RESEARCH PAPER

Evaluation of crestal sinus floor elevations using osseodensification technique- A Clinical study

Archana S[1*], Sumit Malhotra[2], Prashansa Sharma[3]

[1]Department of Periodontology and Oral Implantology, I.T.S Centre for Dental Studies and Research, Ghaziabad, Uttar Pradesh, India

[2]Department of Periodontology and Oral Implantology, I.T.S Centre for Dental Studies and Research, Ghaziabad, Uttar Pradesh, India

[3]Department of Periodontology and Oral Implantology, I.T.S Centre for Dental Studies and Research, Ghaziabad, Uttar Pradesh, India

ABSTRACT

Background: Maxillary sinus augmentation procedures have gained popularity for the placement of dental implants in vertically deficient maxillary ridges in the posterior region with low bone density. Although treatment options using both direct and indirect approaches exist, the Indirect Sinus Lift (ISL) techniques have been proven to be a safe modality with fewer complications.

The aim of the present study was to evaluate the achieved sinus lift, implant stability, and the Buccopalatal width (BPW) changes using Osseodensification technique in patients requiring ISL.

Methods: A total of 10 patients requiring dental implants using the ISL technique were selected. Various clinical and radiographic parameters were recorded at Baseline and 3 months.

Results: The ISQ values showed statistically significant improvement from baseline to 3 months. There was a significant increase in the bone height from baseline to 3 months.

Conclusion: Our study illustrates the role of Osseodensification in the management of insufficient alveolar ridge height for the placement of implants. Within the limitations, the present study shows an increase in implant stability as well as appreciable bone gain even without the use of additional bone grafts. The osseodensification technique shows comparable results and can be used in ISL procedures of deficient maxillary ridges.

Keywords: Osseodensification, Indirect sinus lift, Implant stability quotient

How to cite this article: Archana S, Malhotra S, Sharma P. Evaluation of crestal sinus floor elevations using osseodensification technique - A Clinical study. Int J Drug Deliv Technol. 2026;16(38s): 813-820. DOI: 10.25258/ijddt.16.38s.84

Source of support: Nil

Conflict of interest: None

INTRODUCTION

Maxillary sinus augmentation procedures have been gaining popularity for the placement of dental implants in the posterior maxilla with reduced vertical bone height and have been proven to be a safe modality with fewer complications.[1]

However, lifting the sinus membrane and augmenting the ridge to increase the residual bone height (RBH) and density while keeping the Schneiderian membrane intact and free of perforation remains a challenge.

Traditionally, two techniques are used in the treatment of vertically deficient, edentulous maxillary ridge in the posterior region with low bone density: Direct and Indirect sinus lift (ISL) techniques.[2]

The Indirect technique using the transcrestal approach is often chosen in cases where the residual bone is at least 5 mm high [3]. However, recent studies have reported the possibility of indirect sinus lift in cases where the RBH is < 5 mm. [4] The Indirect technique using transcrestal approach has the advantage of being less invasive than the direct techniques, resulting in fewer complications, reduced swelling, and pain postoperatively. [5]

Various ISL procedures have been reported in literature. The antral membrane balloon elevation sinus lift technique introduced by Kfir et al.[6] used barometric inflators to achieve sinus membrane elevations. The hydraulic sinus lift technique, introduced by Chen and Cha[7], achieved the membrane separation by means of a high-speed hand piece driven by hydraulic pressure. This technique was modified by Sotirakis and Gonshor [8], wherein they used a saline filled syringe to separate the membrane. The gel pressure sinus lift technique by

Corresponding Author: Dr. S. Archana, s.archana_mds22_25@its.edu.in

Pommer and Watsek [9] used canon drills with internal irrigation and a specially designed injection nozzle with a radiopaque gel of hydroxyl propyl methyl cellulose.

