AL-AZHAR
Assiut Dental Journal

The Official Publication of The Faculty of Dental Medicine, Al-Azhar Assiut University, Egypt

AADJ, Vol. 6, No. 2, October (2023) — PP. 259:267

ISSN 2682-2822

Versatility of the Osseodensified Crestal Sinus Lifting Technique as Alternative Procedure for the Lateral Sinus Technique with Simultaneous Implant Placement

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Codex : 10/2023/10

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KEYWORDS

Crestal Sinus Lift, Lateral Sinus Lift, Osseodensification, Densah bur, Implant Placement.

ABSTRACT

Aim: Aim of this study was to evaluate osseodensified crestal sinus lifting technique versus the lateral sinus osseodensified technique with Simultaneous Implant Placement. **Subjects and methods:** Twenty patients were randomly divided into two groups. Group (I) Ten patients were operated upon after performing computer guided crestal sinus lift using Osseodensification with simultaneous implant placement. Group (II) Ten patients were operated upon after performing computer guided lateral sinus lifting technique with simultaneous implant placement. Vertical bone height (mm) and bone density were taken at time of implant placement and 6 months postoperatively. **Results:** both groups showed a non significant difference in b vertical bone height. Crestal group (I) had showed a significant higher bone density than lateral group (II) (p=<0.001). Crestal group (I) had a significant shorter surgical time than lateral group (II). **Conclusion:** Crestal sinus lifting technique may be proposed as a possible alternative procedure for the lateral sinus osseodensified technique with Simultaneous Implant Placement.

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INTRODUCTION

Posterior maxilla posed several challenges for the placement of dental implants. Bone and tissue loss from periodontal disease, post-extraction bone atrophy in height and width, pneumatization of maxillary sinuses, poor bone density, and very high occlusal forces were some factors leading to this difficulty Several techniques have been proposed to overcome these problems including use of short implants and vertical augmentation using sinus floor elevation. Bone grafting in maxillary sinus was solution to obtain adequate bone volume for implant placement [(1)].

Debate existed on whether addition of a bone substitute would enhance bone formation after indirect sinus augmentation. Previous

studies have shown that grafting materials, including autogenous bone, allogeneic bone, and xenogeneic bone, should be used to maintain space below elevated sinus membrane. These studies had been reported high survival rates when osteotome technique was used with simultaneous grafting.[2,3] Recently, studies have shown high success rates with indirect sinus lift even without addition of bone graft.[4,5] It was thought that innate osteogenic potential of sinus membrane may be responsible for endo-sinus bone formation.[6] For indirect sinus lifting Trinh et al.,[7] found that addition of a bone substitute with indirect sinus augmentation resulted in better bone formation than no bone substitute.

Present study proved that computer guided transcrestal sinus lift and simultaneous implant placement using Osseodensification or lateral sinus lifting techniques were reliable procedures and could be used for implant placement in posterior maxilla to restore function.

The main objective of this study was to evaluate The osseodensified crestal sinus lifting technique may be proposed as a possible alternative procedure for the lateral sinus osseodensified technique with Simultaneous Implant Placement

PATIENTS AND METHOD

Twenty patients, with single or multiple missing teeth at sinus zone of posterior maxilla were selected for this study. They had limited bone height at least 4 mm below floor of maxillary sinus, secondary to maxillary sinus pneumatization and alveolar bone ridge must be wide enough not less than 4 mm to accommodate simultaneous implant placement. They were selected from patients attending to department of Oral and Maxillofacial Surgery, Faculty of Dental Medicine, Al-Azhar University, Assuit, Egypt.

All patients had signed informed consent form after being fully informed about study protocol, treatment plan, and alternative treatment approaches.

Eligibility criteria

Inclusion criteria for participants:

All patients were selected without any active periodontal diseases and no systemic, immunologic, or debilitating diseases that would affect normal bone healing. Patients were also free from T.M.J diseases, abnormal oral habits such as bruxism. Edentulous ridges were covered with optimal thickness of mucoperiosteum with no signs of inflammation, ulceration, or scar tissue. Remaining natural teeth were vital with good periodontal tissue support, and occlusion showing sufficient inter-arch space for future prosthesis. On local level, patients with maxillary sinus diseases, former sinus surgery and unfavorable inter maxillary relationship were excluded.

