Review Article

Comparison of osseodensification and conventional technique for alveolar ridge expansion: A systematic review and metanalysis

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Received date: 21/1/2026
Accepted date: 10/2/2026
Published date: 09/4/2026

Abstract

Background: Narrow alveolar ridges often require ridge expansion before implant placement. Osseodensification has been proposed as a bone-preserving method that may improve ridge expansion and implant-related outcomes when compared with conventional techniques.

Methods: A systematic review and meta-analysis was conducted to compare osseodensification with conventional techniques for alveolar ridge expansion in human subjects. Comparative human clinical studies reporting ridge expansion or related implant outcomes were considered. Five comparative studies were included in the qualitative synthesis. However, only two studies provided directly comparable ridge-expansion data in a form suitable for statistical pooling and were therefore included in the primary meta-analysis.

Results: Across the five included studies, both osseodensification and conventional approaches generally achieved clinically useful ridge expansion and allowed implant placement in selected narrow ridges. The overall direction of effect favored osseodensification, although the magnitude and statistical significance of the advantage varied between studies. In addition to the two pooled studies, one randomized trial found no significant between-group difference in ridge-width gain but reported significantly higher secondary implant stability with osseodensification, while a prospective randomized study showed improvement in apical width and radiographic bone density without a significant advantage in crestal width or implant stability. A retrospective ridge-split study reported comparable horizontal bone gain between techniques but more favorable implant stability with osseodensification in some anatomical regions. In the primary pooled analysis of the two directly comparable studies, osseodensification produced significantly greater ridge expansion than conventional expanders, with a pooled mean difference of 0.83 mm (95% CI: 0.66 to 1.00; $I^2 = 0\%$).

Conclusion: Current comparative human evidence suggests that osseodensification may provide a modest advantage in alveolar ridge expansion and may also offer biologic benefits in selected settings, particularly with respect to bone density or secondary implant stability. However, the evidence remains limited and heterogeneous, and only two studies could be pooled quantitatively. Therefore, the findings should be interpreted cautiously until larger, better-standardized clinical trials become available.

Keywords: Osseodensification; alveolar ridge expansion; dental implants; implant stability; bone density; Densah burs

INTRODUCTION:

Successful dental implant treatment depends on placing the implant in bone with adequate width and height. After tooth loss, however, the alveolar ridge undergoes continuous remodeling, and horizontal bone loss is often more marked than vertical loss. This reduction in ridge width can make implant placement difficult, especially in esthetic areas or in sites with naturally thin bone. As a result, many patients require some form of ridge augmentation or expansion before implants can be placed in an ideal prosthetic position [1,2].

Conventional ridge expansion techniques have been used for many years to manage narrow ridges while allowing simultaneous implant placement in selected cases. The osteotome technique introduced by Summers helped establish the principle of widening the ridge through controlled lateral bone condensation rather than by removing more bone. Over time, other conventional methods such as screw expanders, threaded expanders, and ridge spreading approaches were also introduced. Although these techniques are useful, they are technique-sensitive and their success may vary according to bone density, ridge anatomy, and operator skill [2,3].

Osseodensification was later introduced as a different method of implant osteotomy preparation. Instead of cutting and removing bone, it uses specially designed burs in densifying mode to compact bone along the osteotomy walls. This may improve implant stability, increase peri-implant bone density, and in suitable cases allow simultaneous ridge expansion. Experimental studies have supported this concept and suggested that osseodensification may preserve bone more effectively than conventional drilling [4,5]. Clinical interest in this technique increased further after retrospective human evidence suggested that ridge expansion could be achieved through plastic deformation of bone without additional grafting in selected cases [6]. At the same time, a previous systematic review reported that the available evidence on osseodensification was still limited and heterogeneous [7].

