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ORIGINAL ARTICALE

# EVALUATION OF BONE HEIGHT GAIN FOLLOWING TRANS-CRESTAL SINUS FLOOR ELEVATION USING DENSAH BUR VERSUS THE CONVENTIONAL OSTEOTOME TECHNIQUE IN PATIENTS WITH ATROPHIC POSTERIOR MAXILLAE: A RANDOMIZED CONTROLLED CLINICAL TRIAL

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## ABSTRACT

**Background:** Transcrestal sinus floor elevation (TSFE) is a reliable procedure for increasing bone height in the posterior maxilla. However, limited evidence exists comparing outcomes of TSFE using osseodensification (OD) versus the conventional osteotome technique. This study aimed to compare bone height gain, implant stability, sinus membrane elevation, membrane perforation, and patient-reported outcomes between both methods.

**Subjects and methods:** Twenty-four patients with with one or more missing teeth in the maxillary posterior region and residual bone height of 5–8 mm were randomly assigned to two groups: TSFE with Densah burs (test group) and TSFE with osteotomes (control group). Clinical, radiographic, and patient-reported outcomes were assessed over a 6-month follow-up.

**Results:** After 6 months, no significant differences were found between the two groups in sinus membrane elevation ($P = 0.5267$) or implant stability ($P = 0.5573$). Although bone height increased in both groups, the difference between them was not statistically significant ($P = 0.1713$). The Densah group showed a 50% lower risk of sinus membrane perforation compared to the Osteotome group, but this was not statistically significant ($P = 0.5483$). Patient-reported outcomes were similar between groups at both 1 and 2 weeks ($P > 0.05$), while intragroup analysis showed a significant improvement in oral health impact profile in both groups ($P < 0.0001$).

**Conclusion:** The osseodensification technique provides a viable alternative to the osteotome method for crestal sinus floor elevation, with comparable clinical and radiographic outcomes and the potential to reduce surgical trauma and postoperative discomfort. Trial registration number is NCT05411510.

***Keywords****:* sinus lift; osseodensification; densah bur; osteotomes; crestal appr

## INTRODUCTION

Dental implants have become a widely accepted and reliable solution for replacing missing teeth. However, the long-term success of these implants largely depends on both the quality and volume of the surrounding bone. Among the more challenging situations for oral and maxillofacial surgeons is implant placement in the posterior atrophic maxilla, where bone availability is often compromised. This is frequently due to a combination of alveolar bone resorption and maxillary sinus pneumatization following tooth loss [1].

Various techniques have been developed to address the challenges of reduced vertical bone height in the posterior maxilla, including guided bone regeneration (GBR), autogenous inlay and onlay bone blocks with or without xenograft particles, ridge splitting, and distraction osteogenesis. These procedures often involve the use of bone grafts, membranes, titanium meshes, and fixation screws, which contribute to increased treatment costs, even when using autologous bone or blood derivatives. Additionally, they typically require a healing period of 6 to 9 months before a second surgery can be performed for implant placement [2].

More conservative approaches have been developed, such as using osteotomes to expand the

resorbed ridge and compress the bone, thereby increasing its density, a method referred to as crestal sinus floor elevation. However, this technique necessitates the application of considerable force, particularly in areas with dense cortical bone [3]. Since the magnitude and direction of the force cannot be precisely controlled, it may elevate patient discomfort and increase the risk of minor head trauma such as headache and paroxysmal positional vertigo [4].

In an effort to achieve non-traumatic bone augmentation, screw expanders and thread formers were introduced to facilitate gradual horizontal expansion of the cortical bone while condensing the cancellous bone, thereby enhancing implant stability. This technique is considered a reliable, conservative, and cost-effective option in terms of both time and resources. More recently, motorized high-speed rotary expanders have emerged as an alternative approach for bone expansion and preparation through a process known as osseodensification [5].

Osseodensification is a non-excavating technique for implant site preparation that utilizes Densah burs to simultaneously compact and expand bone along the entire length of the osteotomy. This process results in the formation of a dense autografted bone layer [5]. As the densifying bur advances, it compacts bone not only along the osteotomy walls but also at the apex, which can exert upward pressure on the maxillary sinus floor, potentially achieving sinus membrane elevation [6].

Limited high-quality evidence is available regarding the use of osseodensification technique for transcrestal sinus lift. Therefore, this study aimed to compare the bone height gain, implant stability, amount of membrane elevation, sinus membrane perforation, and patient-reported outcomes achieved using Densah burs with that obtained through the conventional osteotome technique.