Osseodensification is another novel surgical approach for the placement of dental implants based on the principle of biomechanical bone preparation, where specialized densifying burs of increasing sizes are used for the preservation and compaction of the bone during the process of elevation of the floor of the maxillary sinus, thereby reducing the chances of sinus membrane perforation.[10]

These ISL techniques, developed over time, can be performed with or without bone grafts. However, the choice of the right material has always been debated. In order to minimize the associated complications with grafting, recent studies have reported favourable results in ISL techniques without the use of bone grafts, wherein the blood clot formed between the sinus membrane and the bone wall promotes osseointegration.[11]

The present study analyses the primary and secondary stability parameters along with the other associated parameters, such as vertical bone gain, Buccopalatal width (BPW) changes in ISL procedures using the osseodensification technique, and to study the overall performance of this technique without the use of bone grafts.

METHODS

This study was conducted in the Department of Periodontology and Oral Implantology, ITS Centre for Dental Studies and Research, Murad Nagar, Ghaziabad. The study was approved by I.T.S Institutional ethics committee (IIEC) under the protocol number ITSCDSR/IIEC/2022-25/PERIO/02.

A total number of 10 patients were included in this present study. Subjects with adequate oral hygiene status aged above 18yrs requiring delayed ISL for implant placement with RBH ≥ 5 mm, with healed bone crest (at least 3 months elapsed from tooth loss/extraction) and no active periodontal disease were included in the present study. The inclusion criteria was also based on the presence of adequate inter- occlusal space in the edentulous region, and the willingness of the subjects to comply with the treatment protocol.

Patients with poor oral hygiene, uncontrolled diabetes, maxillary sinus pathology, autoimmune diseases, psychiatric disorders, osteoporosis, patients undergoing or who underwent chemotherapy and radiation therapy to the head and neck region during the last 12 months, alcoholic, drug abusers and heavy smokers, pregnant women and lactating mothers were excluded from the study.

Diagnostic dental stone casts were fabricated from the alginate impressions of all selected study participants. A soft vacuum forming acetate sheet of 1.5 mm was used to fabricate a semi-rigid stent of the edentulous site along with adjacent area for standardized measurements. A Gutta percha (GP) point was placed on the edentulous area on the stent at the planned Implant site. Additionally six points were marked, 3 each on the buccal and palatal side at 0 mm, 2 mm and 4 mm from the alveolar crest. The stent was positioned in the patient's oral cavity, and CBCT was done.

Surgical Technique:

Prior to surgery, all patients received thorough supra-gingival and sub-gingival scaling and root planing. Oral hygiene instructions were given and patients were reviewed periodically by evaluating the plaque and gingival scores.

After local anaesthesia administration full thickness flap was raised at the planned implant site. After measuring the RBH, the osteotomy preparation was done using the Densah burs® in osseodensification mode till the adequate lift and diameter was reached.

After reaching the required diameter, the vertical position was confirmed with the help of a radiograph. Sinus perforations if any were evaluated using Valsalva maneuver. The Implant was placed at crestal level in the prepared osteotomy site. All the implants that were placed were from the Adin Touareg TM – S, Adin Implant System Ltd., Israel product line featuring a tapered design with standard SLA (Sandblasted, Large grit, Acid-etched) surface. The diameter of the implants placed ranged between

4.2 mm and 5.0 mm and the length ranged between 8 mm and 10 mm.

Implant stability quotient (ISQ) at mesiodistal and buccopalatal directions were measured using Penguin® resonance frequency analysis device. With the help of bone caliper, BPW of bone at the implant site was measured at 0 mm, 2 mm and 4 mm from the crest using pre-fabricated stents and then the sutures were placed.

The following radiographic parameters were evaluated:

1.The Residual bone height (RBH) at baseline was measured as the distance from the alveolar crest to the floor of the maxillary sinus at the planned implant site (indicated by the GP marking), and the Vertical bone height (VBH) at 3 months was measured as the distance from the alveolar crest to the new sinus floor on the CBCT image.

2.The BPW was measured at 0 mm, 2 mm and 4 mm from the alveolar crest.