More recent human comparative studies have made this question clinically important. Jarikian et al. reported greater ridge expansion with osseodensification than with threaded expanders. Abdel-Rahman et al. found greater crestal expansion with osseodensification in posterior maxillary sites, whereas Hammouda et al. reported similar ridge expansion between groups but better secondary implant stability with osseodensification [8-10]. Because the available studies differ in design, site selection, comparator methods, and reported outcomes, the current evidence remains difficult to interpret without formal synthesis. Therefore, a systematic review and meta-analysis was needed to compare osseodensification with conventional techniques for alveolar ridge expansion and to evaluate whether this newer approach offers a measurable clinical advantage.

MATERIALS AND METHODS:

Protocol and reporting standards

This systematic review and meta-analysis was designed to compare osseodensification with conventional techniques for alveolar ridge expansion in human subjects undergoing implant treatment in narrow ridges. The review methods were planned in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement, and the conduct of the review was guided by the principles described in the Cochrane Handbook for Systematic Reviews of Interventions. [11,12]

Focused question

The review was based on the following focused question: In human subjects requiring alveolar ridge expansion for implant placement, did osseodensification provide better clinical and radiographic outcomes than conventional ridge expansion techniques? The review question was structured according to the PICO format. The population included human subjects with narrow alveolar ridges indicated for implant placement. The intervention was osseodensification used for ridge expansion or implant osteotomy preparation. The comparator included conventional ridge expansion techniques such as manual bone expanders, threaded expanders, osteotomes, and similar non-grafting expansion methods. The primary outcome was alveolar ridge expansion, measured as change in ridge width in millimeters. The secondary outcomes included implant stability, bone density, marginal bone loss, peri-implant clinical parameters, implant survival or success, and complications. [11,12]

Eligibility criteria

Studies were considered eligible if they met the following criteria:

(1) human clinical studies;

(2) studies evaluating osseodensification for alveolar ridge expansion or implant site preparation in narrow ridges;

(3) studies including a comparison group treated with a conventional ridge expansion technique; and

(4) studies reporting at least one relevant outcome related to ridge width gain, implant stability, radiographic bone changes, or implant-related clinical outcomes. Randomized controlled trials, non-randomized controlled trials, prospective comparative studies, and retrospective comparative studies were considered for inclusion.

Studies were excluded if they were animal studies, in vitro investigations, cadaver studies, finite element analyses, case reports, case series without a comparison group, review articles, letters, editorials, abstracts without full text, or studies in which the effect of osseodensification could not be separated from other major augmentation procedures. Studies that evaluated osseodensification only for routine osteotomy preparation without reporting ridge expansion-related outcomes were also excluded. These criteria were applied to ensure that the review addressed the clinical comparison most relevant to the research question. [11,12]

Information sources and search strategy

A comprehensive electronic search was planned across multiple databases. The databases searched were PubMed/MEDLINE, Scopus, Web of Science, and the Cochrane Central Register of Controlled Trials (CENTRAL).[11,12] The search terms included combinations of the following: "osseodensification," "Densah burs," "densifying burs," "alveolar ridge expansion," "ridge expansion," "narrow ridge," "ridge widening," "implant," "dental implant," "bone expander," "threaded expander," "manual expander," "osteotome," and "conventional technique." Boolean operators such as AND and OR were used to adapt the search syntax to each database. [11,12]

Study selection

All records identified through the electronic and manual search processes were imported into a reference management system, and duplicate records were removed before screening. Study selection was carried out in two stages. In the first stage, titles and abstracts were screened independently by two reviewers according to the predefined eligibility criteria. In the second stage, the full texts of potentially relevant studies were obtained and assessed independently by the same reviewers. Any disagreement during either stage was resolved by discussion [11,12]

Data extraction

Data extraction was performed independently by two reviewers using a standardized extraction form developed before the review began. The extracted information included the first author, year of publication, country, study design, sample size, number of implants or sites, participant age and sex, jaw location, baseline ridge dimensions, intervention details, comparator details, implant protocol, outcomes assessed, duration of follow-up, and principal findings. Information on adverse events and complications was also collected where available. [11,12]