## Subjects and Methods:

### Study Design and Trial Registration:

This study was designed as a single-center, prospective, randomized controlled clinical trial with a parallel two-arm structure and a 1:1 allocation ratio. The study protocol was registered on ClinicalTrials.gov under the identifier NCT05411510. Ethical approval was obtained in advance from the Research Ethics Committee of the Faculty of Dentistry, Cairo University. The trial was conducted and reported in accordance with the 2010 CONSORT guidelines. The primary outcome assessed was bone height gain, while secondary outcomes included implant stability, extent of sinus membrane elevation, incidence of membrane perforation, and patient-reported outcomes measured using the Oral Health Impact Profile (OHIP).

### Sample Size Calculation:

By adopting an alpha (α) level of 0.05 (5%), power=80%, the predicted sample size (n) was 10 implants in each group, based on a previous study by Rostom and Eiid in 2021 [7]. Sample size was increased by (20%) to account for possible dropouts during follow-up intervals to be total of (24) cases i.e. (12) for each group. Sample size calculation was performed using G*Power 3.1.9.2. (Düsseldorf, Germany).

### Study Setting:

This study was conducted in the Oral Medicine, Oral Diagnosis and Periodontology Department's clinic, Faculty of Dentistry, Cairo University. The trial commenced in 2022 and was completed in April 2025.

### Patient Selection:

Participants were recruited from the outpatient clinic of the Department of Oral Medicine, Oral Diagnosis, and Periodontology, Faculty of Dentistry, Cairo University. A total of 24 patients (10 males and 14 females), aged between 26 and 62 years (mean age: 44 years), were enrolled in the study. All participants presented with one or more missing teeth in the maxillary posterior region, were in good general health, and had no systemic conditions that could affect treatment outcomes. Eligibility criteria included a residual bone height (RBH) between 5 mm and 8 mm, measured from the alveolar crest to the floor of the maxillary sinus, and a minimum bone width of 6 mm. Additionally, implant sites were free from pathological lesions and had adequate inter-occlusal space of 8–10 mm.

Exclusion criteria comprised: (1) history of systemic disease, substance abuse, catabolic medication use, or psychiatric disorders; (2) inadequate bone volume or insufficient vertical space in centric occlusion; (3) patients still in the growth phase or with partially erupted teeth; (4) presence of parafunctional habits such as bruxism or clenching; and (5) current smokers or alcohol consumers. All participants received a detailed explanation of the surgical procedures, potential risks, and signed an informed consent prior to their inclusion in the study

### Implant Selection:

Twenty-four IS-II Active dental implants (Neobiotech Co., Ltd., Seoul, South Korea) were used in this study. These implants are tapered two-piece implants with high load buttress thread design and grit-blasted and acid etched surface.

### Treatment Allocation and Allocation Concealment:

Participants were randomly allocated to either the

test or control group using a computer-generated randomization sequence (Research Randomizer software, Version 4.0) with 1:1 allocation ratio. To ensure allocation concealment, sequentially numbered, opaque, sealed envelopes were prepared, each containing the assigned treatment group. These envelopes were opened by the principal investigator only after administration of local anesthesia at the surgical site. Given the nature of the interventions, blinding of both the operator and the participants was not feasible. However, the outcome assessor and the biostatistician remained blinded to group assignments throughout the study.

**Pre-surgery Clinical and Radiographic Assessment:**

A comprehensive clinical examination involving visual inspection and palpation of oral and peri-oral tissues was performed for each patient (Figure 1). Maxillary and mandibular impressions were taken and poured into dental stone to create study casts for occlusal evaluation and force direction analysis relative to the planned implant site. Preoperative CBCT imaging (Planmeca Promax 3D, Helsinki, Finland) was conducted using the following parameters: 90 kVp, 8 mA, field of view 20 × 6 cm, voxel size 0.4 mm, and exposure time 13.5 seconds (Figure 2). This allowed for precise 3D measurement of residual bone height, assessment of the maxillary sinus, and detection of any subclinical pathology. Additionally, all patients received initial periodontal therapy prior to surgical intervention.