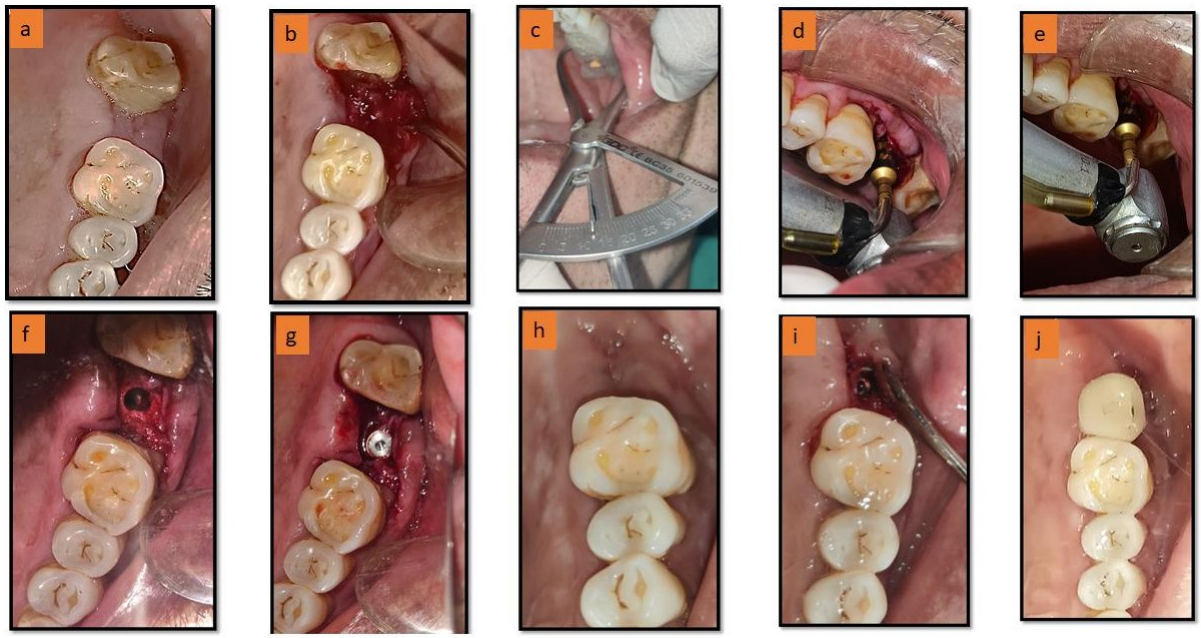


Figure 1 : ISL procedure using Osseodensification technique- (a) Pre-Op (b) Incision and Flap Reflection (c) Measurement using Bone caliper with Stent (d,e) Sequential Drilling using Densah® Burs (f) Osteotomy site (g) Implant Placed (h)3 months Post –Op (i) cover screw (j) Prosthetic rehabilitation

To standardise the image analysis a central image of edentulous site with the GP was evaluated to measure the radiographic parameters.