Exclusion criteria for participants:

Patients with residual bone height less than 4mm, Patients with systemic disease as diabetes, hemocoagulation disorders, immunological deficiency or any disease that might affect bone quality, Patients that had received previous radiation therapy of head and neck area, Patients that were undergoing treatment with bisphosphonates, Patients with poor oral hygiene and active periodontal diseases. Sinus disease (chronic sinusitis, retention cyst, mucocele, tumor, polyp), and History of previous sinus surgery.

Sample size

Sample size was determined using a power calculation. Change in height of alveolar ridge was considered as primary variable outcome, and edentulous site was used as statistical unit. Sample size was determined to provide 80% power to recognize a significant difference of 4 mm between two groups and standard deviation of 1.6 mm at significance level of alpha = 0.05.

Patients grouping and intervention

Patients were classified randomly into two equal groups:

1. Crestal Group (GI): 10 patients with partial or complete edentulous maxillary ridges that were treated by computer guided crestal sinus lift using osseodensification technique with simultaneous implant placement with allogenic bone graft (FDBA) into their ridges.

2. Lateral Group (GII): 10 patients with partial or complete edentulous maxillary ridges were treated by computer guided lateral sinus lift technique using allogenic bone graft (FDBA) with simultaneous implant placement.

Surgical procedure

All patients were receiving prophylactic antibiotic coverage (Amoxicillin 1gm) 2 hours, prior to sinus floor augmentation procedure. They were instructed to rinse their mouth with 0.2% chlorhexidine gluconate for 2 minutes, prior to surgery. The surgical site was wiped with Povidone Iodine (Betadine) solution. All surgical procedures in both two groups were performed using general anesthesia through nasoendo-tracheal intubation., with a strict aseptic condition. An alveolar mid-crestal horizontal incision was performed in edentulous site using no.15 surgical blade to expose surgical site and connected with sulcular incision of adjacent teeth. Muco-periosteal flap was elevated exposing alveolar bone. No vertical releasing incision was employed, and flap was reflected not exceeding alveolar ridge. Surgical guide template was used to guide handpiece mounted by pilot drill to start osteotomy preparation, which should be ended 1mm short of sinus floor.

Osteotomy technique and sinus floor elevation

1. Crestal Group (GI), 10 patients with partial or complete edentulous maxillary ridges were treated by computer guided crestal sinus lift using osseodensification technique with simultaneous implant placement with allogenic bone graft (MinerOss) (FDBA) into their ridges fig (1).

- After exposing alveolar crest then surgical guide was seated, an osteotomy was prepared at desired implant placement area using a pilot drill (1.7 mm) that was rotated at 800 RPM in a clockwise rotation (CW) to desired depth. Pilot drill position was confirmed by radiograph.

- The motor drill was adjusted to reverse- densifying Mode (counterclockwise drill speed 8001200 rpm with copious irrigation).

- The drilling was started with densah bur VT1525 (2.0mm) running in a non-cutting counterclockwise (CCW) direction at 1200 RPM (Densifying Mode) with a bouncing motion to expand osteotomy until 1 mm short of sinus floor.

- Next wider Densah Burs (2.3,3.0 and 3.3) were advanced sequentially in densifying-mode (counterclockwise drill speed 800-1200 with copious irrigation) and propagated into previously created osteotomy with modulating pressure and a pumping motion to expand osteotomy then increase bur size by manufacturer's protocols until desired implant diameter to be equal or slightly wider (up to 0.7mm wider) than initial ridge width without any bone dehiscence.

- When feeling haptic feedback of bur reaching the dense sinus floor, pressure was modulated with a gentle pumping motion to advance past sinus in 1 mm increment.

Maximum possible advancement passing sinus floor at any stage must not exceed 3 mm. As next wider Densah bur was advanced in osteotomy, additional autogenous bone was pushed toward apical end to achieve additional vertical depth and a maximum membrane lift of 3.0 mm.

In cases where vertical sinus augmentation requiring greater than 3 mm and residual alveolar ridge height was less than 5 mm, steps mentioned above were repeated with exception of initial pilot drill. After achieving desired osteotomy width as described earlier, established osteotomy was filled with particulate bone graft substitute MinerOss (FDBA). then, final densifying bur that was previously used was used in counterclockwise rotation at 100 to

200 rpm without irrigation to propel allograft apically in one gentle apical motion toward sinus facilitating additional vertical and lateral membrane elevation. This was repeated until desired vertical augmentation was achieved, also with radiographic verification, and implant was placed. At all times, osteotomy over preparation was avoided which meaned osteotomy major diameter was smaller than implant diameter by no greater than 0.5 to 0.7 mm.

