Keywords
Dental implants, alveolar bone loss, osseodensification, bone density, ridge expansion, implant stability.

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Received:20-06-2026
Revised:24-07-2026
Accepted: 04-08-2026
Doi:10.1922/ejprd.v34i7s.1677



# Effect of Osseodensification Technique on Ridge Expansion and Bone Density for Implant Placement in Posterior Maxilla and Mandible: A Comparative Study

**Abstract**

**Background:** Tooth loss leads to progressive alveolar bone resorption, reducing bone volume and density, especially in the early post-extraction phase. These changes are more pronounced in the posterior maxilla due to sinus pneumatization and poor bone quality while the posterior mandible, though denser remains susceptible to cortical thinning. Achieving primary implant stability in such compromised conditions is challenging. Conventional osteotomy removes bone, potentially compromising implant stability. Osseodensification, introduced by Huwais (2017), is a novel technique that preserves and compacts bone to enhance stability and osseointegration.

**Methods:** Twenty patients with posterior edentulous sites in the maxilla and mandible were selected. Preoperative CBCT (Cone Beam Computed Tomography) assessed bone quality and quantity. Implant osteotomy was performed using the Densah bur kit in densifying (anticlockwise) mode. The osteotomy was ordered up to 4 $^{x}$10 mm depth. Bone density and ridge width were evaluated immediately postoperatively and after four months.

**Results:** Osseodensification significantly increased bone density and ridge expansion in both regions. Greater improvements were observed in low-density bone, particularly in the posterior maxilla. The technique enabled compaction autografting and improved primary stability without compromising cortical integrity.

**Conclusion:** Osseodensification significantly improves peri-implant bone density and ridge width in both posterior maxillary and mandibular regions. While bone density gains were comparable between arches, ridge expansion was significantly greater in the maxilla. Osseodensification may represent an effective alternative to conventional osteotomy techniques for implant placement in compromised posterior sites.

## INTRODUCTION

Dental implant success largely depends on adequate bone quantity, bone quality, and primary implant stability. Following tooth extraction, progressive alveolar bone resorption results in a reduction in ridge dimensions and bone density, particularly during the early healing period, as reported by Schropp et al.[1] and Tan et al.[2] The posterior maxilla is especially challenging because of sinus pneumatization and poor bone quality (D3–D4), whereas the posterior mandible generally presents denser bone (D2–D3) but remains susceptible to ridge resorption and anatomical limitations.

Conventional osteotomy preparation is a subtractive procedure that removes bone during implant site preparation and may compromise primary stability. To overcome these limitations, Summers [3] introduced the osteotome technique; however, subsequent studies by Büchter et al.[4] and Stavropoulos et al.[5] reported potential drawbacks, including microfracture formation and impaired osseointegration.

Osseodensification, introduced by Huwais[6] in 2017, is a non-subtractive osteotomy preparation technique that utilizes Densah burs in reverse rotation to preserve, compact, and autograft bone along the osteotomy walls. This process increases bone density, improves bone-to-implant contact, and facilitates ridge expansion while maintaining the integrity of the surrounding bone.

Previous studies by Huwais et al.[7], Koutouzis et al.[8], and Aloorker et al.[9] have demonstrated improvements in implant stability, peri-implant bone density, and ridge expansion following osseodensification. However, limited evidence exists regarding its comparative effects in the posterior maxilla and mandible. Therefore, the present study aimed to evaluate and compare the effect of osseodensification on peri-implant bone density and ridge expansion in posterior maxillary and mandibular implant sites using CBCT assessment.

## MATERIALS & METHODS

An institution-based prospective comparative clinical study was conducted in the Department of Prosthodontics and Crown & Bridge, Regional Dental College, Guwahati, Assam, India, affiliated with Srimanta Sankaradeva University of Health Sciences. The study was carried out from August 2024 to January 2026. A total of 20 patients with partially edentulous posterior maxillary or mandibular sites requiring implant-supported prosthetic rehabilitation were recruited for the study. Written informed consent was obtained from all participants prior to enrollment, and patient selection was performed according to predefined inclusion and exclusion criteria.

**Inclusion criteria**

Individuals aged 18 years or older with partially edentulous posterior maxillary or mandibular regions requiring at least one dental implant, an edentulous period of at least three months following extraction, a minimum residual ridge width of 4 mm, and a residual bone height of at least 10 mm at the proposed implant site were included in the study.