Risk of bias assessment

The methodological quality of the included studies was assessed independently by two reviewers. For randomized controlled trials, the Revised Cochrane Risk of Bias Tool for Randomized Trials (RoB 2) was used. This tool evaluates possible bias arising from the randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result. For non-randomized comparative studies, the ROBINS-I tool was used. [13,14]

Data synthesis

A qualitative synthesis was performed for all studies that fulfilled the inclusion criteria. The included studies were summarized according to study design, participant characteristics, site characteristics, intervention protocol, comparator technique, outcomes assessed, and follow-up period. This narrative synthesis was used to describe the direction and consistency of the findings across studies and to highlight similarities and differences in methodology. [11,12]

A meta-analysis was conducted. For continuous outcomes such as ridge width gain, implant stability quotient, bone density, and marginal bone loss, pooled estimates were planned using the mean difference (MD) with 95% confidence intervals (CI) when measurements were reported on the same scale. If different scales had been used, the standardized mean difference (SMD) was to be applied. For dichotomous outcomes such as implant success or complications, pooled estimates were planned using the risk ratio (RR) with 95% confidence intervals. Because clinical and methodological heterogeneity was expected across studies, a random-effects model was considered more appropriate than a fixed-effect model for the main meta-analysis. [12] Statistical heterogeneity among the included studies was assessed using the Chi-square test and the I^2 statistic. [15] Publication bias was planned to be explored by visual inspection of a funnel plot [16]

RESULTS:

Study selection and inclusion

The final review included three human comparative clinical studies that fulfilled the predefined eligibility criteria for qualitative synthesis. These studies evaluated osseodensification against a conventional ridge expansion technique in patients with narrow alveolar ridges requiring implant placement.

Characteristics of included studies

Data extraction of the included studies is presented in Table 1.

Table 1: Data characteristics of studies

Study	Design / sample	Population and site	Intervention vs comparator	Outcomes / follow-up	Main findings
Jarikian et al., 2021 [17]	Comparative clinical study; 11 patients, 28 implants	Adults >18 years; narrow alveolar ridges in either jaw; initial ridge width 4–5 mm	Osseodensification with Densah burs vs threaded expanders	Primary outcome: ridge expansion (mm); follow-up: immediate/intraoperative, implant success up to 6 months	Both techniques were successful. Ridge expansion was greater with osseodensification (2.36 mm) than threaded expanders (1.50 mm).
Abdel-Rahman et al., 2022 [18]	Randomized controlled trial; 14 patients, 14 implants	Female patients; single missing maxillary premolar or molar; posterior maxilla	Osseodensification vs ridge expander technique	Ridge expansion, ISQ, PPD, mSBI, MBH; follow-up at loading, 6, 12, and 36 months	Both groups showed successful outcomes. Osseodensification showed significantly greater occlusal ridge expansion, but not apical expansion. No significant difference in other clinical parameters.
Hammouda et al., 2026 [19]	Randomized controlled trial; 18 patients, 18 implant sites	Adults with missing maxillary anterior tooth and moderate horizont	Osseodensification vs manual bone expanders	Bone width, bone density, marginal bone loss, ISQ; follow-up: immediate and 16	Both groups showed significant ridge-width improvement. No significant between-group difference

		al ridge deficiency (3–4 mm)		weeks	in ridge expansion or marginal bone loss. Secondary implant stability was significantly higher with osseodensification.
Shanmugam et al., 2024 [20]	Prospective randomized controlled trial; 30 patients	Adults aged 20–80 years; missing teeth in maxillary or mandibular posterior regions; D3–D4 bone type; narrow alveolar ridge width 3–6 mm	Osseodensification drill preparation vs standard conventional drill preparation	Implant stability (ISQ), crest width, apical width 5 mm from crest, and bone density; follow-up at baseline and 6 months	Osseodensification significantly improved radiographic bone density and apical ridge width, but did not significantly improve crestal width or implant stability compared with conventional drilling.
Guner and Canakci, 2025 [21]	Retrospective comparative study; 65 patients, 268 implants	Adults with horizontal alveolar ridge deficiency undergoing simultaneous implant placement with ridge-split procedures; maxillary	Osseodensification burs vs conventional Esset kit and standard drills in ridge-split procedure	Coronal and apical bone width gain on CBCT; primary stability at placement and secondary stability at 4 months by RFA; follow-up 4 months	