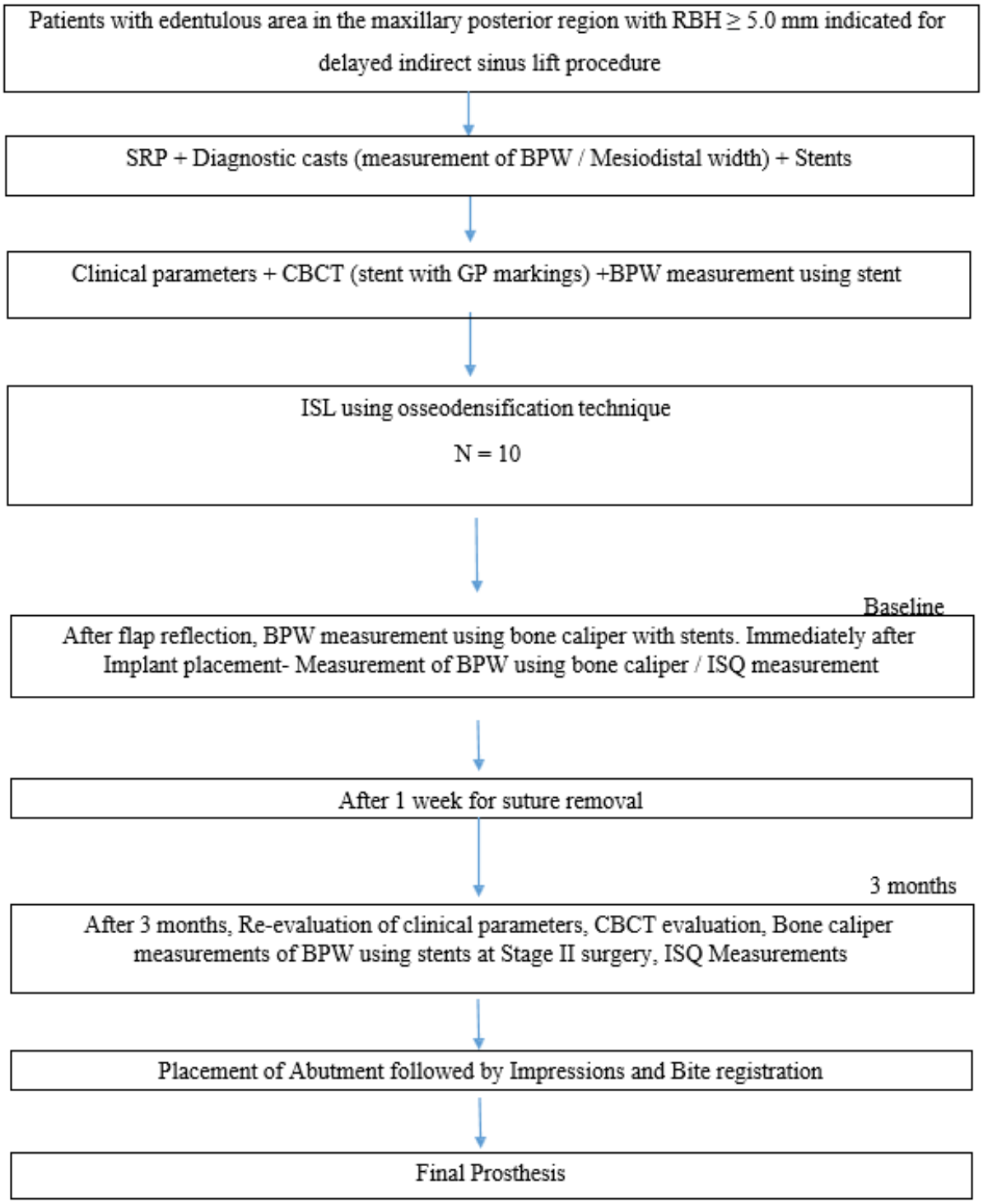
The multiplanar reconstruction (MPR) views were chosen for the standardization of measurements of the radiographic parameters. In the axial section, the teeth were aligned at the level of visible GP and was taken as the standardized slice. A line joining the buccopalatal ridge was drawn, intersecting the line joining the adjacent teeth on either side of the edentulous area passing through the GP marking.

The corresponding sagittal section showing the GP marker was used to calculate the RBH values, while the corresponding coronal section was used for the measurement of BPW.

Second stage surgery was performed after 3 months and the parameters were evaluated again. A final prosthesis was fabricated and delivered to the patient.

The recorded parameters at baseline and 3 months were first tabulated in MS Office Excel and then were subjected to statistical analysis using the Statistical Package for the Social Sciences (SPSS) software package (SPSS 16 Inc, Chicago, IL, USA). The level of significance and confidence interval were fixed as 5% and 95% respectively, i.e., $p < 0.05$.

STUDY DESIGN:



RESULTS

A total of 10 (5 males and 5 females) patients with missing maxillary posterior teeth were selected for this study. The study included subjects with a mean age of 50.70 ± 12.23 years (Table 1).

The plaque and gingival scores were recorded at baseline and at 3 months. At baseline, the mean plaque score was 1.73 ± 0.41 while at the 3rd month, the mean plaque decreased to 1.61 ± 0.41. The mean gingival score at baseline was 1.11 ± 0.51 while, the mean score recorded at the 3rd month decreased to 0.86 ± 0.48 (Table 2). The

intragroup comparison of mean plaque and gingival scores between baseline and 3 months showed a statistically significant reduction ($p < 0.05$) (Table 2).

