A Revolutionary Approach to Predictable Simultaneous Indirect Sinus Grafting During Implant Placement Surgery

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Limiting Factors for the Posterior Maxilla:

Inadequate height, width and density of the alveolar process are considered as some of the common limiting factors for dental implant placements in the posterior maxillary regions. Subsequent to tooth extraction, the lack of occlusal forces transferred to the alveolar bone activates a series of bone remodeling process causing pressure threshold-regulated bone atrophy (Sato et al, 1998). Apart from the resorption of buccal plate of the residual ridge after tooth extraction, increased osteoclastic activity of the periosteum of the maxillary sinus floor leads to the enlargement of the sinus pnumatization at the expense of alveolar ridge height beneath the maxillary sinus (Chanavaz, 1990; Ulm et al, 1995) (Figure 1). Evidently, compromised quality and quantity of bone in posterior edentulous maxilla can adversely affect the clinical outcomes of dental implant treatments with higher incidence of failure rates and complications (Alberktson et al, 1988).

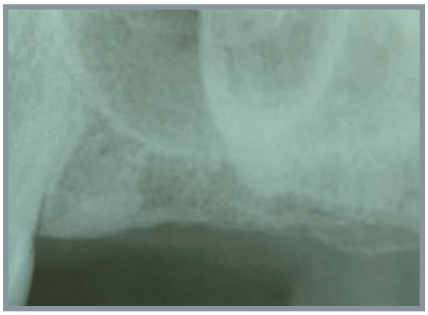

Figure 1 - Pnumatization of posterior maxilla after extraction of tooth with inadequate height of bone for implant placements

Grafting Options for the Posterior Maxilla:

This challenge of compromised height of bone requiring a minimum of 10.0 mm of height has been treated by bone augmentation of the maxillary sinus floor (Tatum, 1986). The surgical approach, known as sinus floor elevation (SFE), can dramatically increase the height of bone available for implant placement. In general, two main sinus floor elevation (SFE) approaches for dental implant placement can be used: 1) Indirect sinus grafting technique: In the presence of at least 5 mm of residual bone, a trans-alveolar approach can be utilized to condense bone grafting materials beneath the Schneiderian membrane. This approach can gain approximately 3-5.0 mm in height within the sinus with a simultaneous implant placement option. (Tan et al, 2008); 2) Direct sinus grafting technique: In cases where the height of residual bone is less than 5.0 mm, sinus lifting through a lateral window approach is recommended as the treatment of choice. The clinical outcomes of increased height of bone greater than 5.0 mm can be gained

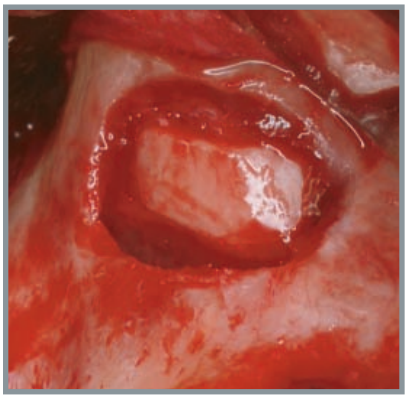

Figure 2 - Direct lateral window grafting technique

and usually requires a delayed staged approach of implant placement after 6-9 months for the sinus graft healing (Esposito et al, 2010) (Figure 2).

While direct grafting technique (Boyne and James, 1980) has evolved into a predictable surgical modality to overcome the vertical bone deficiency in edentulous posterior maxilla (Del Fabbro et al, 2012), technique-sensitivity of the lateral window approach can potentially lead to a range of morbidities and intra/post operative complications. Severe bruising, swelling, and pain may be observed as a result of the inherent traumatic nature of this technique and extensive flap elevation beyond the mucogingival line (Zitzmann and Schaerer, 1998). Meanwhile, the risk of Schneiderian membrane perforation, as the most common complication of this technique (Pjetursson et al, 2008), is not the only concern about the direct sinus grafting. A less common complication due to iatrogenic laceration of intra-osseous branch of posterior superior artery (branch of maxillary artery) may impose a great danger during the surgical procedure (Chen and Cha 2005).