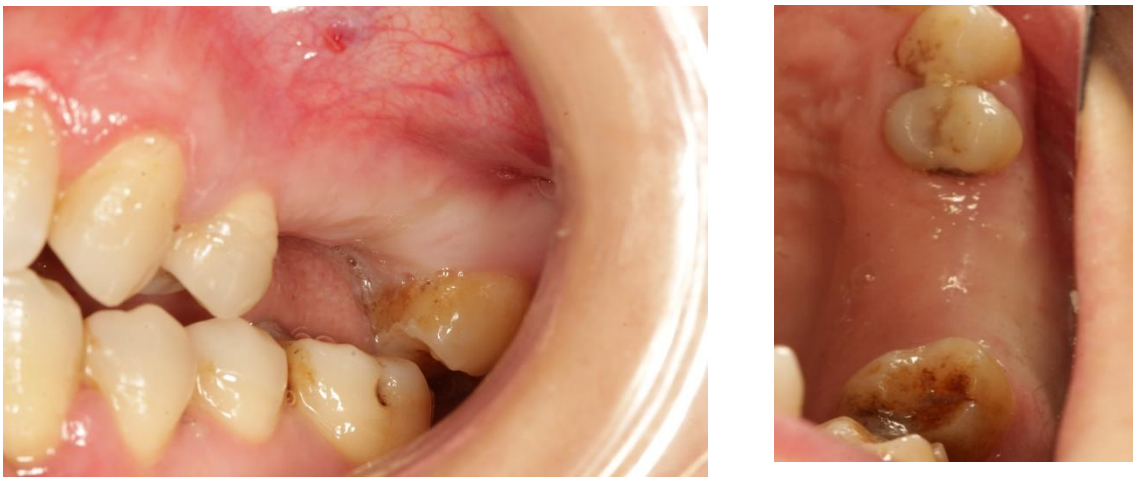


**Figure 1.** Lateral and occlusal views showing the absence of teeth 25 and 26

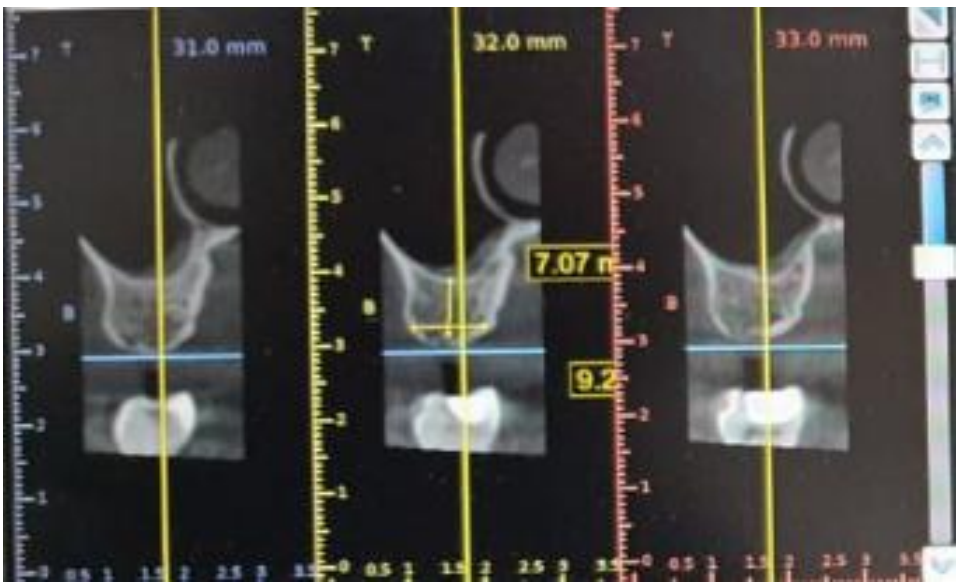



**Figure 2.** Pre-operative CBCT

**Surgical Procedure:**

All patients received local anesthesia (Septocaine, Novocol Pharmaceutical, Canada) via buccal and palatal infiltration. A crestal incision with vertical releasing incisions was made, and a full-thickness mucoperiosteal flap was elevated to expose the surgical site (Figure 3). Osteotomy was prepared using IS-II Active implant drills (Neobiotech Co., Ltd., Seoul, South Korea) under copious saline irrigation, starting with a 2.2 mm drill, then 2.75 mm, and ending with a 3.25 mm drill in soft bone or 4 mm in dense bone, maintaining a depth 1 mm short of the sinus floor.

**For Densah Bur Group:**

The Implant motor was set in counter-clockwise direction at a drilling speed of 1000 rpm. Three Densah® burs (Versah LLC, Jackson, MI, USA) with progressively increasing diameters of 2.5 mm, 3.0 mm, and 3.5 mm, were used sequentially under copious saline irrigation (Figure 4). Once tactile resistance (haptic feedback) was detected, the bur was used in a pumping motion to gently elevate the sinus membrane approximately 2 mm while completing the osteotomy (Figure 5).