The mean ISQ values recorded at baseline and at 3 months were 69.30 ± 7.38 and 73.60 ± 7.46 respectively. The intragroup analysis of the mean ISQ values showed a statistically significant increase ($p < 0.05$) from baseline to the 3rd month (Table 2).

On intragroup analysis, the baseline values (RBH) increased from 6.84 mm ± 1.32 mm to 10.18 mm± 0.48 mm at 3 months (VBH), which was statistically significant ($p < 0.05$) (Table 2).

On intragroup comparison, the mean BPW measured using bone calipers between baseline and immediately after placement of the implant at 0 mm increased from 7.50 mm ± 2.37 mm to 8.60 mm

± 2.32 mm, while the mean BPW measured at 2 mm and 4 mm changed from 10.00 mm ± 1.76 mm to10.10 mm ± 1.85 mm and from 10.90 mm ± 2.08 mm to 10.80 mm ± 2.25 mm, respectively. The changes observed between baseline and immediately after implant was statistically significant at 0mm ($p < 0.05$), while they were not statistically significant at both 2 mm and 4 mm (Table 3).

TABLE 1. Demographic details

Variable	Osseodensification group
Age	50.70 ± 12.23
Gender	Male: 5 Female: 5

TABLE 2. Intragroup assessment of clinical parameters

Parameters	Osseodensification group
Plaque score Baseline	1.734 ± 0.411
Plaque score 3 months	1.608 ± 0.406
p - value	**0.049***
Gingival score Baseline	1.113 ± 0.505
Gingival score 3 months	0.857 ± 0.481
p - value	**0.001***
ISQ Baseline	69.300 ± 7.379
ISQ 3 months	73.600 ± 7.456
p - value	**0.001***
RBH Baseline	6.840 ± 1.319
VBH 3 months	10.180 ± 0.484
p - value	**0.001***

The mean BPW measured using bone calipers between baseline and 3 months at 0 mm were 7.50 mm ± 2.37 mm and 6.80 mm ± 1.75 mm, respectively and the change in the mean BPW at 0 mm was not statistically

significant. However, the mean BPW measured at 2 mm changed from 10.00 mm ± 1.76 mm to 8.90 mm ± 2.23 mm which was statistically significant ($p < 0.05$) while the changes in the mean BPW measurements at 4 mm remained statistically non-significant (Table 4).

The mean BPW measured using CBCT between baseline and 3 months at 0 mm were 7.46 mm ± 1.86 mm and 7.18 mm ± 1.75 mm, respectively, whereas at 4 mm it was 11.01 mm ± 2.11 mm and 10.78 mm and 2.25 mm, respectively. However, the mean BPW changes were not statistically significant both at 0 mm and 4 mm. At 2 mm it was 9.99 mm ± 1.67 mm at baseline which decreased to 9.33 mm

± 2.07 mm at 3 months. The changes recorded were statistically significant at 2 mm ($p < 0.05$) which was similar to the statistically significant results obtained in the mean BPW measured with the help of bone calipers at 2 mm (Table 5).

TABLE 3. Intragroup comparison of BPW measured through caliper at baseline and immediately after implant placement

Section	Baseline		After placement		p-value
	Mean	SD	Mean	SD	
0 mm	7.50	2.37	8.60	2.32	< 0.001*
2 mm	10.00	1.76	10.10	1.85	0.343
4 mm	10.90	2.08	10.80	2.25	0.591

Paired t test; * indicates a significant difference at $p \leq 0.05$

TABLE 4. Intragroup comparison of BPW measured through caliper at baseline and at 3 months within each group

Section	Baseline		3 months		p-value
	Mean	SD	Mean	SD	
0 mm	7.50	2.37	6.80	1.75	0.111
2 mm	10.00	1.76	8.90	2.23	0.017*
4 mm	10.90	2.08	10.20	1.93	0.285

Paired t test; * indicates a significant difference at $p \leq 0.05$

TABLE 5. Intragroup comparison of BPW measured through CBCT at baseline and at 3 months within each group

Section	Baseline		3 months		p-value
	Mean	SD	Mean	SD	
0mm	7.46	1.86	7.18	1.75	0.350
2mm	9.99	1.67	9.33	2.07	0.020*
4mm	11.01	2.11	10.78	2.25	0.679

Paired t test; * indicates a significant difference at $p \leq 0.05$

DISCUSSION

To combat the insufficient bone availability arising due to sinus pneumatization in the posterior maxillary region and to facilitate placement of implants, several sinus augmentation procedures have been discussed in literature.[12]

Although treatment options using both direct and indirect approaches exist, the ISL techniques using

osseodensification approach have been proven to be a safe modality with fewer complications and reduced sinus membrane perforation risks.

