### Internal Sinus Manipulation (ISM) Procedure: A Technical Report

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#### ABSTRACT

*Background:* The sinus augmentation procedure has facilitated dental implant treatment in the posterior maxilla where there is insufficient bone for implant placement. A modified Caldwell-Luc, lateral window technique can be applied in most cases needing sinus augmentation in order to create a larger bone volume. However, treatment morbidity can be a concern, especially in the form of postoperative swelling due to surgical trauma. Vertical augmentation using osteotomes has also been selected as a choice of treatment due to less invasive surgery and less postoperative trauma. Although the osteotome technique enables the surgeon to raise the sinus membrane internally through an implant osteotomy site, the quantity and predictability of bone augmentation can be limiting due to the elasticity of the Schneiderian sinus membrane, difficulty of the membrane to separate from the floor as well as the inability to have direct tactile access to "peel" the membrane off of the floor.

*Purpose:* The objective of this report is to present a new, minimally invasive sinus augmentation technique, called the Internal Sinus Manipulation (ISM) procedure, which has been developed to facilitate sinus floor augmentation while reducing treatment morbidity and yet have direct tactile access to raise the membrane off of the sinus floor.

*Surgical Technique:* Access to the Schneiderian sinus membrane is achieved without perforation of the membrane through a conventional osteotomy drilling procedure alone or combined with osteotome technique, followed by reflection of the membrane utilizing special ISM instrumentation and bone graft procedure laterally and vertically through the osteotomy site. A planned implant is then placed.

*Conclusion:* The Internal Sinus Manipulation procedure can be used as an alternative treatment modality for sinus augmentation as compared to the external lateral window technique while reducing postoperative morbidity for the patients who need implant treatment in posterior maxillary areas.

KEY WORDS: dental implants, internal sinus manipulation, ISM, sinus augmentation, sinus elevation, lateral window technique, internal technique, osteotome technique, Schneiderian sinus membrane, membrane perforation, minimally invasive surgery

The posterior maxilla often presents clinicians with the need to increase the available bone in order to facilitate dental implant placement. The first sinus augmentation technique was presented by Tatum<sup>1</sup> in 1977, and the first publication was made by Boyne and James<sup>2</sup> in 1980. Originally, Tatum accessed the maxillary sinus through the alveolar ridge crest using various instru-

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DOI 10.1111/j.1708-8208.2007.00049.x

ments of his own design. Boyne and James later developed the lateral window technique modifying the Caldwell-Luc operation. A horizontal incision was made in the posterior maxillary vestibule followed by the exposure of the lateral osseous ridge wall of the posterior maxilla. An osteotomy window was then created by using burs in the lateral osseous ridge wall. The window of the lateral wall was either removed or medially repositioned. The sinus membrane was gently released and reflected upward and an autogenous bone graft was then inserted over the exposed sinus floor. The flap was then replaced and primarily closed. A bladed-type implant was placed at 10 to 12 weeks following the augmentation procedure. Fundamental concepts have been retained in contemporary lateral window techniques.<sup>3-4</sup> Implants are often now placed at the time of grafting according to the amount of preexisting bone available

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for initial stability. However, postoperative complications such as pain or swelling resulting from extensive surgical trauma may increase the patient's discomfort.

In 1994, Summers<sup>5-7</sup> published a less invasive method for sinus augmentation using an osteotome instrument. After initial implant osteotomy drilling performed, approximating the sinus floor, an osteotome was inserted to the osteotomy site and gently tapped, fracturing and moving the sinus floor superiorly. The fractured sinus bone was pushed up, reflecting the Schneiderian membrane, and various bone graft materials were then added. Implants were immediately placed. Recently, modifications of this technique using spreading and condensing instrumentation and elevating the sinus using various pressure techniques have also been reported.<sup>8-15</sup> However, the amount of augmentation of the sinus floor and the volume of bone created is limited using these techniques. It is reportedly difficult in many cases to control the osteotome tapping force in order to produce effective membrane lifting without membrane perforation. Sometimes, using the tapping procedure to fracture the sinus floor or to add bone graft material causes discomfort to the patient during the surgery.

A new minimally invasive sinus augmentation technique, called the *Internal Sinus Manipulation* (ISM) procedure, is presented, which is designed to facilitate sinus floor augmentation predictably while reducing treatment morbidity.