To reduce the risk of complications associated with direct grafting technique and in an anticipation of implant placement, a more conservative method of SFE was introduced by Summers (1994). He proposed a one-stage indirect method of elevating the sinus membrane without lateral window preparation. In this technique, SFE and implant placement are carried out simultaneously. After preparing the site one millimeter short of sinus floor using the twist drill, a set of calibrated osteotomes with blunt/concave tips are tapped apically from a crestal approach to fracture the cortical bone of the sinus floor and advance it beyond the normal inferior border of maxillary sinus. Indirect sinus floor elevation can be performed in conjunction with adding particles of autogenic/allogic/xenogenic bone grafts using broad osteotomes to elevate the sinus floor as a hydraulic plug. The hydrostatic pressure can effectively decrease the risk of Schneiderian membrane perforation during the indirect SFE procedure.

This procedure inherently causes compaction of the alveolar ridge. During the osteotomy process, gradual diameter escalation from one osteotome to the next should expand the alveolus and increase the bone density around the osteotomy site. Hence, sufficient bone width for dental implant placement is secured and higher primary implant stability is achieved by compressing the spongy cancellous compartments of the maxillary alveolar process (Summers, 1994). As compared with the lateral window direct grafting procedure, the indirect SFE is considered a less invasive and less time-consuming intervention with a lower rate of post-operative complications (Zitzmann and Schaerer, 1998). Less morbidity, lower cost, and shorter healing time will be expected when this approach is used to augment the sinus floor (Pjetursson et al, 2008; Tan et al, 2008).

Disadvantages to Indirect Sinus Grafting Technique:

While this is a conservative solution to enter the sinus cavity and elevate Schneiderian membrane through the osteotomy, the original indirect SFE approach may become problematic due to lack of visibility or blinded approach during manipulation of the membrane. Limited access and visibility can lead to accidental perforation of the sinus membrane when using the twist drill or osteotomes. Valsalva maneuver confirms the occurrence of membrane perforation if air bubbles appear in the osteotomy. It is also important to note that the bone grafting material is "blindly" packed beneath the membrane, which in turn increases the risk of membrane perforation. In addition, the placement of the grafted material within the osteotomy is uncontrolled and may lead to uneven distribution around the apex of the implant after healing. For this reason, it is not surprising that Tan et al. (2008) concluded in a systematic review that membrane perforation was the most frequently reported complication which observed in 3.8% of indirect SFE procedures. A recent study (Penarrocha-Diago, 2008) has also reported the occurrence of post-operation headache or benign paroxysmal positional vertigo (BPPV) due to extensive mallet pressure during the indirect SFE procedure.

The limited control of the clinician over the operation field in this technique reduces the amount of sinus floor augmentation compared to that obtained with the lateral window technique (Esposito et al, 2010). Most studies demonstrate that 3 to 5 mm bone augmentation can be achieved using indirect SFE (Pjetursson et al, 2008). To improve the total amount of bone gain through a more conservative procedure, different modifications of Summers' technique have been introduced. A recent experimental ex-vivo study (Stelzle and Benner, 2011) has claimed that sinus floor elevation with an inflatable balloon system may result in an augmentation up to 10 mm. However, clinical studies are yet needed to confirm the results of this experimental study.

Revolutionary Approach to Minimally Invasive Sinus Lift Surgery:

In order to overcome problems associated with the indirect sinus grafting approach, various techniques and options have been developed over the years by different manufacturers and clinicians. Recently a novel crestal approach sinus kit (CAS-KIT; Hiossen) has been developed

to provide a convenient sinus grafting surgery to enhance maximum safety while easily provide the lift of the membrane in a controlled manner for the maxillary sinus. (Table #1) Due to the inverse conical drill design, the conical bone chips in between the cutting blades are shifted and elevate the membrane safely creating a membrane auto lifting function. The four blade drill is designed to reduce deflection of the bone while the straight sides dampen the vibrations to the patient. The unique stopper system also prevents membrane perforation and excessive drill penetration. Progression of 1.0 mm increments can be accomplished until penetration is achieved in a controlled manner. Any anatomical variations of inclined or septum within the maxillary sinus will pose additional clinical complications with the traditional indirect osteotome approach. The unique design of the drill from the CAS-KIT allows for sinus cavity whether it is flat, inclined or with a septum in the maxillary sinus. The hydraulic lift component utilizes a 3cc syringe filled with saline solution to create the hydraulic lift for the membrane. The hydraulic lifter fully covers the drilling osteotomy in order to create the pressure for a uniform lift of the membrane. Depending on the extent of the sinus height elevation desired , the 3cc syringe can be used to slowly raise the sinus membrane in a controlled and non traumatic fashion to create the space for the grafting material. The bone grafting material can be delivered in the sinus cavity through the osteotomy with a bone carrier. The bone condenser can be used to further push the grafting material into the cavity to the desired height.