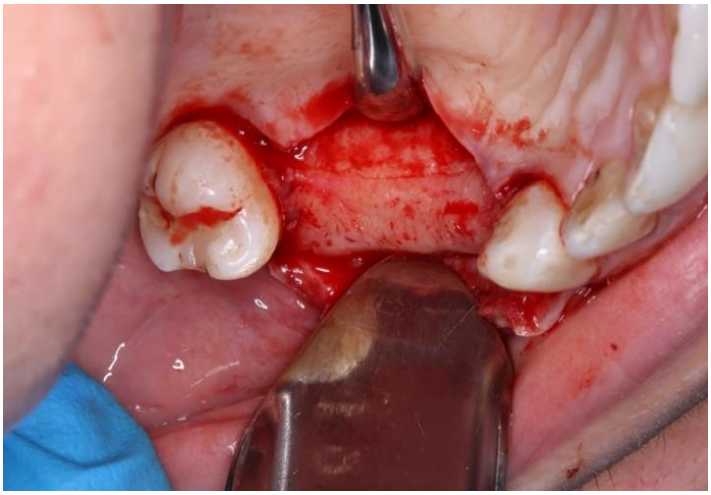


**Figure 3.** A full thickness flap was raised (crestal incision)

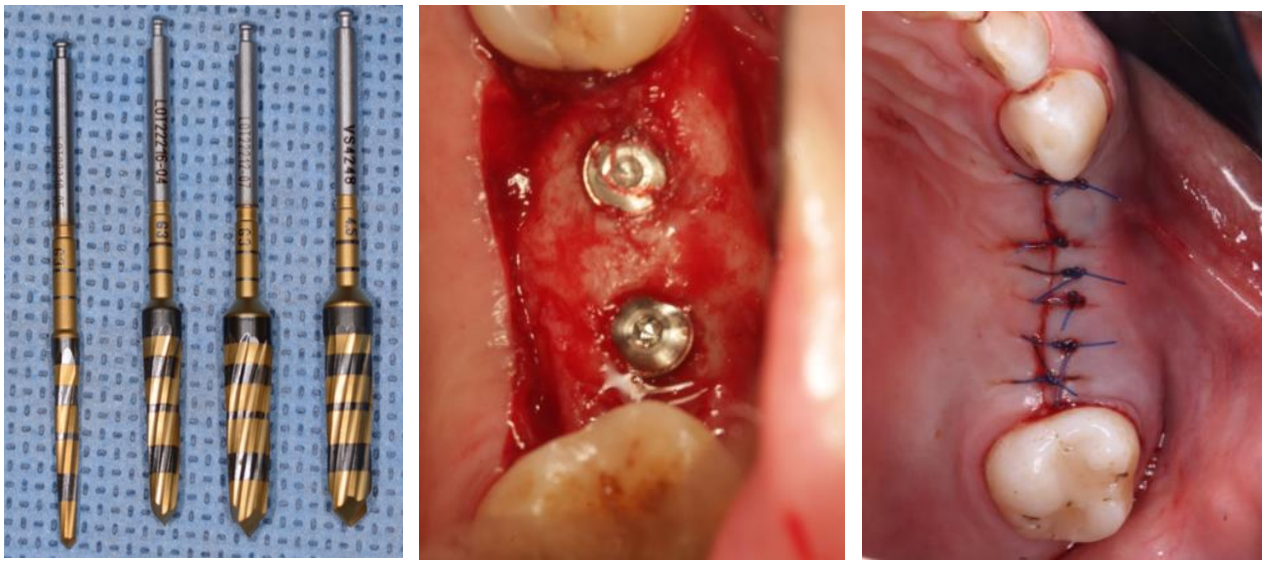


**Figure 4.** Densah® burs (Versah LLC, Jackson, MI, USA) were used to achieve a 4 mm sinus lift

**Figure** 5. Two implants (4 × 8.5 mm and 4.5 × 8.5 mm) were placed to replace the missing 25 and 26 teeth. Cover screws were attached to seal the internal connections.

**Figure 6.** The flap was sutured with 5-0 Prolene® using an interrupted suturing technique

**For Osteotome Group:**

A Flat end osteotome (IS-II Active implants; Neobiotech Co., Ltd., Seoul, South Korea) of appropriate diameter (3.75 or 4.5 mm) was used to in-fracture the sinus floor using light malleting, following the direct sinus floor infracture protocol.

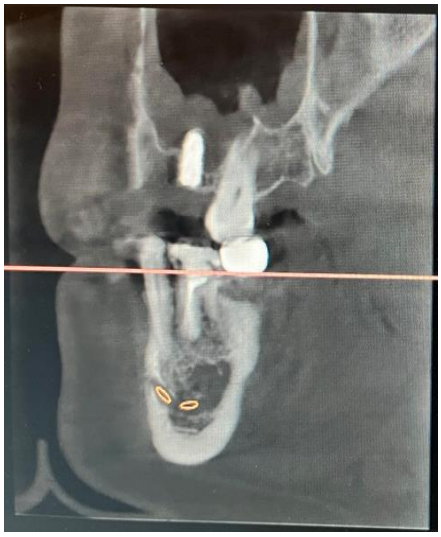
**Then for both groups**:

