

Graftless crestal hydraulic sinus lift with simultaneous implant insertion

ABSTRACT

Background: The posterior maxilla is always a challenge for dental implant restoration. The presence of maxillary sinus and reduced subantral bone height are the limitations for implant insertion. The need of the hour is to make the surgical procedures simple, minimally invasive, and predictable. Can we perform the sinus lift and simultaneous implant insertion by minimally invasive, simple, cost-effective, and less time-consuming technique? With this in consideration, the author carried out this study for graftless crestal hydraulic sinus lift (CHSL) and simultaneous implant insertion in partially edentulous posterior maxilla for 26 implants. The aim is to evaluate the clinical and radiological success of graftless CHSL with simultaneous implant insertion.

Material and Method: The sample size was 17 patients and 26 implants were inserted. The clinical as well as radiological follow-up was done for 1 year. The outcome variables were the gain in bone height and implant survival.

Result: Mean Bone height Gain is 5.6 mm; Mean torque used 32 nm, Mean age of the patient was 53 years. The literature shows a success of graftless lateral and osteotome-mediated sinus lift. The concept is the blood filling the gap around the implant in tented sinus lining can eventually result in the ossification to form bone. Until now, no study has demonstrated the bone formation in the peri-implant area of CHSL with simultaneous implant insertion. CHSL, a minimally invasive sinus lift surgery is very encouraging, easy to master, and predictive. The simultaneous implant insertion acts to retain the elevated sinus lining by tenting. It also reduces treatment time. After a sinus lifting procedure, the compartment around the implants under the sinus mucosal lining in the sinus floor is filled with a blood clot from surrounding bleeding. Blood clot can be considered autologous osteogenic graft material, to which osteoprogenitors can migrate, differentiate, and regenerate bone.

Conclusion: The graftless CHSL is predictable and safe for the sinus lift. The gain of up to 5–6 mm of subantral bone is possible.

Keywords: Crestal Sinus Lift Kit, crestal hydraulic sinus lift, maxillary sinus, Schneiderian membrane, sinus lift

INTRODUCTION

The posterior maxilla is always a challenge for dental implant restoration. The anatomical presence of maxillary sinus and reduced subantral bone height and the quality of bone are the anatomical limitations for implant insertion. The need of the time is to make the surgical procedures simple, minimally invasive, and predictable.

In 1970, Tatum developed the lateral sinus lift procedure. It is the generally accepted method with advantages of wide exposure of sinus hence good accessibility, significant elevation of the sinus floor, and increase in sufficient subantral bone

volume. There are some disadvantages which include the relatively extensive surgical needed which has a steep learning curve and possibility of risk of perforation of Schneiderian membrane, longer recovery time, and added cost. The second most commonly used procedure is Summers' technique of osteotome-mediated crestal sinus lift (CAS). This is less invasive,

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the sinus lift through the osteotomy site of implants. The use of osteotome is inconvenient and unacceptable for patients. The access is limited and limited amount of gain in the subantral bone. Recently, the kit of drills safe for the sinus floor with the stoppers for the controlled entry into the sinus are available. Dr. Chen and Cha^[1] introduced a sinus lift technique and hydraulic sinus condensing. He was the first one to introduce the concept of hydraulic sinus lift. Sotirakis and Gonshor^[2] used the hydraulic sinus lift pressure to elevate the sinus membrane along with the osteotome through the crestal approach.

The placement of the graft in the sinus lift procedure was considered necessary. Recently, the literature shows success of graftless sinus lift. Lundgren *et al.* (2004, 2007), Chen *et al.* (2007), Ellegaard *et al.* (2007), and Sohn *et al.* (2010) published the long series of cases and studies with evidence for the subantral bone formation in graftless lateral sinus lift.