#### SURGICAL TECHNIQUE

The treatment plan for ISM should be established based on clinical evaluation, diagnostic wax-up on a study cast, and radiographic information from a periapical radiograph, panoramic radiograph, or computerized tomogram (Figure 1). After a full-thickness flap elevation or through a flapless procedure, a standard implant osteotomy drilling sequence is followed using a surgical guide, round marker, and subsequent twist drills. Special twist drills with stopping cylinders can be used to drill up to the sinus floor, barely breaking through the existing bone (Figure 2). A depth-gauge instrument with a blunt tip that a manufacturer supplies in its surgical kits is useful in checking membrane integrity and in verifying the amount of membrane lifted (Figure 3). Any remaining thin segments of bone may be tapped and fractured gently using osteotomes via the Summers technique or removed with a bone-breaking instrument





**Figure 1** *A and B*, Fifty-two-year-old female patient. Previously, root canal treatment had failed on tooth #12 and the tooth was extracted. A general dentist attempted to place an implant that failed. A bone graft (Bio-Oss) was performed after implant removal. Six months later, the Internal Sinus Manipulation procedure with implant placement was carried out. Approximately 7-mm bone height existed below the maxillary sinus floor.

(JMY 2, H & H Co., Ontario, CA, USA) (Figure 4). The osteotomies are then widened to the appropriate width prior to implant placement utilizing the same length of stopping cylinder twist drills or standard implant manufacturer's twist drills. An internal sinus membranelifting instrument (JMY 1, H & H Co.) is then utilized within the osteotomy and manipulated gently in lateral and upward motion, always keeping the working edge against the bony floor of the sinus while raising the sinus floor membrane (Figure 5, A and B). This specially designed membrane-lifting instrument consists of two parts. One is the disk-shaped tip, and the other is the angled neck. The disk-shaped tip releases the membrane from the bony wall of the sinus floor. The angled neck helps the proper positioning of the working tip. The inflection portion of the angle of the neck extending

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**Figure 2** *A and B*, Final osteotomy through flapless surgery was performed using twist drills, and the sinus floor was approximated leaving an intact sinus membrane.

from the working tip allows the clinician to feel the tension of the membrane and determine the amount of initial lateral and vertical membrane reflection. The procedure for membrane release and elevation should be continued until the planned amount of augmentation is achievable. The bone graft of choice is then placed and packed with a bone graft packing instrument (JMY 4, H & H Co.) (Figure 6, A and B). Additional augmentation is expected, as additional vertical pressure is generated by bone packing. At the final stage of bone grafting, a tapping bur can be used to pack and push up additional bone graft material into the osteotomy socket (Figure 7). The depth-gauge instrument can be used to check the height of the vertical augmentation while packing the bone material. After completion of the bone grafting, an implant is then placed (Figure 8). When a perforation of the sinus membrane is found or suspected, any resorbable membrane of choice can be trimmed and inserted with a repair membrane carrier (JMY 5, H & H Co.) as a "backstop" to prevent displacement of bone graft prior to insertion of bone graft



**Figure 3** *A and B*, The sinus membrane integrity was checked and residual bone height was measured with a ball gauge instrument.

and implant placement (Figure 9). The initial stability of the implant can determine whether a one-stage or two-stage surgey would be performed. If the initial stability is not achieved, the osteotomy site can be grafted as in a conventional extraction socket preservation technique. An implant would then be placed following bone healing and maturation.



Figure 4 The thin segment of the remaining bone of the sinus floor was removed using a bone-breaking instrument (JMY 2).





Figure 7 Bone material was further condensed using a tap drill.



**Figure 5** *A and B*, The sinus membrane was detached and lifted using an internal sinus membrane-lifting instrument (JMY 1).

### CASE REPORTS

# Case 1: Delayed Implant Placement with the ISM Procedure

A 32-year-old healthy man presented with a root canal treatment failure and a root fracture on tooth #14. The

tooth was not restorable. The patient did not want a fixed bridge on #13 to #15. A final decision was made for the delayed placement of an implant with sinus augmentation using the ISM procedure on #14. A repeat root canal treatment was performed on #13. The implant surgery was performed 3 months after the tooth extraction. Initially, approximately 3-mm residual bone existed below the sinus floor (Figure 10A). The sinus membrane was lifted about 10 mm and a bone graft (Bio-Oss, Osteohealth Co., Shirley, NY, USA) was placed under the sinus membrane through the osteotomy site. A  $5.5 \times 11.5$ -mm implant (Brånemark Mk IV, Nobel Biocare, Yorba Linda, CA, USA) was then placed (Figure 10B). Minimal postoperative pain or swelling was reported. No sinus problems have been developed.

