

12. Place a collagen membrane (Bioguide; Geistlich Pharma Inc) over the lateral window and secure it with 2 tacks (TruTACKS; ACE Surgical Supply Co). Reapproximate the flap and suture it with passive primary closure using a combination of polytetrafluoroethylene (Gore-Tex; W.L. Gore & Associates) and chromic gut (Ethicon US, LLC).

13. Make a postoperative CBCT to evaluate the sinus graft (Fig. 7).

To date, the authors have successfully performed 14 lateral approach sinus graftings using a lateral window guide. Of the 14 guides, 12 were tooth supported and 2 were bone supported.

**DISCUSSION**

The primary technical complication during sinus grafting is membrane perforation. The risk of perforation is increased with a lateral window of inadequate size, making it difficult to reflect the membrane. The use of a surgical guide to assist in creating the proper size and positioning of the lateral window could decrease sinus membrane perforations.

Additionally, specific anatomic structures, including the posterior superior alveolar blood vessels, sinus septa, and surrounding roots, can be avoided. Intraoperative bleeding from intraosseous arteries is usually not threatening because of their small size. However, the bleeding can interfere with visualization of the Schneiderian membrane during elevation and can increase the risk of perforation. Patients treated by the authors using this technique allowed accurate identification and preservation of these intraosseous arteries (Fig. 8).

Mandelaris and Rosenfeld were the first to describe the use of a sinus guide. In their protocol, 2 separate cutting guides were fabricated, one for the superior border alone and a second guide for the remaining borders. The guide was designed and fabricated using a stereolithography system by a surgical guide company. The present technique differs in that it allows the fabrication of a single 3D-printed guide that outlines the entire window and also guides the implant placement.

With this technique, the clinician can prosthetically plan the implant positions before surgery. The lateral window can be planned on the basis of those implant positions in order to have adequate extension of the graft material. This can help avoid compromising ideal implant placement or regrafting during a second stage surgery, especially in the edentulous maxilla (Fig. 9).

An added benefit of this technique is the ability to incorporate an implant-placement guide. The implant was placed using a fully guided drilling protocol in a single staged approach. If needed, the sinus guide portion can be trimmed leaving simply an implant guide which can be sterilized and saved for a second surgery if implant placement is not indicated at the time of sinus augmentation.

Potential disadvantages to this technique include the need to learn the software used in the technique. While some of the software is free (such as, InVesalius, BlueSky Plan, and Meshmixer), Geomagic Control is not. Future techniques may allow the use of free software throughout the process. Another potential disadvantage is the time required to design and fabricate the guide.

While this technique describes the use of in-office 3D printing, those who do not have access to the software or a 3D printer can use the services of dental laboratories with experience in fabricating surgical guides. In the first description of a sinus guide by Mandelaris and Rosenfeld, collaboration between the clinician and laboratory was documented.
Together with in-office 3D printing or dental laboratory support, clinicians can outline and create lateral window osteotomies accurately and safely. As a result, potential complications are reduced, and adequate graft placement based on the planned implant position is ensured.

**SUMMARY**

Clinical research is required to assess the guide’s ability to reduce the number of complications and demonstrate the potential increase in successful lateral approach sinus grafting.

**REFERENCES**


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