Implant (Biohorizon) was placed into osteotomy and primary stability was recorded by Osstell. If using motor drill to tap implant into place, motor drill might stop when reaching placement of implant to maximum depth with maximum torque that was apparent on ratchet wrench, and flap was sutured as a primary closure using vicryl 3/0.

2. Lateral Group (GII), 10 patients with partial or complete edentulous maxillary ridges were treated by computer guided lateral sinus lift technique using allogenic bone graft with simultaneous implant placement fig (2). Lateral wall of sinus was exposed by performing a crestal incision and a mucoperiosteal flap. A bony window was created by applying a Dask bur (Dentium sinus lift kit). When bony window became visible, we had started to separate sinus membrane from inferior edge of osteotomy region and pushed membrane upward. Sinus membrane was carefully separated from inner and inferior walls. At same time, external wall was pushed inward and upward to form a new horizontal roof for space created. Care was exercised not to perforate membrane; however, in cases of perforation less than 5 mm a resorbable collagen membrane was applied to cover perforation. Graft material MinerOss (FDBA) was mixed with normal saline solution and packed gently into sinus in order to completely fill the cavity with bone substitute material and achieved desired bone height.

Implant (Biohorizon) was placed into osteotomy and primary stability was recorded by Osstell. If using motor drill to tap implant into place, motor drill might stop when reaching placement of implant to maximum depth with maximum torque that was apparent on ratchet wrench. Next, a resorbable collagen membrane (Bioteck) was placed on outer surface of window and flap was sutured as a primary closure using vicryl 3/0.

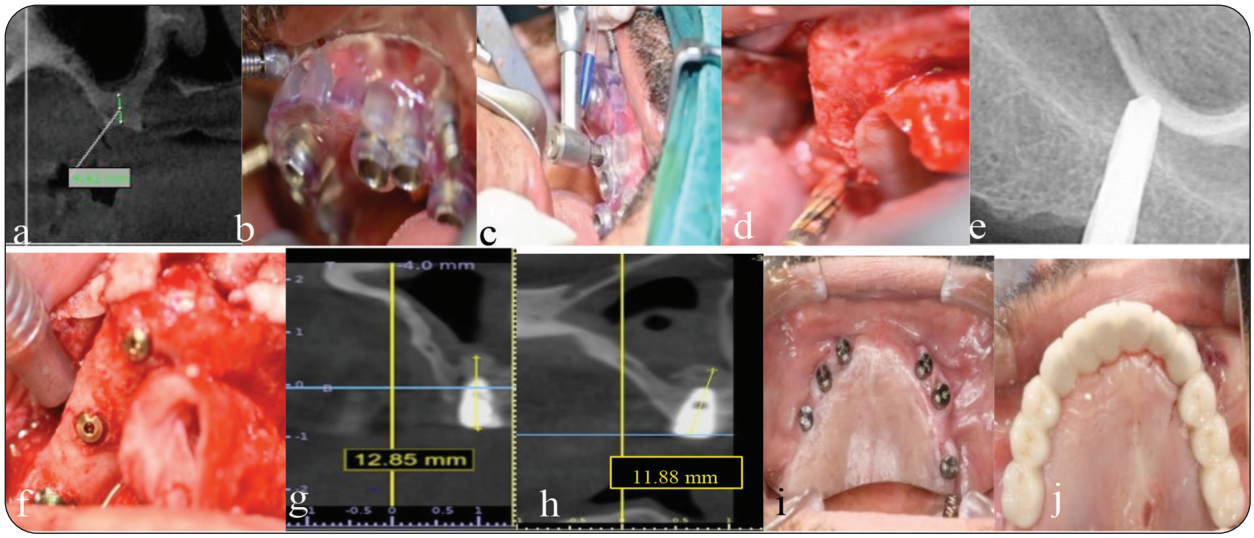

Fig. (1) Crestal group (GI): a, CBCT, initial lengths of alveolar ridge., b, Surgical guide fixation., c, pilot drill through surgical guide at implant site, d, osseodensification drill at implant site propel bone graft to sinus floor.,e, periapical x ray film showing Densah bur. f, implant in desired site, g, bone lengths of alveolar ridge immediately postoperative, and h, bone lengths of alveolar ridge 6 months postoperatively, i, Clinical photograph showing healing abutment, j, porcelain fused to metal bridge.