Table 1:

Features for the Crestal Approach Sinus Kit (CAS-KIT)
1. Inverse conical drill design to create conical bone chips to elevate the membrane safely.
2. Four blade drill design to reduce deflection and dampen vibrations.
3. Stopper system to prevent membrane perforation and excessive drill penetration.
4. Conical drill design to address flat, inclined or septum within the sinus.
5. Unique hydraulic lift to control vertical sinus membrane elevation.
6. Bone grafting carrier, condenser and spreader to provide an evenly distributed graft material within the sinus prior to implant placement.
7. Minimally invasive, controlled and safe procedure for indirect sinus grafting.

Using a slow speed (50 rpm), the bone spreader can evenly spread the material within the cavity. This step can be repeated until the desired height and volume of the sinus cavity is filled and ready for implant insertion.

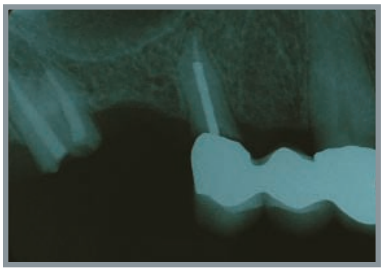

Figure 3 - Pre-operative Radiograph; First premolar with recurrent decay and root fracture and second molar to be extracted.

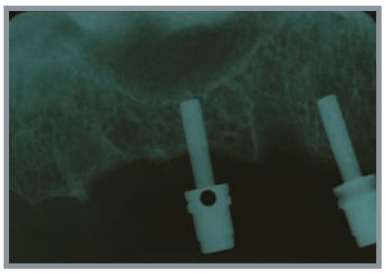

Figure 4 - Direction indicating pins for implant placement to first premolar and indirect sinus lift to first molar position.

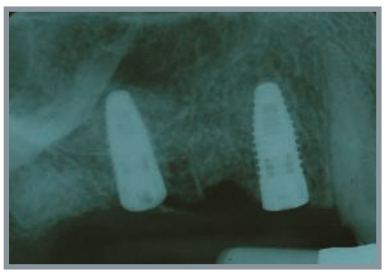

Figure 5 - Post-operative Radiograph; Implant placement to first premolar and simultaneous indirect sinus lift with CAS-kit (Hiossen) in first molar position.

Treatment Options for the Posterior Maxilla Avoiding Sinus Grafting:

To avoid the sinus augmentation procedure, one may consider different alternatives of treatment options in the posterior maxilla. No posterior replacement or treatment with a shorten dental arch concept can be considered. In addition, short axial dental implants of less than 10.0 mm may be evaluated under the sinus floor. Use of tilted implants less than 35 degrees can also be placed parallel to the anterior wall of the maxillary sinus to bypass the sinus and minimize the length of the distal cantilever for the final implant restoration. These alternatives aim to reduce the complexity, expense and time as compared to the traditional sinus augmentation procedure. Two recent systematic reviews (Sun etl al, 2011; Annibali et al, 2012) did not find any clinically relevant difference between the survival and success rate of short implants (defined as <10mm) and those of long implants. Despite the lack of long-term studies, Esposito et al in a Cochrane Database of Systematic Review (2010) concluded that short implants (5mm long) with wide 6-mm platforms could be

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Dr. Mark Lin graduated from the University Of Toronto in the Biochemistry Specialists honors program. He received his dental degree from University of Detroit Mercy and completed a 1-year General Practice Residency. He practiced general dentistry for 13 years then completed his post graduate training in the specialty of Prosthodontics at the University of Toronto. He currently holds the title as "Assistant Professor" at the faculty of dentistry, at the University of Toronto. In addition, he maintains a full time specialty practice as a Prosthodontist at Dr. Mark Lin Prosthodontic Center with focus on full mouth reconstructions, dental implant surgery and implant prosthetics. He is a Fellow and serves as an Examiner with the Royal College of Dentists of Canada in the specialty of Prosthodontics. Dr. Lin has given numerous lectures, presentations and courses on the topics of Implant Dentistry (Surgical/Prosthetics) with live surgical and prosthetic demonstrations, anterior implant esthetics, Implant complications and Practice Management. Over the past 10 years, he has given more than 200 lectures at various different professional and scientific meetings in Canada, U.S., Taiwan, Germany, India, Iran and China.