In their review article, Riben and Thor^[3] concluded that the innate osteogenic potential of the Schneiderian membrane may be a main reason for the successful formation of bone with graftless sinus lift. Leblebicioglu *et al.*, Neider *et al.*, He *et al.*, and Fermergard *et al.* published a long series of cases with osteotome-mediated indirect sinus lift without bone graft material. In the systemic review of this Pérez-Martínez *et al.*^[4] concluded that evidence available suggests that indirect sinus lift without the use of bone graft material could be a valid technique to treat with implants atrophic posterior maxillae with residual heights between 5 and 9 mm. The indirect sinus lift procedure in these studies was osteotome mediated. Few studies also used two-stage procedures, which increases the treatment duration.

The sinus lining elevation through the dental implant osteotomy by water jet and the use of safe drills for sinus perforation is a recent technique mentioned here as crestal hydraulic sinus lift (CHSL). The insertion of dental implant will result in tented sinus lining. The blood filling the gap around the implant in this tented sinus lining can eventually result in the ossification to form bone. There is scarcity of studies on this type of graftless CHSL with simultaneous implant insertion.

MATERIALS AND METHODS

The prospective study was carried out with aim to evaluate the clinical and radiological success of graftless CHSL with simultaneous implant insertion.

The study participants were patients with partially edentulous posterior maxilla and subantral bone between 4 and 8 mm indicated for the implant-supported prosthesis. Intervention was the sinus lift through the implant osteotomy by water

jet pressure and simultaneous implant insertion.

The outcome was the survival of implant and evidence of bone formation in the peri-implant area and the success of implant. The sample size included 17 patients who were included in the study, and 26 number of implants were inserted.

Inclusion criteria

1. Physically healthy individuals with no systemic or local diseases which can contraindicate the implant or sinus surgery
2. Subantral bone between 4 and 8 mm
3. Patients with controlled diabetes mellitus
4. No sinus pathology.

Exclusion criteria

1. Uncontrolled diabetes mellitus
2. Smoking
3. history of repeated sinusitis
4. Patients unfit for minor surgery.

The study design was prospective interventional study.

The approval from the institutional ethics committee was obtained, IEC letter no GDCH/5374/2015 dated 11/9/2015 and then, the participants were enrolled for the study. The details of the procedure of sinus lift, implant insertion, and time of prosthesis were explained to all the participants. The written informed consent was taken from all the participants. The study was conducted in our department from September 2016 to December 2017.

For all the participants, thorough history was taken. The routine blood investigations were done.

The imaging was carried out by the pre- and post-Intraoral Periapical (IOPA), orthopantomogram (OPG), and cone-beam computed tomography (CBCT) for all cases. After informed written consent, the surgical procedure was performed.

Surgical procedure

Under aseptic precautions, the mucoperiosteal incision was taken to expose the alveolar ridge. The pilot drill used to locate the implant osteotomy site. Followed by the use of step-wise sequential drills with the serial stoppers till the sinus floor is perforated. The sinus lift instrument used here was crestal approach sinus (CAS) kit.

Figure 1 shows the schematic diagram of the drills of CAS kit used for this study. The drill tip was with an inverse conical shape. This shape formed a conical bone chip when drilling, which assisted with safely lifting the membrane. In

addition, bone particles generated when drilling discharged upward, producing a membrane auto-lift function. The unique stoppers were color coded for particular length. The atraumatic design of the drill tip allowed to perform the sinus surgery even if the sinus floor was flat, incline, or presence of septum. The Figure 1 also shows the concept of the use of waterjet for hydraulic lift system that easily and safely lifts the membrane. Figure 2 shows drill with the stopper used for the sequential drilling used for osteotomy preparation. The depth gauge with atraumatic tip was used for the separation of sinus membrane. Figure 3 shows the use of depth gauge with length-specific stopper. The hydraulic lifter in the CAS kit was fixed with the 5 cc syringe containing normal saline. After the planned osteotomy, the adapter was attached to the alveolar crest side of implant osteotomy. Figure 4 shows the adapter with tube attached to the syringe with normal saline. The required volume of saline to expand 3 mm of the membrane was 0.2 to 0.3 cc of saline injected slowly. This saline introduced by slow pressure on piston of syringe produced pressure on the membrane resulted in its lifting. The depth gauge with stopper can be used to confirm the sinus lining separation and the lift of sinus membrane. Here, the tactile sensation of the operator was important to feel the soft sinus lining. As the lift by hydraulic pressure occurred, the increased depth was appreciated with depth gauge and higher length stopper. Here, extreme caution in using depth gauge was needed. The perforation of sinus membrane could be a possible unfortunate complication at this stage. The perforation could be appreciated by tactile sensation with depth gauge by the lack of soft touch of membrane.