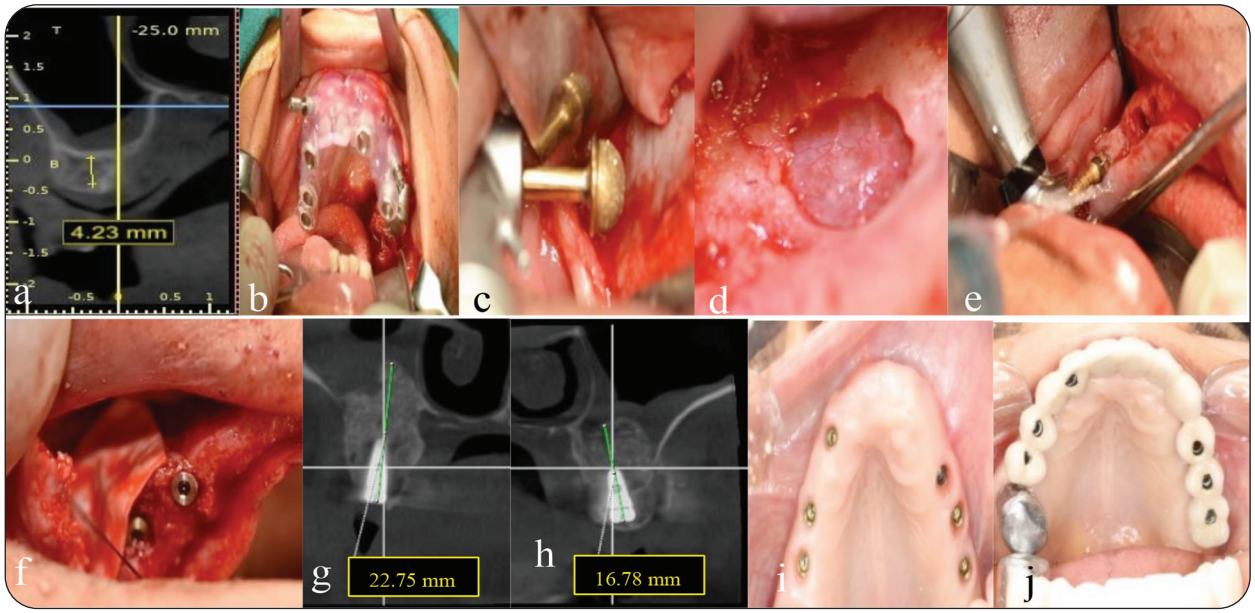

Fig. (2) Lateral group (GII): a, CBCT, initial lengths of alveolar ridge, b, Surgical guide fixation, c, Dask bur used for lateral window, d, lateral wall opening with intact sinus membrane, e, osseodensification drill at implant site,f, lateral wall covered with collagen membrane and implants in site. g, bone length of alveolar ridge immediately postoperatively. h, bone lengths of alveolar ridge after 6 months postoperatively, i, Clinical photograph after healing abutment removal, j, patient's screw retained porcelain fused to metal bridge.

Assessment

Duration of procedure (time).

CBCT was used to evaluate bone density, height of bone from alveolar crest to sinus floor and width of alveolar ridge from buccal to palatal bone.

- Residual bone height in CBCT (mm) preoperatively.
- Vertical bone gain at CBCT (mm) immediate and 6 months postoperatively.
- Bone density (HU) immediate and 6 months postoperatively.

Follow up and data collection

Radiographic parameters

CBCT radiographic examinations were performed immediately after surgery and 6 months postoperatively. This had included measurements of alveolar ridge length and recording bone density value around implants immediate and 6 months postoperatively.

1. Measuring of vertical bone height:

The reference-plane for vertical bone gain measurement was determined by the bone-level crestal plane of inserted implants in cross sectional view of CBCT of each implant that was measured in millimeters on day of implant placement (immediate) and 6 months postoperatively.

Measuring of bone density:

The change in bone density around implant was mesured in Hounsfield units using BlueSky Bio. (software) (HU). On buccal, lingual, mesial, and distal sides of implant, measurement sites were positioned at top, middle, and apical parts. The average density was calculated using mean values of bone density along each side implant. This procedure was carried out at each postoperative follow-up interval (immediate and 6 months).

Prosthetic phase

Following a second surgical exposure six months after implant placement, gingival formers were placed for 2 weeks to establish proper gingival

shape at implants' collar region. Impression was taken using open tray impression technique with implant impression couping and implant analogues. Porcelain fused to metal screw retained crowns were delivered to all patients for both groups and abutments were screwed to implants with a torque of 35 N/cm, and implants were functionally loaded. Patients were instructed about maintenance of oral hygiene by means of dental floss, interdental brush, and mouth wash.