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"successfully loaded in maxillary bone with a residual height of 4 to 6 mm below the sinus without making any augmentation procedure". In some cases where the anatomical landmarks permit, regular size implants can be placed with a distal angulation (tilted) to avoid the maxillary sinus (Aparicio et al, 2001).

In general, the survival rate for implants inserted in combination with sinus floor elevation is comparable with that of implants placed in non-grafted sites. Tan et al. (2008) in a meta-analysis of more than 12,000 implants reported that cumulative survival rate for implants inserted indirectly in sinus floor elevated sites was just over 90% after 3 years of follow-up. When 5 to 7 mm of sub-sinus bone was available for indirect SFE technique, the survival rate for 499 implants was as high as 97.5% after a period of 2 to 5 years of follow-up. In agreement with the above mentioned studies, Wallace and Froum (2003) reported a 93.5% survival rate for implants in sites augmented with indirect SFE. According to the clinical evidence present in the dental literature, it may be concluded that indirect SFE technique is a predictable treatment approach with low incidences of surgical complications. The short-term (3 years) clinical success/survival of implants in sinus augmented sites is not different from that of implants placed in the non-grafted alveolar process. Further studies are required to assess the long-term clinical outcomes of this treatment approach. ■

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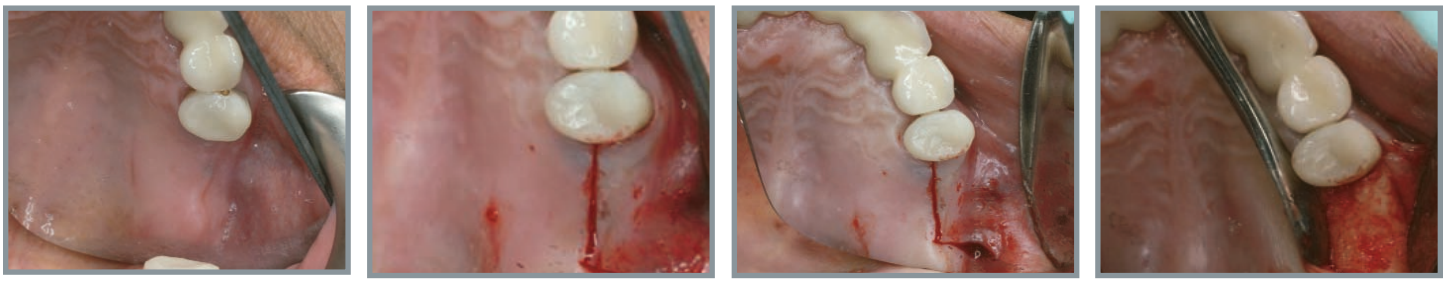
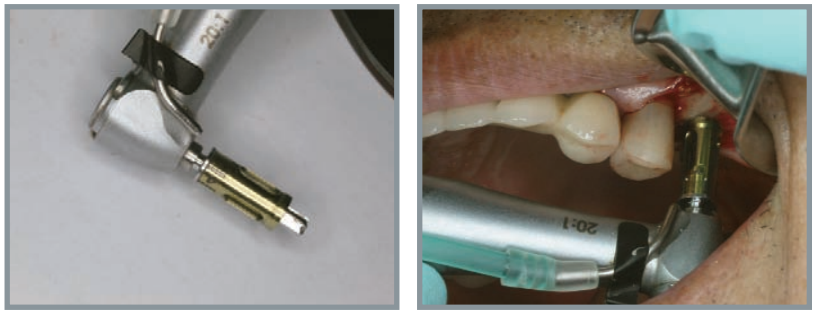
Step 1: Full thickness mucoperiosteal flap was raised.



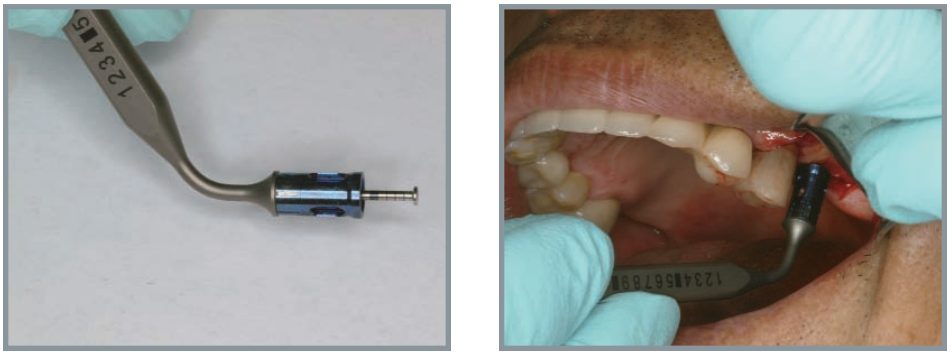
Step 2: A Twist Drill with a 7mm stopper was used to start with. The goal was to reach about 2 mm short of the sinus floor. In this case, we had about 9mm crestal bone as per the periapical X-ray.

