Inadequate height and width of alveolar process is considered as the most common limiting factor for implant placement in maxillary alveolar process. Subsequent to tooth extraction, the decrease of occlusal forces transferred to the alveolar bone activates a series of bone remodeling events 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 ostoclastic activity of the periosteum of the maxillary sinus floor leads to the enlargement of the sinus (pneumatization) at the expense of alveolar ridge height beneath the maxillary sinus (Chanavaz, 1990; Ulm et al, 1995). Evidently, inferior quality and quantity of bone in posterior edentulous maxilla can adversely affect the clinical outcomes of dental implant treatments (Alberktson et al, 1988).

This obstacle has been overcome by bone augmentation of the maxillary sinus floor (Tatum, 1986). A 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 cab be used: 1) Indirect grafting technique: In the presence of at least 4 to 5 mm residual bone, a trans-alveolar approach can be utilized to condense bone grafting materials beneath the Schneiderian membrane (Tan et al, 2008); 2) Direct grafting technique: In cases where the height of residual bone is only 1 to 3 mm, sinus lifting through a lateral window approach is recommended as the treatment of choice to achieve successful long-term clinical outcomes (Esposito et al, 2010).

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 Schaefer, 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 simultaneous 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 at the same time. After preparing the site one millimeter short of the sinus floor using a twist drill, a set of calibrated osteotomes with blunt/concave tips are tapped apically from the crestal osteotomy hole to fracture the cortical bone of the sinus floor and advance it beyond the normal inferior border of maxillary sinus. Indirect SFE can be performed in conjunction with adding particles of autogenic/allogenic/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 (Summers, 1994).

An interesting advantage of indirect SFE is the fact that the 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, denser bone 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).

While it is a great conservative solution to enter the sinus cavity and elevate Schneiderian membrane, the original indirect SFE approach may become problematic due to poor visibility 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. 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 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 malleting 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.
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 trials are yet needed to confirm the results of this experimental study.

To avoid the sinus augmentation procedure, one may consider different alternatives ranging from onlay bone grafts (Esposito et al, 2009) to the use of short implants. These alternatives aim a less complex, less expensive and less time-consuming method to substitute sinus augmentation. Two recent systematic reviews (Sun et al, 2011; Annibali et al, 2012) did not find any statistical or 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 “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 of 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 12000 implants reported that cumulative survival rate for implants inserted in indirectly 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 (Bruschi et al, 1998). 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.
References


Chen L, Cha J. An 8-year retrospective study: 1,100 patients receiving 1,557 implants using the minimally invasive hydraulic sinus condensing technique. J Periodontol. 2005; 76:482-491.