# Case 2: Immediate Implant Placement with the ISM Procedure

A 51-year-old man with no medical contraindication for implant treatment presented with root fracture on tooth



Figure 6 A and B, Bone material chosen (Bio-Oss) was inserted and packed using a bone-condensing instrument (JMY 4).





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Figure 8 A and B, A 7-mm vertical sinus augmentation was achieved. A 13-mm-long implant was placed  $(4.3 \times 13 \text{ mm}, \text{Replace Select}, \text{Nobel Biocare}, \text{Yorba Linda, CA, USA}).$ 



**Figure 9** When perforation of sinus membrane is suspected, a repair membrane carrier can be used to place a bioabsorbable membrane to cover the perforation (JMY 5).

#13 (Figure 11A). The tooth was determined to be unrestorable. The patient refused to have a fixed partial denture. The tooth was extracted and an immediate implant placement with sinus augmentation using the ISM procedure was planned. Initial radiographic residual bone was approximately 5 mm from the alveolar ridge crest. The sinus was augmented radiographically about 6 mm with a bone graft material (Bio-Oss), accommodating a  $4 \times 10$ -mm implant (Brånemark Mk IV implant) (Figure 11B). Adequate initial implant stability was obtained. Tooth #12 was also extracted 2 years later because of root fracture. Initial radiographic bone height was 6 mm. The implant was immediately placed after extraction and sinus augmentation using the ISM



**Figure 10** Thirty-two-year-old male patient. *A*, Preoperative radiographic image after extraction of tooth #14. Residual radiographic bone height was 3 mm. *B*, Postoperative radiograph. Approximately 10-mm radiographic sinus augmentation was achieved using the Internal Sinus Manipulation procedure accommodating an 11.5-mm-long implant.



**Figure 11** Fifty-one-year-old male patient. *A*, Preoperative radiographic image. The patient complained of pain while chewing on tooth #13. Root fracture on #13 was found. Immediate implant placement was planned. Initial radiographic bone height was 5 mm from the ridge crest after extraction. *B*, Sinus was augmented about 6 mm using the Internal Sinus Manipulation procedure for a 10-mm-long implant.

procedure. The sinus membrane was lifted using the same ISM technique, and a  $4 \times 13$ -mm implant (Brånemark Mk IV) was placed (Figure 12). Bone graft material was not inserted on this site. The implant-supported restorations have been functioning for about 5 and 7 years, respectively, since the final crowns were seated on #12 and #13. No sinus complications have been reported.

# Case 3: Multiple Implant Placement with the ISM Procedure

A 69-year-old woman with osteoporosis presented with a failed fixed partial denture on tooth #13 to #15 because of secondary dental caries and failed root canal treatment (Figure 13A). The teeth were unrestorable. Extraction and implant treatment were planned. Rehabilitation of #15 was not necessary because of missing opposing tooth. Splinted implant-supported single crowns were planned to replace teeth #13 and #14. Immediate implant placement was performed for #13. Initial radiographic bone height on #13 was 7 mm from the bone crest and 3mm on #14. The sinus was augmented radiographically 5 mm on #13 and 9 mm on #14 using the ISM procedure with a bone graft (Bio-Oss). Implants measuring 4 × 11.5 mm (Prima Connex, Lifecore Biomedical Inc., Chaska, MN, USA) were placed with good initial stability in both areas (Figure 13B). Final prostheses were delivered 6 months after implant placement (Figure 14). Minimal postoperative discomfort and no sinus complications have been reported.



**Figure 12** Two years after implant placement on #13. The tooth #12 was extracted because of root fracture. Immediate implant placement and simultaneous sinus augmentation without bone graft using the Internal Sinus Manipulation procedure was performed on #12. A 13-mm-long implant was placed. Restorations have been functioning for 5 and 7 years on #12 and #13, respectively.