**Exclusion criteria**

Patients with American Society of Anesthesiologists (ASA) physical status III or higher, immunocompromised conditions, pregnancy or lactation, parafunctional habits, active periodontal disease, poor oral hygiene, tobacco use, inadequate bone dimensions, or unwillingness to comply with follow-up visits were excluded from the study.

Participants were allocated into two groups according to implant location: Maxillary group (posterior maxilla) Mandibular group (posterior mandible)

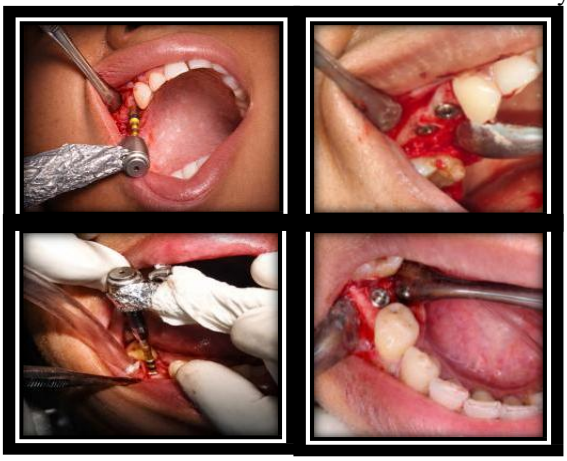
**Radiographic Assessment**

CBCT scans were obtained preoperatively, immediately after implant placement, and four months postoperatively. Bone density was recorded in Hounsfield units (HU), while ridge width was measured at:

- Crestal level
- 5 mm from crest
- 10 mm from crest

**Surgical Protocol**

Following local anesthesia and flap reflection, osteotomy preparation was initiated using pilot drills. Subsequent osteotomy preparation was performed using Densah burs in counterclockwise densifying mode with copious irrigation. A 4 × 10 mm implant was placed into a 3.5 × 10 mm osseodensified osteotomy. Standard postoperative medications and oral hygiene instructions were provided.



(a) (b)

**Figure1. Clinical workflow of osseodensification- assisted implant placement. (a) Sequential osteotomy preparation using Densah burs in densifying mode. (b) Implant placement following completion of osseodensification.**

**Data Collection**

Clinical and radiographic data were collected at three time intervals: preoperatively (baseline), immediately after implant placement, and four months postoperatively. A detailed clinical examination and CBCT assessment were performed for all participants before treatment. Bone density and ridge width measurements were obtained at the proposed implant site using CBCT images analyzed with BlueSkyPlan software (Version 5.0, USA).

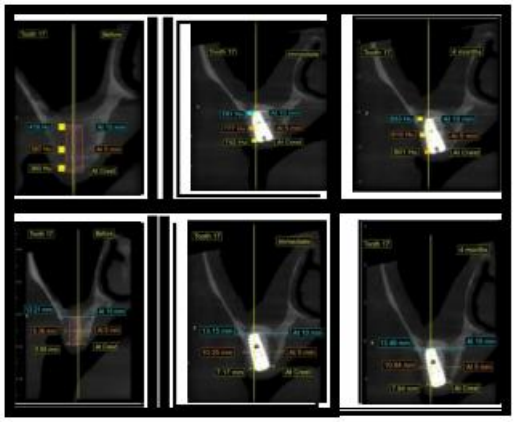
Bone density was assessed using grayscale values expressed in Hounsfield units (HU), while ridge width was measured in millimeters at the crestal level, 5 mm from the crest, and 10 mm from the crest. The same measurements were repeated immediately after implant placement and at the four-month follow-up visit to evaluate changes in peri-implant bone density and ridge expansion following osseodensification.

All measurements were performed using standardized imaging protocols to minimize measurement bias. The collected data were entered into Microsoft Excel and subsequently analyzed using SPSS software version 26.0 (IBM Corp., Armonk, NY, USA).

**Statistical Analysis**

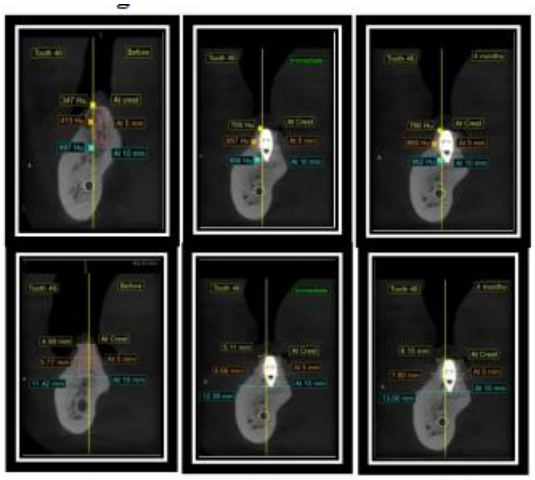
Data were analyzed using SPSS Version 26. Independent t-tests were used for inter-arch comparisons, while repeated-measures ANOVA and post hoc testing evaluated changes over time. Significance was set at $p<0.05$.