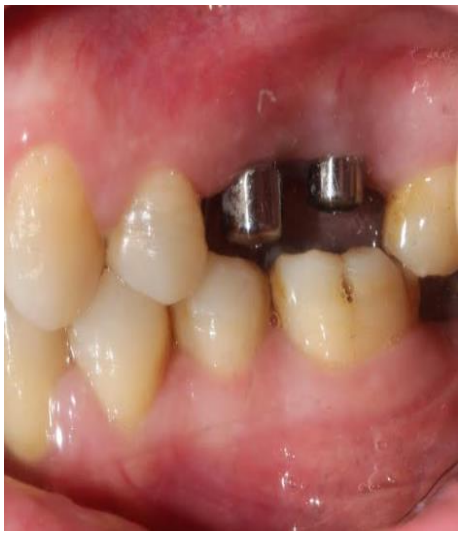
Sinus membrane integrity was evaluated using a blunt probe and the Valsalva maneuver (air bubble observation during gentle nasal exhalation with pinched nostrils). Neobiotech dental implants (Neobiotech Co., Ltd., Seoul, South Korea) were placed: 14 implants of size 4.5 × 8 mm and 10 implants of 4.5 × 10 mm. Implants were inserted using a PEEK carrier and rotated clockwise until resistance was encountered, followed by seating with a 2.2 mm hex driver and ratchet wrench until flush with the alveolar crest. A cover screw was placed (Figure 5), and the flap was repositioned and sutured with 5-0 Prolene® (Ethicon, USA) using an interrupted technique (Figure 6). A postoperative CBCT was taken to confirm implant positioning, initial peri-implant bone levels and sinus membrane elevation. Sinus membrane elevation was determined by subtracting the residual bone height from the total implant length(Figure 7).

Postoperative care included cold compresses for 24 hours, and patients were advised to avoid smoking, intense activity, brushing at the site, and behaviors that increase sinus pressure (e.g., sneezing with a closed mouth, drinking through straws). A soft diet was recommended for one week. After 24 hours, patients used chlorhexidine mouthwash (The Arab Drug Company, Cairo, Egypt) twice daily for two weeks. Augmentin 1000 mg (GlaxoSmithKline, London, UK) was prescribed twice daily for five days to reduce the risk of infection [8].

**Prosthetic Phase:**

Following a three-month healing period, surgical re-entry was performed using an X-incision technique to expose the implants, after which healing abutments were placed (Figure 8). The soft tissues were allowed to heal for 10 days. Subsequently, impressions were made using polyvinyl siloxane impression material (Cavex SilconA, Cavex, The Netherlands), and the final prosthetic crowns were fabricated and cemented in place (Figure 9).





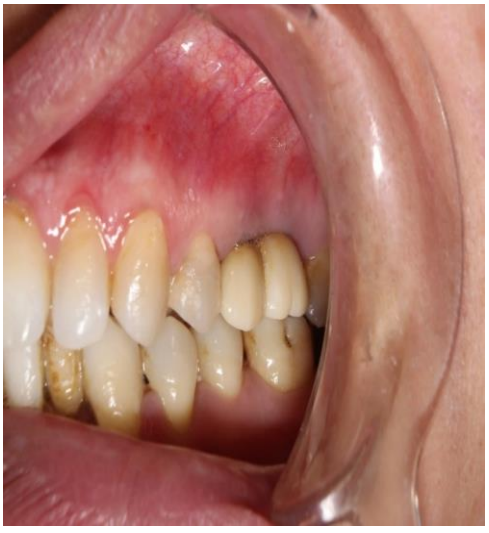


**Figure 7.** Post-operative CBCT showing a 4 mm elevation of the sinus membrane
**Figure 8.** Healing collars were placed three months after implant placement following implant exposure using the X-incision technique.
**Figure 9.** Final zirconia crown restorations

**Postoperative Evaluation:**
**Radiographic evaluation:**

A comparative evaluation of preoperative and 6-month postoperative CBCT scans was performed using specialized imaging software (OnDemand 3D, Seoul, South Korea). The CBCT datasets were imported for secondary reconstruction, and scan alignment was standardized through image fusion with distinct color coding. Manual alignment based on anatomical landmarks was followed by automatic registration to ensure accurate superimposition.

Preoperative bone height was measured as the vertical distance from the alveolar crest to the sinus floor cortex. Six months later, bone height was assessed from the most coronal to the most apical point of bone-to-implant contact. Bone gain was calculated by subtracting the initial from the postoperative height. Sinus floor elevation was determined by subtracting the residual bone height from the total implant length (Figure 10).