Statistical analysis:

Numerical data were presented as mean and standard deviation values. They were explored for normality by checking data distribution using Shapiro-Wilk test. Data had showed parametric distribution and were analyzed using paired t-test. The significance level was set at $p \leq 0.05$ within all tests. Statistical analysis was performed with R statistical analysis software version 4.1.3 for Windows.

RESULTS

Computer guided crestal sinus lift with simultaneous implant placement had significantly a shorter duration (21.60±4.22) than sinus lift which was treated with lateral approach (48.00±10.37) table (1).

Computer guided crestal sinus lift using Osseodensification technique (densah bur) with simultaneous implant placement had showed a high significant increase of vertical bone height (mm) immediate postoperatively (13.68±1.34) from pre-operative readings (4.31±0.39) and after 6 months bone height was a non-significant.

Computer guided crestal approach using Osseodensification technique (densah bur) sinus lift with simultaneous implant placement had showed a highly significant difference in bone density between immediate postoperative (497.22±91.13) and after 6 months (623.78±120.69) with high percentage of increase (25.94±16.18%) ($p<0.001$). While sinus lift treated with lateral approach using Osseodensification technique (densah bur) with simultaneous implant placement had showed a non-significant decrease in bone density between immediate postoperative (499.25±134.48) and after 6 months (469.42±31.31). At 6 months crestal sinus lift had showed a highly significant higher bone density than Lateral Sinus lift (p=<0.001*) table (1).

Table (1) *Intergroup and intragroup comparisons of different parameter*

	Crestal group	**Lateral group**	**p-value**
Duration (min)	21.60±4.22	48.00±10.37	0.002*
Vertical bone height (mm)			
Pre-operatively	4.31±0.39^{C}	3.96±0.16^{C}	0.026*
Immediately post-operative	13.68±1.34^{A}	18.96±3.32^{A}	<0.001*
6 months	12.37±1.28^{B}	13.74±2.04^{B}	0.057ns
p-value	<0.001*	<0.001*	
Bone density (HFU)			
Immediate postoperative	497.22±91.13	499.25±134.48	0.971ns
6 months	623.78±120.69	469.42±31.31	<0.001*
p-value	<0.001*	0.529ns	

Means with different superscript letters within the same **vertical column** *were significantly different *; significant ($p \leq 0.05$) ns; non-significant ($p>0.05$)*

DISCUSSION

The main objective of this study was to evaluate computer guided crestal sinus lift using Osseodensification (Densah bur) versus lateral window technique with simultaneous implant placement. A comparison was made of these two techniques regarding vertical bone height and bone density. Considering results of this study, both sinus floor elevation procedures had showed 100% implant survival rate for 6 months after implant placement.

Crestal sinus approach was indicated when there was at least 5 mm remaining crestal bone height, and primary implant stability could usually be achieved. [8-10] Crestal approach was generally considered to be a far less invasive procedure with less complications, less postoperative pain, and less swelling for patients. Schneiderian membrane could withstand 4 to 8 mm of elevation without rupture. [11]

In present study, ridge height in crestal sinus lift (GI) were average of (4.31±0.39 mm), and in lateral sinus lift (GII) were (3.96±0.16 mm). Implant length of 10.5 mm was selected to minimize the risk of sinus membrane perforation and to provide space for endo-sinus bone formation. Various graft materials had been used for sinus augmentation. In this study, freeze-dried bone allograft (FDBA) MinerOss (Biohorizon Company) was applied. Although full extent of this bone inducing capacity was questionable, working mechanism of freeze-dried bone allograft was mainly based on an osteoconductive principle which was responsible for increase of mineralized tissue by remineralization of (FDBA) and life formation via osteoconduction.[12]

In present study, Computer guided crestal sinus lift with simultaneous implant placement had showed a high significant increase of vertical bone height (mm) immediate postoperatively (13.68±1.34) from pre-operative readings (4.31±0.39) and after 6 months bone height was (12.37±1.28). While sinus lift treated with lateral approach using Osseodensification technique (densah bur) with simultaneous implant placement had showed a highly significant increase in Vertical bone height (mm) immediate postoperatively (18.96±3.32) from pre-operative readings (3.96±0.16) and after 6 months bone height was (13.74±2.04). Lateral group (13.74±2.04) had showed a higher value than crestal group (12.37±1.28) yet difference was not statistically significant (p=0.057). we had observed that there was marked decrease in bone height after 6 months in lateral group more than crestal one. Sinus lift that had been treated with lateral approach using Osseodensification technique with simultaneous implant placement had a significantly more decrease in Vertical bone height (mm) than crestal group, because endo-sinus contamination due to intraoral pathogens as a complication of lateral approach had led to extensive resorption of grafting materials. [13]