Step 3: Now start using the ***CAS drills*** sequentially till the implant size is reached using the same stopper. The goal here is to widen the Osseotmy till the desired implant size.

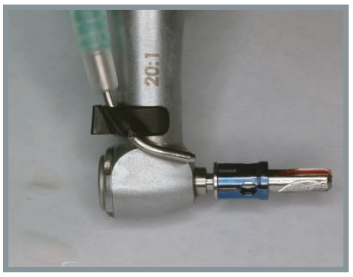


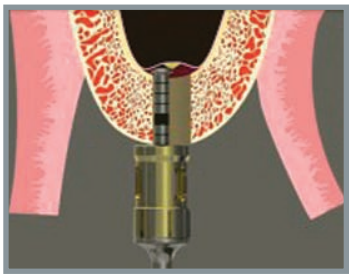
Step 4: Now start going deeper by changing the stopper sequentially in 1mm increments till the drop into the sinus floor is felt or the sinus membrane is felt manually, in this case 8mm and 9mm.

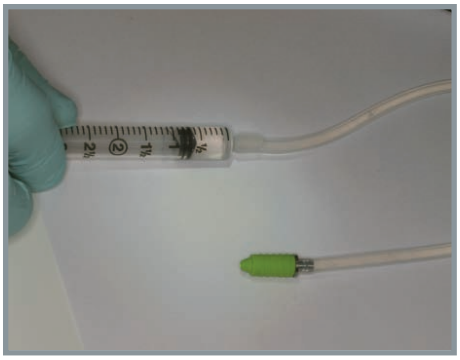
Step 5: After using the drill with the 9mm stopper, the provided Depth Gauge was used to check to see if the sinus membrane has been reached. The Depth gauge has to be used with the last stopper.

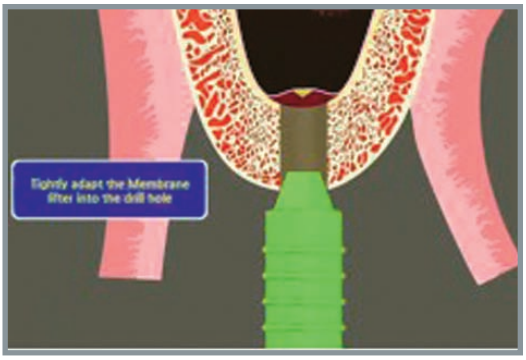


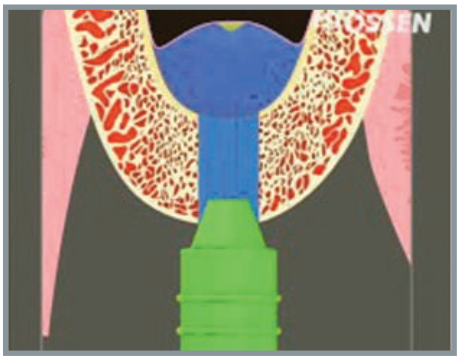
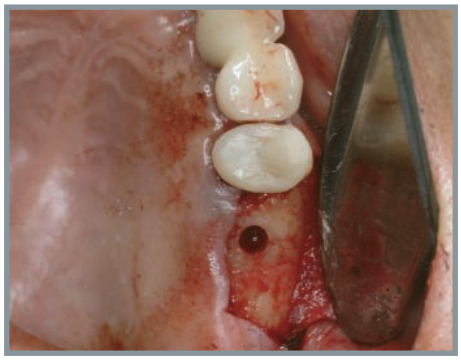
Step 6: Since the Sinus floor was not felt with the last stopper, the next stopper, 10mm was used with the drill. A definite "drop" into the sinus was felt. This was also confirmed by feeling with the Depth Gauge.