**Figure 13** Sixty-nine-year-old female patient. *A*, Preoperative radiographic image. The fixed partial denture on #13 to #15 failed because of secondary dental caries and root fracture. The fixed partial denture was removed and the teeth were extracted. Initial radiographic ridge height was 7 mm on #13 and 3 mm on #14, respectively. *B*, Postoperative radiograph. Sinus augmentation was accomplished using the Internal Sinus Manipulation procedure with a bone graft. Approximately 5- and 9-mm augmentation was achieved on #13 and #14, respectively. Implants measuring 11.5-mm long were placed in both areas.

#### DISCUSSION

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Sinus augmentation techniques have expanded indications of dental implant treatment, allowing the placement of dental implants in the posterior maxilla where, often, an inadequate bone height of residual ridge exists because of the position of the maxillary sinus. Placement of bone grafts inferior to the sinus floor membrane improves bone height and volume, allowing for implant placement.

There have been two major approaches utilized for sinus augmentation: a modified Caldwell-Luc, *lateral window technique*,<sup>2</sup> and a vertical alveolar ridge access, *osteotome technique*.<sup>5–7</sup>

Although the previously published Summers osteotome technique provides the ability to raise the sinus membrane internally through an implant osteotomy site, the quantity of bone augmentation is



Figure 14 A radiographic image after setting of final prostheses.

limited because of the restriction in sinus membrane release. It is also difficult to control the tapping force for an effective membrane lift without perforating the sinus membrane. Therefore, it would be of importance that clinicians select the case carefully for this technique. Despite the limited indications, this technique has become an elected choice of treatment for sinus augmentation with implant placement whenever possible because the technique produces less invasive surgical trauma.

Often, when the residual ridge is of minimal height, an external approach to access the sinus antrum and provide sufficient space for bone graft volume is preferable. No limitations of the indication of this external lateral window technique for sinus augmentation could be expected in terms of the height of residual bone. It also may be easier to manipulate the sinus membrane, control the amount of augmentation, and repair a small perforation of sinus membrane than in the Summers technique because direct access to the sinus membrane can be achieved. However, because of the proximity of the infraorbital neurovascular structures and the somewhat extensive flap management during the external lateral window technique, more pain and swelling would be expected, compared with the internal Summers technique.

Considering the advantages of the external lateral window technique and the internal Summers technique and the potential complications of these techniques, a new internal sinus augmentation procedure called ISM has been developed. To date, more than 150 implants



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placed following the ISM procedure have been successfully functioning for more than 5 years. The success rate of implants placed using this technique would be the same as with implants placed using other sinus augmentation procedures, as the only difference is in the technique for the manipulation of the sinus membrane. Wallace and Froum<sup>16</sup> published a review article on implant survival rate related to sinus augmentation in 2003. They proposed a 92.6% overall survival rate of implants with various techniques, ranging from 91.9 to 98.3, which was comparable to that of conventional implant treatment in nonsinus augmented sites.

From a technical viewpoint of this ISM procedure, it should be noted that the more implants placed sideby-side through adjacent osteotomy sites, the easier and more sinus membrane lift can be achieved, and that the shorter the initial residual ridge height available, the easier it is to access and manipulate the sinus floor membrane.

The benefit of the ISM procedure, as compared with the lateral window external technique, is much less postoperative morbidity plus a reduction in complications, as well as the overall time saved for implant treatment. The degree of swelling with this technique is dramatically reduced as compared with that of the lateral sinus augmentation procedure. The postoperative pain level is also markedly less. The outcome of sinus augmentation using this technique would be more predictable than the internal Summers technique in cases needing sinus augmentation of more than 5 mm, because it would not be easy to lift the sinus membrane predictably without membrane perforation in the Summers technique.

A practical limitation of this technique would be the predictability in a two-stage surgical case, which needs a large amount of bone volume, horizontally and/or vertically. Another limitation of the procedure may be if antral septae are present in the area, thereby limiting internal manipulation with instruments. There is an initial learning curve to perform the procedure, which may seem difficult because of the limited access for visualization and instrumentation relying on tactile sense in great part through an osteotomy site.

In spite of these limitations, the newly designed ISM procedure can be used as a predictable alternative treatment modality as compared with the external lateral window technique, while at the same time reducing postoperative morbidity for patients who need implant treatment in posterior maxillary areas. This technique can also provide more predictable outcomes than the vertical osteotome technique for clinicians to overcome the limited indications.

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