After completion of osteotomy and hydraulic sinus lift, the implant was inserted, the cover screw was fixed and sutured. The second stage for prosthesis was done after 6 months. The CBCT analysis for bone formation in the peri-implant region was carried out. The implant survival was observed 1-year post sinus lift. Thus, the follow-up duration was 1 year for all cases. The Osstem's TS III fixtures are used for all cases of this study.

The parameters recorded were as follows:

1. Residual bone height at implant placement (subnasal bone height as measured on [CBCT]: presurgical bone height [pre-SBH]) H1
2. Bone height after the surgery measured on CBCT 6-month postoperative-post-surgical bone height (post-SBH) H2
3. Height gain (HG)
4. Mean primary implant stability at 32 nm torque
5. Length of the implants used 8.5 mm–3 nos., 10 mm–7 nos., 11.5 mm–10 nos., and 13 mm–6 nos.

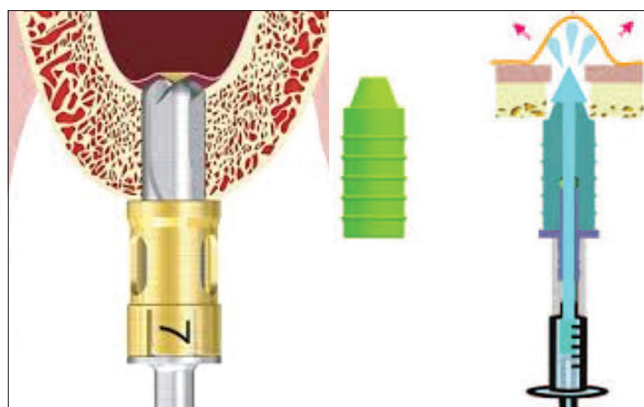


Figure 1: This is a schematic diagram as given by the Hiossen for Crestal Sinus Lift Kit. The left side picture is the safe drill perforating the sinus. The right side shows the waterjet as hydraulic pressure which can lift the sinus membrane



Figure 2: Osteotomy preparation using the drill with stopper attached



Figure 3: The use of the depth gauge with safe end for assessing the osteotomy depth, confirming perforation of the sinus floor

6. Incidence of perforation – nil
7. Implant survival – 100%.

For the survival of implant, the survival criteria proposed by Buser *et al.*^[5] and Cochran *et al.* (2002) were used, including (i) absence of clinically detectable implant mobility, (ii) absence

of pain or any subjective sensation, (iii) absence of recurrent peri-implant infection, and (iv) absence of continuous radiolucency around the implant.

RESULTS

A number of participants were 17; ten male and seven female. Twenty-six number of implants and CHSL were performed. Table 1 shows the presurgical bone height (H1), postsurgical bone height (H2), bone HG, and torque at the time of implant insertion. Mean H1 = 6.5 mm; Mean H2 = 11.7 mm; Mean HG = 5.6 mm; and Mean torque used = 32 nm The mean age of the patients was 53 years.