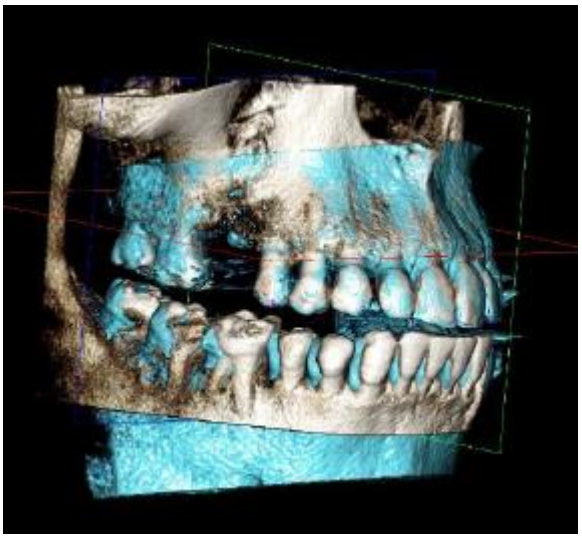


**Figure 10.** Superimposition of the postoperative image on the preoperative image.

**Clinical evaluation:**

Implant stability was assessed using the Periotest® M device (Medizintechnik Gulden, Bensheim, Germany), which provides measurements on a scale ranging from −8 to +50. Two repeated measurements were obtained for each implant and the mean of these two readings was recorded as a Periotest value (PTV). PTV between −8 and 0 were considered indicative of optimal implant stability and successful osseointegration. Implant failure was defined as the presence of mobility, indicating a lack of complete osseointegration [9].

Patient-reported outcomes were assessed using the Oral Health Impact Profile-14 (OHIP-14) questionnaire at one and two weeks postoperatively. The OHIP-14 consists of 14 items covering seven domains: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap—each domain represented by two questions. Responses were recorded on a five-point Likert scale (0 = never to 4 = very often). The total score, ranging from 0 to 56, was calculated by summing all item responses, with higher scores indicating a greater negative impact on oral health-related quality of life [10].

**Statistical analysis:**

Data analysis was performed using MedCalc software, version 22 for Windows (MedCalc Software Ltd, Ostend, Belgium). Normality of quantitative variables was evaluated using both Kolmogorov–Smirnov and Shapiro–Wilk tests, confirming that all continuous data were normally distributed. These data were presented as means ± standard deviations (SD). Independent t-tests were applied for between-group comparisons, while paired t-tests were used for within-group comparisons. Cohen's d was used to calculate effect sizes for continuous variables.

Categorical variables were expressed as frequencies and percentages, with the chi-square test employed for between-group comparisons. Relative risk (RR) was calculated to estimate effect sizes for categorical outcomes. The study was designed with 80% statistical power, a significance threshold of $P \leq 0.05$, and all tests were two-tailed with a 95% confidence interval.

## RESULTS

A total of 24 patients completed the study and were evaluated after a 6-month follow-up period. For each participant, comprehensive data were collected and subjected to statistical analysis. This included demographic information, radiographic measurements (initial bone height, bone gain, and extent of sinus membrane elevation), clinical outcomes (sinus membrane perforation and implant stability), as well as patient-reported outcomes assessed using the Oral Health Impact Profile-14 (OHIP-14) questionnaire.

**1. Demographic data:**

The study included a total of 24 patients who were randomly assigned to either the intervention or control group, with 12 participants in each arm. All participants completed the 6-month follow-up, resulting in a 100% retention rate. The overall mean age of the study population was 44.42 ± 8.94 years. Within the intervention group, the mean age was 42.67 ± 8.17 years, while the control group had a mean age of 46.17 ± 9.68 years; this difference was not statistically significant (P = 0.3491). Gender distribution between the groups is presented in Table 1, with no significant difference observed (P = 0.4176).

**2. Radiographic Results:**

A statistically significant increase in bone height was observed within both treatment groups when comparing initial measurements to those obtained at the 6-month follow-up [Table 2]. The mean baseline bone height in the control group was 6.59 ± 1.00 mm, slightly higher than that of the test group, which measured 5.97 ± 1.26 mm. However, this difference was not statistically significant (P = 0.1962). After 6 months, no significant differences were noted between the groups regarding final bone height (P = 0.5950), bone gain (P = 0.1713), or sinus membrane elevation (P = 0.5267) [Table 3].

**3. Clinical Results:**

At the 6-month follow-up, there were no statistically significant differences in implant stability between the two groups (P = 0.5573) [Table 3]. Similarly, intergroup comparison of sinus membrane perforation incidence revealed no significant difference (P = 0.5457). Although the Densah group exhibited a 50% lower risk of membrane perforation compared to the osteotome group, this reduction was not statistically significant (RR = 0.5, 95% CI: 0.05201 to 4.807; P = 0.5483) [Table 4].

**4. Patient-reported Outcomes:**

Regarding oral health impact profile, no statistically significant differences were found between the two groups at either the 1-week or 2-week postoperative evaluations (P > 0.05). However, intragroup analysis demonstrated a statistically significant improvement in OHIP scores in both groups over time (P < 0.0001). The effect size, calculated using Cohen's d, was 0.31, indicating a small but meaningful improvement in perceived oral health-related quality of life [Table 5].