## RESULTS



(a) (b) (c)

**Figure 2. CBCT evaluation of a posterior maxillary implant site treated with osseodensification. (a) Preoperative CBCT image demonstrating reduced ridge width and baseline bone density at the planned implant site. (b) Immediate postoperative CBCT image showing implant placement with evidence of ridge expansion following osseodensification. (c) Four-month postoperative CBCT image demonstrating increased peri-implant bone density and maintenance of ridge dimensions.**



(a) (b) (c)

**Figure 3. CBCT evaluation of a posterior mandibular implant site treated with osseodensification. (a) Preoperative CBCT image demonstrating baseline ridge width and bone density at the implant site. (b) Immediate postoperative CBCT image showing implant placement and ridge expansion achieved using osseodensification. (c) Four-month postoperative**

CBCT image demonstrating increased peri-implant bone density and preservation of alveolar ridge dimensions.

Comparison of Bone Density Between Maxillary and Mandibular Implant Sites

Peri-implant bone density increased progressively in both the maxillary and mandibular implant sites following osseodensification. Although the mandible demonstrated higher mean bone density values than the maxilla at all time intervals, the differences were not statistically significant at the crestal, 5-mm, or 10-mm levels ($p > 0.05$) (Table 1).

**Table 1. Comparison of Bone Density (HU) Between Maxillary and Mandibular Implant Sites at Different Time Intervals**

| TIME | Bone density | ARCH | Mean | Std. Deviation | T value | pvalue |
|---|---|---|---|---|---|---|
| PRE-OP | At crest (mm) | MAXILLA | 274.30 | 77.264 | -2.036 | .057 |
| | | MANDIBLE | 366.30 | 120.166 | | |
| | 5mm | MAXILLA | 391.80 | 137.160 | -.250 | .80 |
| | | MANDIBLE | 406.30 | 121.434 | | |
| | 10 mm | MAXILLA | 444.80 | 137.587 | -.195 | .84 |
| | | MANDIBLE | 456.60 | 132.663 | | |
| immediate | At crest (mm) | MAXILLA | 650.80 | 140.229 | -1.572 | .13 |
| | | MANDIBLE | 733.40 | 89.070 | | |
| | 5mm | MAXILLA | 749.50 | 84.276 | -.102 | .92 |
| | | MANDIBLE | 753.50 | 90.923 | | |
| | 10 mm | MAXILLA | 760.10 | 91.105 | -.069 | .94 |
| | | MANDIBLE | 762.60 | 70.631 | | |
| 4 months | At crest (mm) | MAXILLA | 781.20 | 65.192 | -1.581 | .13 |
| | | MANDIBLE | 825.80 | 60.908 | | |
| | 5mm | MAXILLA | 823.50 | 53.232 | -.445 | .66 |
| | | MANDIBLE | 835.00 | 62.048 | | |
| | 10 mm | MAXILLA | 831.50 | 57.157 | -1.420 | .17 |
| | | MANDIBLE | 870.00 | 63.944 | | |

