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ORIGINAL ARTICALE

COMPARATIVE EVALUATION OF BOVINE DERIVED XENOGRAFTS (BIO-OSS) AND DEMINERALIZED BONE MATRIX (OSSEOGRAFT) IN POST-EXTRACTION RIDGE PRESERVATION: A CBCT-GUIDED CLINICAL TRIAL.

Varun batra [1], Jaiganesh Ramamurthy [1*]
[1] Department of Periodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu.
***Corresponding author:** Jaiganesh Ramamurthy Department of Periodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences,Saveetha University, Chennai, Tamil Nadu. +91-9840443463 mailto:jaiganeshr@saveetha.com

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ABSTRACT

Objective: To compare the effectiveness of Dimineralised Bone Matrix (Osseograft) and Bio-Oss in preserving alveolar ridge dimensions following tooth extraction, using Cone Beam Computed Tomography (CBCT).
Materials and Methods: This randomized controlled trial included 30 extraction sockets. 20 Participants were randomized into two groups: the Osseograft group and the Bio-Oss group. Following Atraumatic extraction, the respective graft material was placed in the socket. Immediately after extraction, socket dimensions were measured both bucco-lingually and mesio-dismally and then CBCT scans were conducted 3 months post-extraction. The primary outcomes measured were changes in socket dimensions and horizontal bone width.
Results: Bio-Oss group showed statistically significant gains in both bucco-lingual (0.54 ± 0.20 mm) and mesio-distal (0.38 ± 0.15 mm) dimensions (p < 0.001), while Osseograft showed minimal change, significant only in mesio-distal width (p = 0.033).
Conclusion: Bio-Oss showed superior performance in maintaining alveolar ridge dimensions compared to Osseograft, suggesting it may be a more effective material for socket preservation. Further studies with larger sample sizes and longer follow-up periods are recommended to validate these

Keywords*:* Alveolar ridge, Bio-Oss, Bone graft, CBCT, Osseograft, Socket preservation

1.INTRODUCTION

After tooth extraction, the alveolar ridge undergoes rapid remodeling that can significantly reduce bone volume and alter ridge architecture. Studies report that approximately 50% of alveolar bone width may be lost within the first year after extraction, with the majority of resorption occurring within the first 3 to 6 months.[1-3] Resorption is typically greater in the horizontal dimension (especially the buccal plate) than in the vertical dimension, resulting in a narrower, lower ridge profile.[4,5] Such post-extraction atrophy is clinically significant: it can hinder ideal implant placement and compromise prosthetic and aestheticoutcomes. Accordingly, clinicians often perform socket preservation (alveolar ridge preservation, ARP) at the time of extraction to mitigate bone loss and preserve ridge dimensions for future implant rehabilitation.[6] Socket preservation involves placing a bone graft into the fresh extraction socket and often covering it with a barrier membrane to stabilize the material.[7] This approach promotes bone fill in the socket while limiting external ridge resorption. Common graft materials include autografts, which are the patient's own bone, providing live osteogenic cells but limited in quantity and requiring a donor site; allografts, which are cadaveric human bone, serving as an osteoconductive scaffold with some osteoinductive potential and no second surgical site; xenografts, derived from animals such as bovine, serving as a slowly resorbing osteoconductive framework; and alloplasts, which are synthetic materials like tricalcium phosphate and

hydroxyapatite that act as inert scaffolds for bone ingrowth.[8,9] Clinical evidence indicates that grafting extraction sites, whether with or without membranes, significantly preserves more ridge width and height compared to ungrafted healing.[10] For example, preserved sockets tend to lose around 2 mm less horizontal width and 1 mm less vertical height than natural healing sockets.[11] Despite the variety of available materials, no single graft type has proven to be definitively superior for alveolar ridge preservation in all cases.[12] Each type has its own advantages and drawbacks: autografts are osteogenic but require a donor site, whereas xenografts and slowly resorbing allografts tend to better maintain ridge volume by resisting resorption.[12]