The present study evaluated the efficacy and treatment outcomes in ISL procedures using osseodensification technique without the use of bone grafts.

As oral hygiene plays a crucial role in treatment outcomes, full mouth plaque and gingival scores were monitored at baseline and at regular intervals to eliminate the bias in the assessment of treatment outcomes. The intragroup comparison of the scores at baseline and 3 months showed a statistically significant reduction ($p < 0.05$).

In our study, the ISQ values were determined at baseline and at 3 months. The intragroup analysis of ISQ values of the osseodensification group showed a statistically significant increase ($p < 0.05$), which could be attributed to the non-subtractive drilling of the specialized Densah® burs and increased bone to implant contact as mentioned in previous studies. Arafat et al. [13] and El-Ghobashy et al. [14] have also reported similar trend in the results with respect to the ISQ in their study using osseodensification. Stacchi et al. [15] in their study demonstrated similar results suggesting that the osseodensification technique induce limited remodelling of the peri-implant bone.

Hashem et al. [16] in their study compared different crestal sinus lift techniques, and had demonstrated that the mean ISQ was highest for the osseodensification group and was lowest for the piezosurgery group both at baseline and after 6 months.

The Intragroup comparison of the mean bone height from baseline to 3 months showed a statistically significant increase ($p < 0.05$). This could be attributed to the special flute designs of the Densah® burs and the compressive forces by them creating micro fractures which in turn stimulate osteogenic process. Samir et al. [17] had also concluded that osseodensification yielded effective sinus elevation with statistically significant increase in the bone height postoperatively than when compared with baseline values.

The BPW measured using bone calipers at 0 mm increased significantly from baseline to immediately after implant placement ($p < 0.05$). However, at the 3 months examination the BPW at 0 mm reduced

when compared to baseline but it was non-significant ($p \geq 0.05$). The increase in the BPW noted immediately after implant placement in the osseodensification group could be attributed to the non- subtracting drilling protocol of the specialized densah burs having a bone compaction effect.

The BPW at 2 mm and 4 mm measured intra-surgically using bone calipers revealed no statistical significance difference from baseline to immediately after implant placement ($p \geq 0.05$).

This is in accordance with the results concluded by Koutouzis et al. [18] that the BPW increase at the crestal region in contrast apical region could be linked to the presence of a higher proportion of the cortical bone with relatively less trabecular spaces at the crestal region resulting in plastic deformation. The study also reported that the tapered shape of the densah bur with the narrower portion at the apical region and the wider portion at the crestal region could also be a contributing factor for the significant expansion at the crestal region.

At the 3-month examination, the mean BPW measured using both bone calipers and CBCT, at 2 mm reduced significantly when compared to baseline ($p < 0.05$). However, the BPW at 4 mm, measured at 3 months, decreased when compared to baseline but did not show any statistical significance ($p \geq 0.05$).

The limitations of the present study include a small sample size and a follow-up period of only 3 months. Despite precautions being taken to perform atraumatic extractions wherever possible, differences in extraction techniques and healing patterns may have influenced the residual bone height and ISQ values, which were not considered in the present study. Another limitation of the present study is the differences in the implant sizes, which could have introduced inter-subject variability and patient-related confounding factors.

CONCLUSION

Our study illustrates the role of ISL procedure using osseodensification technique in the management of insufficient alveolar ridge height for placement of Implants. Within the limitations, the present study shows an increase in implant stability as well as appreciable bone gain even without the use of additional bone grafts. However, further research in this area should be carried out with a larger sample size and longer follow ups.

COMPETING INTERESTS

The authors declare that they have no competing interests.