Test used- independent t test, $p>0.05$statistically insignificant

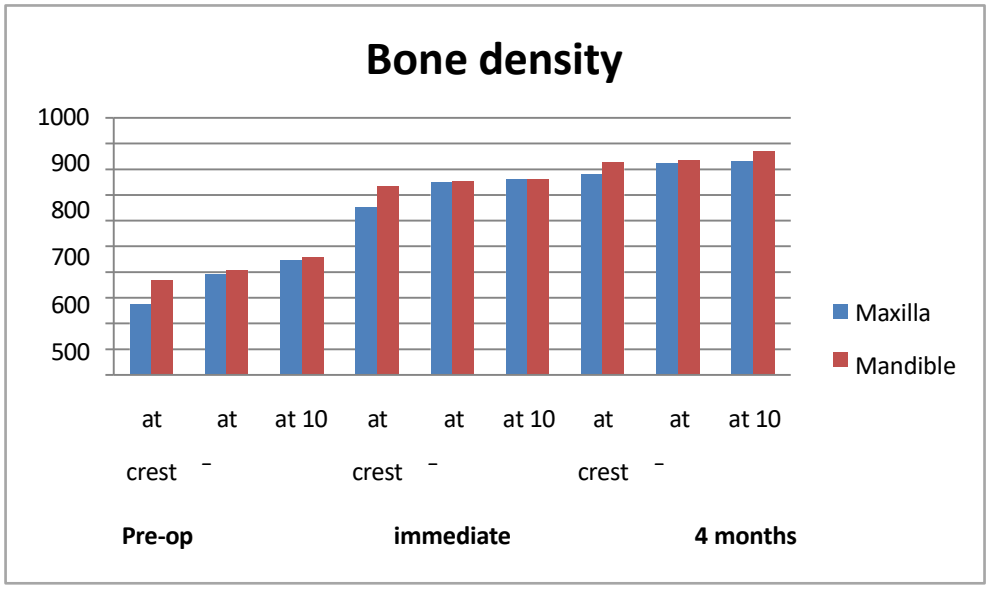



**Figure 4. Changes in peri-implant bone density following osseodensification. Graphical representation of mean bone density values (HU) measured at the crestal, 5-mm, and 10-mm levels in the maxillary and mandibular groups at baseline, immediate postoperative, and four-month follow-up intervals. Both groups demonstrated a progressive increase in peri-implant bone density following osseodensification.**

Comparison of Ridge Width Between Maxillary and Mandibular Implant Sites

Ridge width increased significantly in both arches following osseodensification. The maxilla demonstrated significantly greater crestal ridge expansion than the mandible immediately after implant placement ($p = 0.010$) and at the four-month follow-up ($p = 0.008$). No statistically significant inter-arch differences were observed at the 5-mm and 10-mm levels ($p > 0.05$) (Table 2).

**Table 2. Comparison of Ridge Width (mm) Between Maxillary and Mandibular Implant Sites at Different Time Intervals**

| TIME | RIDGE WIDTH | ARCH | Mean | Std. Deviation | T value | pvalue |
|---|---|---|---|---|---|---|
| PRE-OP | At crest (mm) | MAXILLA | 7.610 | 1.9035 | 1.761 | .09 |
| | | MANDIBLE | 6.250 | 1.5299 | | |
| | 5mm | MAXILLA | 8.580 | 2.1337 | 1.012 | .32 |
| | | MANDIBLE | 7.740 | 1.5284 | | |
| | 10 mm | MAXILLA | 9.850 | 2.1809 | .240 | .81 |
| | | MANDIBLE | 9.610 | 2.2869 | | |
| immediate | At crest (mm) | MAXILLA | 9.970 | 2.0483 | 2.715 | .01* |
| | | MANDIBLE | 7.810 | 1.4609 | | |
| | 5mm | MAXILLA | 10.780 | 2.2024 | 1.928 | .070 |
| | | MANDIBLE | 9.150 | 1.5160 | | |
| | 10 mm | MAXILLA | 12.210 | 2.2811 | 1.222 | .23 |
| | | MANDIBLE | 11.020 | 2.0687 | | |
| 4 months | At crest (mm) | MAXILLA | 10.750 | 2.1864 | 3.0 | .008* |
| | | MANDIBLE | 8.330 | 1.3141 | | |
| | 5mm | MAXILLA | 11.680 | 2.2675 | 1.900 | 0.07 |
| | | MANDIBLE | 10.020 | 1.5796 | | |
| | 10 mm | MAXILLA | 13.100 | 2.3500 | 1.210 | 0.23 |
| | | MANDIBLE | 11.920 | 2.2389 | | |

Test used- independent t test, $p>0.05$statistically insignificant , $p^*< 0.05$ significant