Figure 5 shows the OPG of one case, missing teeth are 25, 26, and 27. The fixed implant supported bridge was done with implants in 25 and 27. The preoperative, 6 months, and 1-year postoperative OPG shows the ossification in the peri-implant region of both 25 and 27 region. Figure 6 is the cross-section of the same case showing old and new sinus levels. The bone formation in the peri-implant region above old sinus level can be seen. Similarly, in one more case, 1-year postoperative CBCT cross-sections shows bone formation in



Figure 4: The hydraulic system is seen in action attached to the osteotomy, the tubing, and the syringe

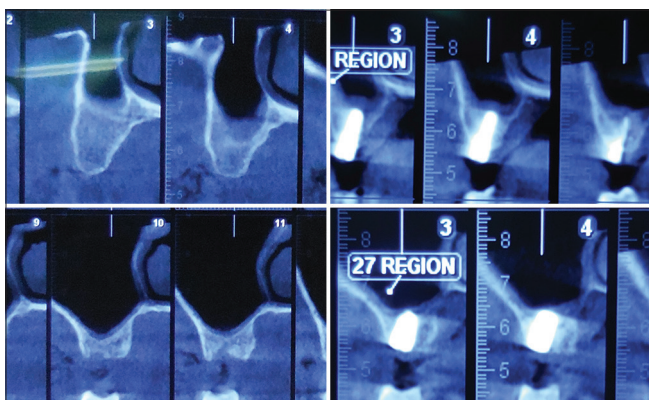


Figure 6: Cone-beam computed tomography cross-section of case number 2 preoperative and postoperative 6 months

the peri-implant region above old sinus level. Figure 7 shows the 1-year postoperative CBCT cross-section of another case. This image is with arrow showing old and new sinus floor levels. This indicates a bone formation between these layers.

DISCUSSION

It is necessary to keep the implant surgeries simple yet predictable. The dental implant treatment is basically for prosthesis. Undergoing an extensive unpredictable surgery may discourage the patients from opting for implant-supported prosthesis. This is author's personal experience. This study is a case series of successful graftless CHSL and simultaneous implant insertion. The use of safe drills for sinus lining along with stoppers and waterjet sinus lining elevation makes CHSL, a minimally invasive sinus lift surgery. It is very encouraging, easy to master, and predictive. The simultaneous implant insertion acts to retain the elevated sinus lining by tenting. It also reduces treatment time.

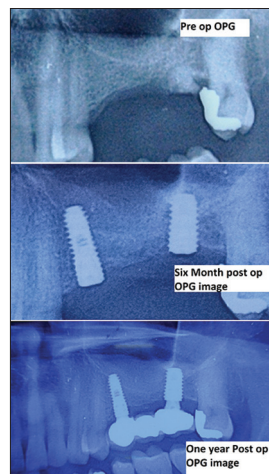


Figure 5: Collage of orthopantomogram of case number 2. Preoperative, 6 months, and 1 year postoperative. The peri-implant bone formation and old sinus level are evident

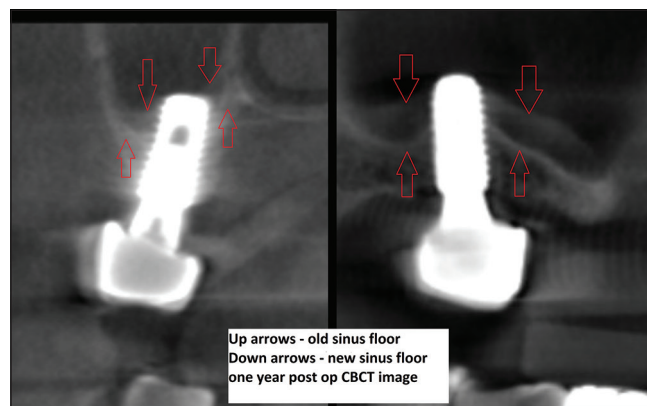


Figure 7: One-year postoperative cone-beam computed tomography cross-section of case number 9

Table 1: The observations of the outcome variables

Tooth	H1	H2	HG	Stability torque	Length of implant used
16	6	9	3	30	8.5
27	5	9	4	35	8.5
25	6	12	6	30	11.5
27	7	10	3	35	10
16	7	13	6	32	13
26	7	13	6	35	13
26	7	13	6	30	13
26	5	10	5	32	10
26	7	13	6	34	13
26	5	12	7	35	11.5
27	5	10	5	32	10
17	4	10	6	30	10
25	6	12	6	35	11.5
27	5	12	7	35	11.5
15	8	13	5	30	13
17	5	12	6	35	11.5
25	6	13	7	30	13
27	5	12	7	34	11.5
15	5	12	7	32	11.5
16	6	13	7	35	13
25	7	12	5	35	11.5
26	5	12	7	30	11.5
15	8	13	5	35	13
16	6	12	6	35	11.5
27	8	12	4	30	11.5
26	8	12	4	32	11.5