FUNDING

This study was self-funded, and there has been no significant financial support for this work that could have influenced its outcomes.

REFERENCES

1. Bathla SC, Fry RR, Majumdar K. Maxillary sinus augmentation. J Indian Soc Periodontol. 2018; 22(6):468-73.
2. George J, Gopal S, Huda F, Thomas N. Minimally Invasive Transalveolar Sinus Augmentation: An

Answer to Sinus Conundrum. Dent Med Res. 2020;8:4–9.
3. Khehra A, Levin L. Maxillary sinus augmentation procedures: a narrative clinical review.Quintessence Int. 2020;51(7):578-84.
4. Alhayati JZ, Al-Anee AM. Evaluation of crestal sinus floor elevations using versah burs with simultaneous implant placement, at residual bone height ≥ 2.0 _ < 6.0 mm. A prospective clinical study. Oral Maxillofac Surg. 2023;27(2):325-32.
5. Salgar N. Osseodensified Crestal Sinus Window Augmentation: An Alternative Procedure to the Lateral Window Technique. J Oral Implantol. 2021;47(1):45-55.
6. Kfir E, Kfir V, Mijiritsky E, Rafaeloff R, Kaluski E. Minimally invasive antral membrane balloon elevation followed by maxillary bone augmentation and implant fixation. J Oral Implantol. 2006;32(1):26-33.
7. 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(3):482-491.
8. Sotirakis EG, Gonshor A. Elevation of the maxillary sinus floor with hydraulic pressure. J Oral Implantol. 2005;31(4):197-204.
9. Pommer B, Watzek G. Gel-pressure technique for flapless transcrestal maxillary sinus floor elevation: a preliminary cadaveric study of a new surgical technique. Int J Oral Maxillofac Implants. 2009;24(5):817-822.
10. Huwais S, Meyer EG. A novel osseous densification approach in implant osteotomy preparation to increase biomechanical primary stability, bone mineral density, and bone-to-implant contact. Int J Oral Maxillofac Implant 2017;32(1):27–36.
11. Rawat A, Thukral H, Jose A. Indirect sinus floor elevation technique with simultaneous implant placement without using bone grafts. Annals of maxillofacial surgery. 2019;9(1):96-102.
12. Sharan A, Madjar D. Maxillary sinus pneumatization following extractions: a radiographic study.Int J Oral Maxillofac Implants. 2008;23(1):48-56.
13. Arafat, S., A Elbaz, M. Clinical and radiographic evaluation of osseodensification versus osteotome for sinus floor elevation in partially atrophic maxilla: A prospective long term study. Egyptian Dental Journal, 2019; 65(Issue 1 - January (Oral Surgery): 189-95.
14. El-Ghobashy MT, Shaaban AM, Melek LN. Osseodensification by densah burs versus osteotome for transcrestal maxillary sinus lifting with simultaneous implant placement. Alexandria Dental Journal. 2023 Apr 1;48(1):51-58.
15. Stacchi C, Troiano G, Montaruli G, Mozzati M, Lamazza L, Antonelli A, Giudice A, Lombardi T. Changes in implant stability using different site preparation techniques: Osseodensification drills versus piezoelectric surgery. A multi-center prospective randomized controlled clinical trial. Clinical Implant Dentistry and Related Research. 2023;25(1):133-40.
16. Hashem AH, Khedr MF, Hosny MM, El-Destawy MT, Hashem MI. Effect of Different Crestal Sinus Lift Techniques for Implant Placement in the Posterior Maxilla of Deficient Height: A Randomized Clinical Trial. Applied Sciences. 2023; 13(11):6668.
17. Samir M, Bissar MW, Abuel-Ela HA. Osseodensification versus piezoelectric internal sinus elevation (PISE) technique in delayed implant placement (a randomized controlled clinical trial). BMC Oral Health. 2024;24(1):1306.
18. Koutouzis T, Huwais S, Hasan F, Trahan W, Waldrop T, Neiva R. Alveolar Ridge Expansion by Osseodensification-Mediated Plastic Deformation and Compaction Autografting: A Multicenter Retrospective Study. Implant Dent. 2019;28(4):349-55