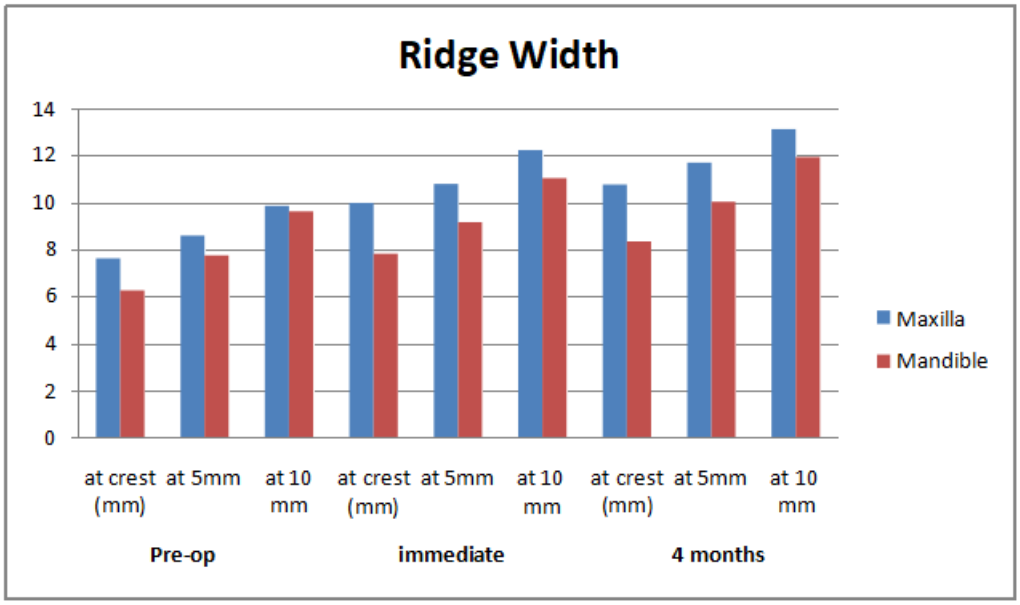



**Figure 5.Changes in ridge width following osseodensification.**
**Graphical representation of mean ridge width (mm) measured at the crestal, 5-mm, and 10-mm levels in the maxillary and mandibular groups at baseline, immediate postoperative, and four-month follow-up intervals. Greater ridge expansion was observed in the maxilla, particularly at the crestal level.**

Overall, osseodensification resulted in substantial improvements in peri-implant bone density and ridge width in both arches. While bone density changes were comparable between the maxilla and mandible, ridge expansion was more pronounced in the maxilla, particularly at the crestal level.

## DISCUSSION

The present study evaluated the effect of osseodensification on peri-implant bone density and ridge expansion in posterior maxillary and mandibular implant sites. The findings demonstrated a significant increase in bone density and ridge width in both arches following osseodensification.

The increase in peri-implant bone density observed in the present study supports the concept of bone compaction and autografting associated with osseodensification. Similar findings have been reported by Huwais et al.[7], Hindi and Bede[10], Yeh et al.[11], Vaddamanu et al.[12],and Shilpi et al.[13], who demonstrated improved bone density and implant stability following densifying osteotomy preparation.

Although the mandible showed higher mean bone density values than the maxilla, no statistically significant inter-arch differences were observed. This suggests that osseodensification effectively enhances bone quality irrespective of the initial bone density, which is consistent with the findings of Vaddamanu et al.[12].

Ridge width increased significantly in both arches after osseodensification. These findings are in agreement with studies by Koutouzis et al.[8], Mohamed et al.[14], Salman and Bede[15], and Zeid et al.[16], who reported significant ridge expansion following osseodensification-assisted implant site preparation.

A notable finding of the present study was the significantly greater crestal ridge expansion observed in the maxilla compared with the mandible. This may be attributed to the predominance of less dense trabecular bone in the maxilla, which is more amenable to plastic deformation during osseodensification. Similar observations have been reported by Koutouzis et al.[8]and Guner and Canacki[17].

Within the limitations of the study, the findings suggest that osseodensification is an effective technique for improving peri-implant bone density and ridge width, thereby facilitating implant placement in posterior maxillary and mandibular regions.

### Clinical Implications

Osseodensification may reduce the need for ridge augmentation procedures in moderately narrow ridges by allowing simultaneous ridge expansion during osteotomy preparation. The enhanced bone density may also improve primary implant stability and facilitate successful implant placement in compromised posterior regions.

### Limitations

The study had a relatively small sample size and a short follow-up period of four months. Implant stability quotient measurements and histologic evaluation were not performed.

Larger randomized controlled trials with long-term follow-up are recommended.

## CONCLUSIONS

Osseodensification significantly increases peri-implant bone density and ridge width in both posterior maxillary and mandibular implant sites.

The posterior maxilla demonstrated significantly greater ridge expansion than the mandible, whereas bone density gains were comparable between arches.

Osseodensification appears to be a predictable and minimally invasive technique for improving implant site quality and may be particularly advantageous in low-density posterior bone.

### Conflict of Interest

The authors declare no conflict of interest.

### Funding

No external funding was received for this study.

### Ethics Statement

Institutional ethical approval was obtained prior to commencement of the study, and informed consent was obtained from all participants.

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