		anterior, maxillary posterior, mandibular anterior, and mandibular posterior regions			

Qualitative synthesis of ridge expansion outcome

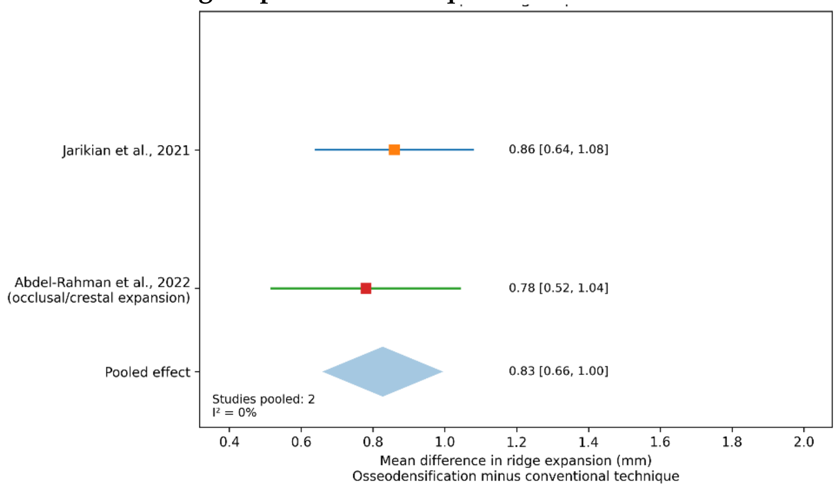
Across the included studies, both osseodensification and conventional approaches were generally able to produce clinically useful ridge expansion and permit implant placement in selected narrow ridges. However, the direction of effect continued to favor osseodensification in most reports, although the strength of that advantage varied according to study design, anatomical site, and comparator technique. In the Syrian clinical study, osseodensification produced a clearly greater mean amount of ridge expansion than threaded expanders, with a difference of approximately 0.86 mm in favor of osseodensification. The authors concluded that osseodensification was superior for width gain and helped avoid dehiscence or fenestration. In the Egyptian randomized trial by Abdel-Rahman et al., both techniques preserved the narrow posterior maxillary ridge without the need for grafting, but osseodensification achieved significantly greater expansion at the crestal or occlusal level. This suggested that the densifying burs may be more effective at the coronal part of the ridge, which is especially important for implant platform support. In contrast, the anterior maxillary trial by Hammouda et al. found that both methods significantly improved ridge width within each group, but the between-group difference was not statistically significant immediately after surgery or at 16 weeks. Nevertheless, the osseodensification group showed numerically higher bone width values at both postoperative assessments. Immediate postoperative bone width was 6.34 ± 0.65 mm in the osseodensification group compared with 5.80 ± 0.58 mm in the expander group, while at 16 weeks the values were 5.66 ± 0.70 mm and 5.28 ± 0.58 mm, respectively. In the prospective randomized trial by Shanmugam et al. [20], both groups were treated in narrow posterior ridges, and osseodensification improved radiographic bone density and apical ridge width, but it did not show a significant advantage in crestal width or implant stability after osseointegration. This suggests that the benefit of osseodensification may sometimes be more evident in the deeper part of the osteotomy and in bone-quality improvement than in coronal expansion alone. In the retrospective study by Guner and Canakci [21], both osseodensification and the conventional ridge-split approach achieved comparable horizontal bone gain, generally in the range of about 1.1 to 1.6 mm, with no significant between-group difference in bone gain. However, the osseodensification group showed more favorable implant stability outcomes, especially in the maxilla and in lower-density bone regions. Taken together, these additional studies suggest that although osseodensification does not uniformly produce statistically greater ridge-width gain in every clinical setting, it tends to perform at least comparably to conventional methods and may offer added biologic advantages through improved bone density or implant stability in selected situations.