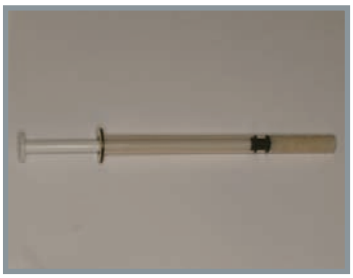
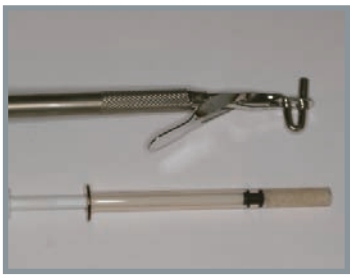





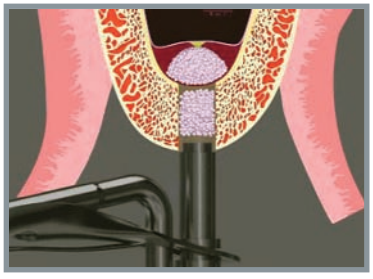


Step 7: The membrane is now lifted using the ***Hydrolic Lift*** system provided. Since we needed about 4 mm of lift, 0.5 cc of saline was used.

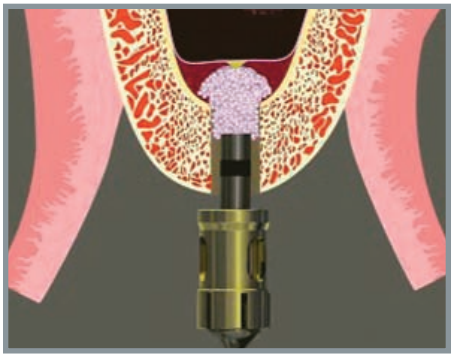






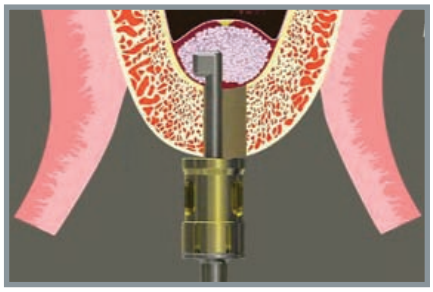


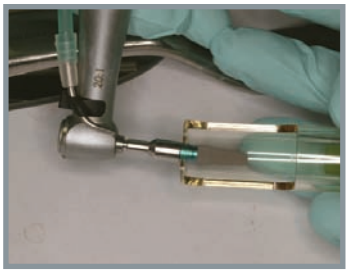
Step 8: The Bone graft material 50% Accell Connexus (Citagenix) and 50% BioOss (Geistlich) was then carried to the site using the syringe. You may also carry the graft material to the site using the Bone Carrier provided.

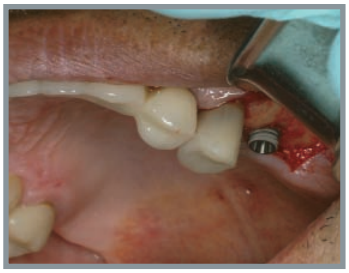
Step 9A: The Bone graft material was then condensed into the site using the Bone Condensor provided. The last stopper used, has to be inserted into the bone condensor while it is being used.



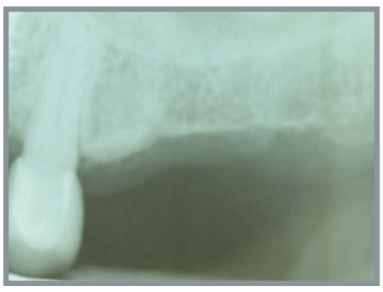
Step 9B: The Bone Spreader provided was then used with the last stopper to spread the graft material inside the site. This was done at a speed of 50rpm.



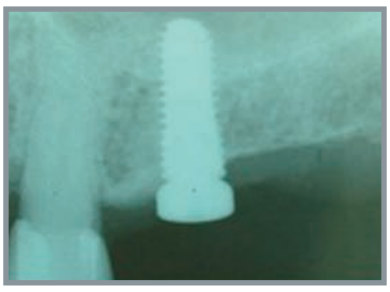




Step 10: A Hiossen ET III 4.5x13mm implant was placed into the site and torque down to 30NCm with a solid initial stability. The open thread design ensured that every mm of the implant assisted with the stability.



Pre-operatory Radiograph: Pnumatized sinus floor with 5-7mm residual ridge height.



Post-operatory Radiograph: Hiossen ET III 4.5x13mm implant with indirect Sinus lift using the CAS-Kit.