In present study, Computer guided crestal sinus lift with simultaneous implant placement had showed a highly significant difference in bone density between immediate postoperative (497.22±91.13) and after 6 months (623.78±120.69) with high percentage of increased bone density (25.94±16.18%) (p<0.001). While sinus lift that had treated with lateral approach using Osseodensification technique (densah bur) with simultaneous implant placement showed a nonsignificant decrease in bone density between immediate postoperative (499.25±134.48) and after 6 months (469.42±31.31) with low percentage of decrease (-10.75±14.05%) (p=0.529). The crestal sinus lift had showed a highly significant higher bone density than lateral Sinus lift (p=<0.001*). A similar result had been obtained before by Fouad W et al. [14] Densah burs had allowed for bone preservation and condensation through compaction autografting during osteotomy preparation, thereby increasing bone density in periimplant areas and improving implant mechanical stability. Bone remodeling unit had required more than 12 weeks to repair damaged area that had created by conventional drills that extract substantial amount of bone to let strains in walls of osteotomy reach or go beyond bone microdamage threshold. Hence, bone density would help to preserve bone bulk and increased density, thereby shortening healing period. [13]

In present study, computer guided crestal sinus lift with simultaneous implant placement had a significantly a shorter duration (21.60±4.22) than sinus lift which was treated with lateral approach (48.00±10.37) using Osseodensification technique (densah bur) with simultaneous implant placement.

The timer had been set to record time of surgery, from flap reflection and wound closure were included in time frame. Computer guided crestal sinus lift with simultaneous implant placement had a significantly a shorter duration and demonstrated a simplifed, less traumatic, minimally invasive membrane elevation method with less morbidity and operation time. These results were in agreement with Alhayati et al., [15] who had been evaluated efficacy of Versah drills in breaching maxillary sinus floor with recorded time that was about (11.2±1.85) min.

CONCLUSION

Crestal sinus lifting technique may be proposed as a possible alternative procedure for the lateral sinus osseodensified technique with Simultaneous Implant Placement.

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AADJ, Vol. 6, No. 2, October (2023) — PP. 267

امكانية استخدام تقنية رفع الجيب الانفى بالتكثيف العظمى لحافة العظم كبديل لتقنية رفع الجيب الانفى الجانبية مع وضع غرسة الاسنان الفورية

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الملخص :

الهدف: كان الهدف من هذه الدراسة هو تقييم تقنية رفع الجيب الانفى المكثف مقابل تقنية تكثيف عظم الجيب الانفى مع وضع الزرع الفورى.

المواد والأساليب: تم تقسيم عشرين مريضا عشوائيا إلى مجموعتين. المجموعة (الأولى) تم إجراء عملية جراحية لعشرة مرضى بعد إجراء عملية رفع الجيب الانفى الموجهة بالكمبيوتر باستخدام تكثيف العظام مع وضع الزرع المتزامن. المجموعة (II) تم إجراء العمليات الجراحية لعشرة مرضى بعد إجراء تقنية رفع الجيوب الأنفية الجانبية الموجهة بالكمبيوتر مع وضع الزرع المتزامن. تم أخذ ارتفاع العظم العمودي (م) وكثافة العظام في وقت وضع الزرع وبعد 6 أشهر من العمل الجراحي.

النتائج: أظهرت كلا المجموعتين اختلافا غير ملحوظ في ارتفاع العظم العمودي ب. أظهرت المجموعة الكريستالية (I) كثافة عظام أعلى بكثير من المجموعة الجانبية (P=<0.001) (II). كان لدى المجموعة الكريستالية (I) وقت جراحي أقصر بكثير من المجموعة الجانبية (II).

الخلاصة: يمكن اقتراح تقنية رفع الجيب الكريستالي كإجراء بديل محتمل لتقنية تكثيف عظم الجيب الجانبي مع وضع الزرع في وقت واحد.

الكلمات المفتاحية: الجيب الانفى ، رفع الجيب الانفى المكثف ، رفع الجيب الانفى الجانبى، الزرع الفورى ، مثقاب دنسى .