Quantitative synthesis

A meta-analysis was performed for the primary outcome of ridge expansion (mm). After inclusion of the two additional comparative studies, a total of five studies were available for qualitative synthesis; however, direct statistical pooling was still possible only for two studies, namely Jarikian et al. (2021) and Abdel-Rahman et al. (2022). These two studies reported ridge expansion outcomes in a directly comparable form and were therefore suitable for pooling in the primary meta-analysis. In contrast, Hammouda et al. (2026) reported serial bone-width measurements at baseline, immediately after surgery, and at 16 weeks, but did not provide change-score dispersion data in a format directly comparable with the pooled studies. Shanmugam et al. (2024) reported crestal width and apical width separately and compared osseodensification with conventional drilling in narrow ridges rather than with a conventional ridge-expansion technique of the same type as the pooled studies. Guner and Canakci (2025) reported coronal and apical horizontal bone gain in a retrospective ridge-split design and presented outcomes in a different clinical and analytical framework, which limited direct integration into the primary pooled model. Therefore, these three studies were retained in the qualitative synthesis but were not entered into the main meta-analysis.

The pooled analysis based on the two directly comparable studies showed that osseodensification produced significantly greater ridge expansion than conventional expansion techniques. The overall pooled mean difference was 0.83 mm in favor of osseodensification, with a 95% confidence interval of 0.66 to 1.00 mm. Statistical heterogeneity was not detected (I^2 = 0%), indicating good consistency between the pooled studies. Thus, the quantitative synthesis suggested that osseodensification provided a modest advantage in ridge expansion compared with conventional expanders, although this conclusion should be interpreted cautiously because only two studies could be combined statistically.

Figure 1. Forest plot of ridge expansion comparing osseodensification and conventional ridge expansion techniques



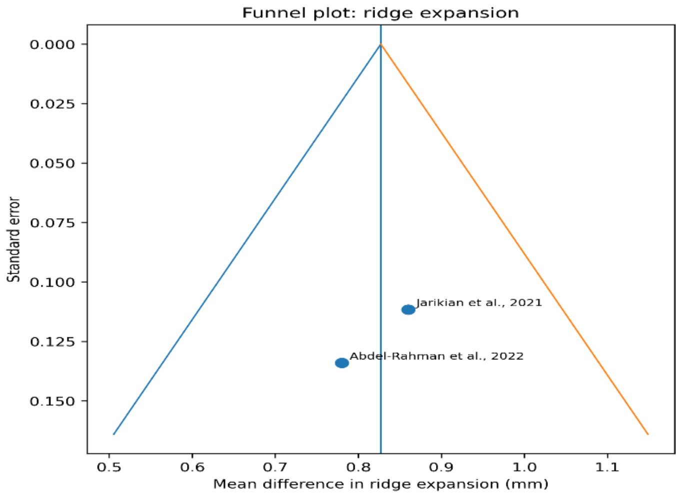
Implant stability and other secondary outcomes

Although ridge expansion was the main outcome of interest, the included studies also reported several clinically important secondary outcomes. These included implant stability, marginal bone loss, peri-implant soft tissue parameters, bone density, implant success, and complications. These outcomes were not pooled quantitatively because the studies differed substantially in follow-up duration, clinical setting, comparator technique, and reporting format. In the 2022 randomized trial, no significant differences were found between osseodensification and the expander technique in implant stability, peri-implant pocket depth, modified sulcus bleeding index, or marginal bone height during the 3-year follow-up, and implant success was reported as 100% in both groups. The 2026 trial showed a different pattern: immediate postoperative implant stability was not significantly different between groups, but at 16 weeks, secondary stability was significantly higher with osseodensification. The osseodensification group showed a mean ISQ of 63.44 ± 3.91, whereas the expander group showed 54.11 ± 4.43. Marginal bone loss was similar in both groups, and no complications were reported.