**Table 1. Gender distribution among groups**

| Group | Gender | | Row total (RT) |
|---|---|---|---|
| | Male | Female | |
| **Densah** | 4 | 8 | 12 (50%) |
| | 33.3% RT | 66.7% RT | |
| | 40.0% CT | 57.1% CT | |
| **Osteotome** | 6 | 6 | 12 (50%) |
| | 50.0% RT | 50.0% RT | |
| | 60.0% CT | 42.9% CT | |
| **Column total (CT)** | 10 | 14 | 24 |
| | 41.70% | 58.30% | |
| **P value** | P = 0.4176 | | |

Significance level at p-value ≤0.05.

**Table 2. Intragroup comparison of bone height over the 6-month period:**

| Study groups | Bone height | Mean ± SD | P value |
|---|---|---|---|
| **Densah** | Initial bone height | 5.97 ± 1.26 | P < 0.0001* |
| | Bone height after 6 months | 8.57 ± 0.63 | |
| **Osteotome** | Initial bone height | 6.59 ± 1.00 | P < 0.0001* |
| | Bone height after 6 months | 8.75 ± 0.99 | |

Statistical test: Paired t-test. * Indicates statistical significance at $P \leq 0.05$. SD – standard deviation.

**Table 3. Intergroup comparison of bone height, bone gain, membrane elevation, and implant stability at 6 months**

| Outcome | Densah (Mean ± SD) | Osteotome (Mean ± SD) | P value |
|---|---|---|---|
| **Final Bone Height (mm)** | 8.57 ± 0.63 | 8.75 ± 0.99 | 0.5950 |
| **Bone Gain (mm)** | 2.60 ± 0.95 | 2.16 ± 0.47 | 0.1713 |
| **Membrane Elevation (mm)** | 2.80 ± 0.97 | 2.58 ± 0.66 | 0.5267 |
| **Implant Stability** | -3.49 ± 2.02 | -2.94 ± 2.48 | 0.5573 |

Statistical test: Independent t-test. Significance level at p-value ≤0.05. SD – standard deviation.

**Table 4. Membrane perforation distribution among groups**

| Group | Membrane Perforation | | Row total (RT) |
|---|---|---|---|
| | Yes | No | |
| **Densah** | 1 | 11 | 12 (50%) |
| | 8.3% RT | 91.7% RT | |
| | 33.3% CT | 52.4% CT | |
| **Osteotome** | 2 | 10 | 12 (50%) |
| | 16.7% RT | 83.3% RT | |
| | 66.7% CT | 47.6% CT | |
| **Column total (CT)** | 3 | 21 | 24 |
| | 12.50% | 87.50% | |
| **P value** | P = 0.5457 | | |

Significance level at p-value ≤0.05

**Table 5. Intra- and Intergroup comparisons of Oral Health Impact Profile after 1 and 2 weeks**

| Outcome | Densah (Mean ± SD) | Osteotome (Mean ± SD) | 95% CI | P value |
|---|---|---|---|---|
| **1 week** | 5.58 ± 2.07 | 6.58 ± 1.93 | -0.69-2.69 | 0.2332 |
| **2 weeks** | 1.25 ± 0.97 | 1.58 ± 2.27 | -1.14-1.81 | 0.6449 |
| **Difference** | -4.33 ± 1.87 | -5.00 ± 2.37 | -2.47-1.13 | 0.4502 |
| **P value** | P < 0.0001* | P < 0.0001* | | |

Statistical tests: Independent t-test for inter-group comparison; paired t-test for intra-group comparison.

* Indicates statistical significance at $P \leq 0.05$. SD – standard deviation.

## DISCUSSION

Sinus floor augmentation enables implant placement in the posterior maxilla despite limited bone height due to resorption and pneumatization. While Summers' osteotome technique (1994) is predictable [11], it poses risks such as Schneiderian membrane perforation and Benign Paroxysmal Positional Vertigo (BPPV) from malleting [12].

Osseodensification, introduced by Huwais and Meyer in 2017, uses motorized Densah burs to compact bone, elevating the sinus floor while preserving bone structure. This technique may reduce perforation risk, enhance implant stability, and eliminate the need for bone graft [6]. These advantages stem from the combined effects of hydraulic compression and hydrodynamic wave action [13]. Given the limited evidence on its use for transcrestal sinus elevation, this study compared clinical and radiographic outcomes of osseodensification versus conventional osteotome technique.

The necessity of grafting materials in sinus floor augmentation remains controversial. In this study, bone formation was observed around the implant apex without grafts, suggesting that membrane elevation alone may stimulate bone growth [14]. Previous studies have shown no significant differences in implant survival rates regardless of whether grafting materials were used [15,16].