H1: Presurgical bone height; H2: Postsurgical bone height. HG: Bone height gain

After a sinus lifting procedure, the compartment around the implants under the sinus mucosal lining in the sinus floor is filled with a blood clot from surrounding bleeding. Based on this case series, blood clot can be considered autologous osteogenic graft material, to which osteoprogenitors can migrate, differentiate, and regenerate bone.

Boyne^[6] published the first experimental study regarding simple elevation of the membrane without bone grafting. The new bone formation around implants in the maxillary sinus without the use of graft is reported by Lundgren *et al.*^[7] It has been suggested that a prerequisite for the peri-implant bone formation is that the implant apex serves as a tent pole for the sinus membrane. Elevation of the Schneiderian membrane creates a compartment, in which a fibrin clot is stabilized and is protected from the external trauma, other than intrasinus air pressure. The clot has the potential to stimulate the bone formation (Lundgren *et al.* 2004, Hatano *et al.*^[8] 2007). Graft shrinkage/resorption appears to be a common problem following bone augmentation procedure in the maxillary sinus (Hatano *et al.* 2004). The first histological evidence to verify a new bone formation was demonstrated in 2006 by Palma *et al.*^[9] on four tufted capuchin primates that experienced the maxillary sinus membrane

elevation surgery using a replaceable bone window technique. Sohn *et al.*^[10] obtained the graftless sinus elevation, they placed 21 implants with an average residual bone height of 5 mm. In 2007, a study was published by Chen *et al.*^[11] where maxillary sinus augmentation without bone graft using only blood was performed on 33 patients.

Ellegaard *et al.*^[12] presented a study in 1997, where 24 periodontally compromised patients were treated with implant therapy of which 38 included the sinus lift procedure. Fenestration was prepared in the lateral sinus wall after that the sinus membrane was lifted and the implants were inserted creating a compartment filled with blood between themselves and the sinus membrane. The blood clot formed under the lifted Maxillary sinus lining appears to be of critical importance in bone neoformation potential, precluding the need for exogenous graft materials.^[13]

From the data mentioned that extracted from the current literature, we see clear radiological evidences to bone formation in the sinus after using lateral window technique for the lift while using blood clot alone for the bone formation. The osteotome-mediated CAS has been done without graft. Nedir *et al.*^[14] published predictable and favorable long-term results of stability of the peri-implant bone formation following implant placement without grafting by osteotome-mediated sinus lift into resorbed posterior maxilla.

In this study of CHSL, author used the new technique of sinus lift, and this technique is quite advantageous, as it is having narrow learning curve, minimal invasiveness, and greater precision. The graftless sinus lift has made this procedure simpler and affordable. The lateral sinus lift needs graft and membrane both. The results of this case series are very promising. All implants are successful with 100% survival rate. The mean subantral bone HG is 5.6 mm. All cases had intact sinus membrane, which resulted in its tenting around implant. The blood collected in the peri-implant area, the fibrin clot is protected here, which ultimately gets ossified. The blood clot formed under the lifted MSSM appears to be of critical importance in bone neoformation potential, precluding the need for exogenous graft materials. This is a case series of graftless CHSL. The postoperative cross-section of the implants shows that the bone is formed around the implant apex but not above it. The direct contact of the sinus lining may be the reason for this. The other limitations of this study are small sample size and improper study design.

CONCLUSION

This pilot study concludes that graftless CHSL is predictable and safe for the sinus lift. The gain of up to 5–6 mm of

subantral bone is possible with this simple technique. The prospective clinical trial of longer follow-up duration and bigger sample size is needed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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