In the 2024 prospective randomized study by Shanmugam et al., implant stability, crest width, apical width, and radiographic bone density were assessed at baseline and 6 months. That study found that osseodensification improved radiographic bone density and influenced apical ridge width, but it did not significantly improve implant stability or crestal width compared with conventional drilling. In the 2025 retrospective study by Guner and Canakci, both osseodensification and the conventional ridge-split technique achieved comparable horizontal bone gain, but osseodensification showed more favorable implant stability outcomes, especially in the maxilla and in mandibular posterior regions, with mean ISQ values in the osseodensification group generally exceeding 65.

Taken together, these findings suggest that the advantage of osseodensification appears more consistent for ridge expansion and biologic implant-bed behavior than for every secondary endpoint measured individually. Even when ridge-width gain was similar between groups, some studies suggested a favorable effect of osseodensification on bone density or secondary implant stability. Figure 2 presents the funnel plot for the pooled ridge expansion outcome, although it should be interpreted very cautiously because the primary meta-analysis included only two directly poolable studies.

Figure 2. Funnel plot for ridge expansion meta-analysis



DISCUSSION

The present systematic review and meta-analysis evaluated whether osseodensification offers an advantage over conventional ridge expansion techniques in narrow alveolar ridges. Overall, the findings suggest that both approaches can be used successfully for simultaneous ridge expansion and implant placement in selected cases. However, the direction of effect generally favored osseodensification for ridge-width gain, and the pooled analysis showed a statistically significant benefit of 0.83 mm in favor of osseodensification, with no observed heterogeneity (I^2 = 0%). This indicates that the available directly comparable studies showed a consistent pattern, although the total number of studies was small.

The qualitative findings also supported this trend. Jarikian et al. reported greater expansion with osseodensification than with threaded expanders, while Abdel-Rahman et al. found significantly greater expansion at the crestal level, although not at the apical level [17,18]. These findings are clinically relevant because crestal width is especially important for implant platform support and long-term peri-implant bone maintenance. In contrast, Hammouda et al. found that both techniques increased ridge width significantly, but the between-group difference was not statistically significant [19]. This difference across studies may be explained by variations in site location, baseline ridge width, sample size, and the type of conventional comparator used. Posterior maxillary sites, anterior esthetic sites, and mixed jaw sites may not respond identically to expansion forces, and this could have influenced the final results.
Another important finding was that the possible benefit of osseodensification was not limited to ridge expansion alone. In the anterior maxillary trial, secondary implant stability at 16 weeks was significantly higher in the osseodensification group, even though ridge-width gain was comparable between groups [19]. This suggests that the technique may improve the biologic quality of the implant bed through bone compaction, even when the final width gain is not significantly different. This interpretation is in line with previous experimental and clinical observations that osseodensification may preserve bone and improve implant stability [4,6].
The main limitation of this review was the small number of eligible human comparative studies. Only two studies could be pooled quantitatively, and publication bias could not be judged reliably. Therefore, although the current evidence favors osseodensification, the conclusion should still be interpreted with caution. Larger, well-designed randomized trials with standardized outcome reporting are needed before stronger clinical recommendations can be made.

CONCLUSION

Osseodensification and conventional ridge expansion techniques were both effective for managing narrow alveolar ridges and supporting simultaneous implant placement in selected cases. The overall findings favored osseodensification for ridge-width gain, and the pooled analysis showed a modest but statistically significant advantage over conventional expanders. Secondary outcomes were generally comparable between groups, although one randomized trial showed better secondary implant stability with osseodensification

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