In line with Suk-Arj et al. in 2019, all patients in this study underwent CBCT imaging at three time points: preoperatively to evaluate residual bone height and thickness, immediately postoperatively to assess implant positioning, initial bone levels, and sinus membrane elevation, and after six months to measure bone height gain [17].

Patients with a minimum residual bone height (RBH) of 5 mm were included, as RBH <5 mm

compromises primary stability [18,19]. Primary stability was achieved in the current study in all cases, likely due to the elastic properties of maxillary bone enveloped by preserved periosseous connective tissue, which allows close adaptation around the implant [20].

Moreover, all cases met the requirement of at least 6 mm of bone width, ensuring 2 mm cortical bone buccally and palatally, adequate cancellous bone, and safe use of Densah burs or osteotomes without cortical damage [3]. A minimum interocclusal space of 8–10 mm was confirmed for functional prosthesis placement [21]. A crestal incision with full-thickness flap reflection was performed to allow visual inspection of bone integrity and enhance irrigation, reducing the risk of overheating and tool cutting inefficiency [22]. No implant failures were observed in the current study in either group based on established success criteria [23].

The present study revealed a statistically significant increase in bone height in the test group, where values improved from $5.97 \pm 1.26$ mm at baseline to $8.57 \pm 0.63$ mm after six months, resulting in an average endo-sinus bone gain of $2.60 \pm 0.95$ mm. These findings are consistent with those of Elghobashy et al. in 2023, who reported a similar significant increase from $6.2 \pm 0.7$ mm to $9.4 \pm 0.9$ mm, with a mean gain of $3.2 \pm 0.8$ mm following osseodensification [24]. In the control group, a comparable trend was observed, with bone height increasing from $6.59 \pm 1.00$ mm to $8.75 \pm 0.99$ mm and a mean gain of $2.16 \pm 0.47$ mm. This aligns with the findings of Ye at al. in 2021, whose systematic review and meta-analysis reported an average endo-sinus bone gain of approximately 2.2 mm after osteotome sinus floor elevation (OSFE) [15].

Although both groups demonstrated significant bone gain individually, the intergroup comparison showed no statistically significant difference. This could be attributed to the clinical objective in both techniques, to elevate the sinus membrane just enough to accommodate the implant of the intended length, without the use of grafting materials to support further elevation beyond the apex. Consequently, the extent of vertical bone gain was limited. Similar conclusions were drawn by Elghobashy et al. in 2023, who also found no significant difference in bone gain between groups despite a mean gain of 3.2 mm in the two groups [24].

Membrane perforation remains the most common intraoperative complication during sinus floor elevation, with a reported incidence of 20% [25]. In the current study, membrane integrity was assessed using the Valsalva maneuver and a blunt probe, revealing perforation rates of 8% in the Densah group and 16% in the OSFE group, with no statistically significant difference ($P = 0.5483$). The Densah group showed a 50% lower relative risk of perforation. These results align with the findings of Rostom and Eiid in 2021, who also observed rates of 7.3% and 25% in the Densah and OSFE groups, respectively, noting higher perforation in cases with residual bone height under 5 mm [7].

Discomfort, including pain, dizziness, and vertigo, is a known complication of sinus membrane elevation with osteotomes, typically resolving within days to weeks [7]. This study found no statistically significant difference in OHIP-14 scores between the osteotome and Densah groups at 1 week ($P = 0.2332$) or 2 weeks ($P = 0.6449$), though both groups showed significant intragroup improvement over time ($P < 0.0001$). Several patients in the osteotome group experienced transient vertigo, while none did in the Densah group, supporting the hypothesis that malleting may dislodge otoliths, causing positional vertigo [26].

Consistent with these findings, Rostom and Eiid in 2021 reported no significant differences in headache, vertigo, or swelling between techniques using combined HRQOL tools [7]. Similarly, Elghobashy et al. in 2023 found no significant differences in pain or edema, attributing the absence of vertigo to a non-malleting screwable osteotome technique [24].

Based on current evidence, osseodensification appears to be a promising alternative for crestal sinus floor elevation, offering reduced treatment time and patient discomfort. However, the small sample size and short follow-up period in this study highlight the need for larger, long-term randomized trials to confirm these findings.

## CONCLUSIONS

Within the limitations of this study, Osseodensification presents a reliable alternative to the osteotome technique for crestal sinus floor elevation, offering better patient comfort with comparable clinical and radiographic outcomes, including implant stability, bone gain, membrane integrity and oral health impact profile.

## DECLARATION

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**Conflict of Interest**
The authors declare no conflict of interest.

**Ethical approval**
This study protocol was approved by the ethical committee of the faculty of dentistry- Cairo university and all participants signed informed consent prior to their inclusion in the study.

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