Xenogeneic bone substitutes are widely used in ARP due to their availability and reliable performance. Bio-Oss (Geistlich) is a deproteinized bovine bone mineral (DBBM) that is a well-studied xenograft in periodontology and implant dentistry.[13] It provides an osteoconductive mineral scaffold derived from bovine bone, which gradually integrates with newly forming bone. Bio-Oss particles resorb very slowly and often remain at the site in the long term, supporting the maintenance of ridge volume as native bone fills the socket.[14] Histologic studies confirm that new bone forms in close contact with residual Bio-Oss particles, demonstrating the biocompatible incorporation of the particles into the healing bone.[15] Osseograft (Advanced Biotech) is another xenograft consisting of demineralized bovine bone matrix enriched with collagen.[16] Retaining the organic matrix gives Osseograft an osteoinductive potential in addition to osteoconductivity. It is designed to fully resorb, gradually being replaced by the patient's own bone during healing.[16] Osseograft has shown favorable results in periodontal regeneration; however, its application for socket preservation is less well-documented than that of Bio-Oss. Little published data is available comparing these two xenografts' performance in preserving extraction socket bone. Accurate evaluation of post-extraction ridge changes is critical for assessing socket preservation outcomes. Traditional methods (2D radiographs or calipers) are often imprecise, whereas cone-beam computed tomography (CBCT) provides three-dimensional, high-resolution imaging for ridge assessment.[17] Pre-operative and post-operative CBCT scans enable clinicians to quantify alveolar ridge width and height changes precisely and to visualize socket healing in cross-section. [18] CBCT can detect subtle dimensional changes that may be missed on planar radiographs, providing standardized, objective data for comparing different graft materials.[19] Accordingly, CBCT is increasingly employed in ARP research, as it enables the quantitative evaluation of treatment efficacy to inform evidence-based decision-making.[20] Despite the popularity of xenografts like Bio-Oss and the emergence of newer materials like Osseograft, the comparative performance of these materials in socket preservation remains unclear. Current literature largely reports on grafted versus ungrafted sockets or on broad material classes. A focused search of Scopus and PubMed revealed no clinical trials to date directly comparing Bio-Oss and Osseograft with CBCT outcomes. Such head-to-head studies on specific graft products are notably scarce in the published literature. This lack of direct evidence makes it uncertain whether one xenograft offers any significant advantage over the other in preserving socket bone for subsequent implant placement. Therefore, the present study aims to address this gap by comparing socket preservation outcomes with Bio-Oss versus Osseograft, using CBCT-based measurements of post-extraction ridge dimensions. The findings will provide clinicians and researchers with objective data on the relative efficacy of these two xenografts, supporting evidence-based graft selection for alveolar ridge preservation in clinical practice.

2. MATERIALS AND METHODS

With approval from the local ethics committee and using a research approval number of CTRI/2024/11/076550, a preliminary, randomized, controlled, parallel-group study was conducted between December 2023 and June 2024. Both written consent and the full protocol were explained to the patients. The research involved 30 extraction sockets from 20 patients selected from different clinics of Saveetha Dental College.Patients were selected according to specific criteria

Inclusion criteria:

- Endodontically non restorable teeth indicated for extraction
- Periodontitis affected teeth with grade III mobility
- Teeth indicated for extraction due to trauma

Exclusion criteria:

- Patients with uncontrolled systemic conditions like diabetes, hypertension, bleeding disorders
- Pregnant women,
- Patients having smoking habit
- Patients taking medications that impair healing, such as bisphosphonates orimmunosuppressants, pose significant challenges for dental procedures.
- Teeth exhibiting more than 50% dehiscence on the buccal or lingual wall.

2.1 Sample Size Calculation

Sample size estimation was performed using G*Power software (version 3.1.9.7). Based on preliminary data, the expected effect size for bucco-lingual dimensional change between Bio-Oss and Osseograft groups was 1.70 (Cohen's d), with a significance level (α) of 0.05 and power (1−β) of 0.95. The calculated minimum sample size required per group was 13 sockets. To account for potential dropouts and ensure adequate power, 15 sockets per group were included, totaling 30 sockets for the study.

2.2 Randomization

Extraction sockets were randomly divided into two equal groups using computer generated codes for both the groups. Grouping: Thirty extraction sockets from 20 participants were randomly assigned to two groups:
Group (I): 15 extraction sockets were filled with Bio-OSS
Group (II): 15 extraction sockets were filled with Osseograft

2.3 Material used:

Bovine derived xenograft (Bio-Oss) is a relatively new material used in periodontal regeneration. It is prepared through protein extraction from bovine bone, resulting in a structure similar to human cancellous bone and the ability to enhance bone formation. Demineralized bone matrix (Osseograft) - It is a sterile, bioresorbable bovine bone made of type I collagen. Prepared from bovine cortical bone with a particle size of approximately 250 µm, it is completely replaced by host bone in 5–6 months.

2.4 Procedure

Atraumatic tooth extraction was performed in patients with periodontally compromised or unrestorable teeth exhibiting grade 3 mobility. After extraction, all granulation tissue was removed, and the socket was thoroughly irrigated. Both the mesio-distal and bucco-lingual dimensions of the socket were measured using William's probe. In Group 1, Bio-Oss bone graft was used, while Osseograft was applied in Group 2. Both were carefully packed into the extraction socket before achieving primary closure (Fig 1 and 3). After three months, CBCT scans were taken to evaluate the amount of bone formed in both groups and to compare which bone graft better preserved the socket post-extraction as shown in (Fig 2 and Fig 4)

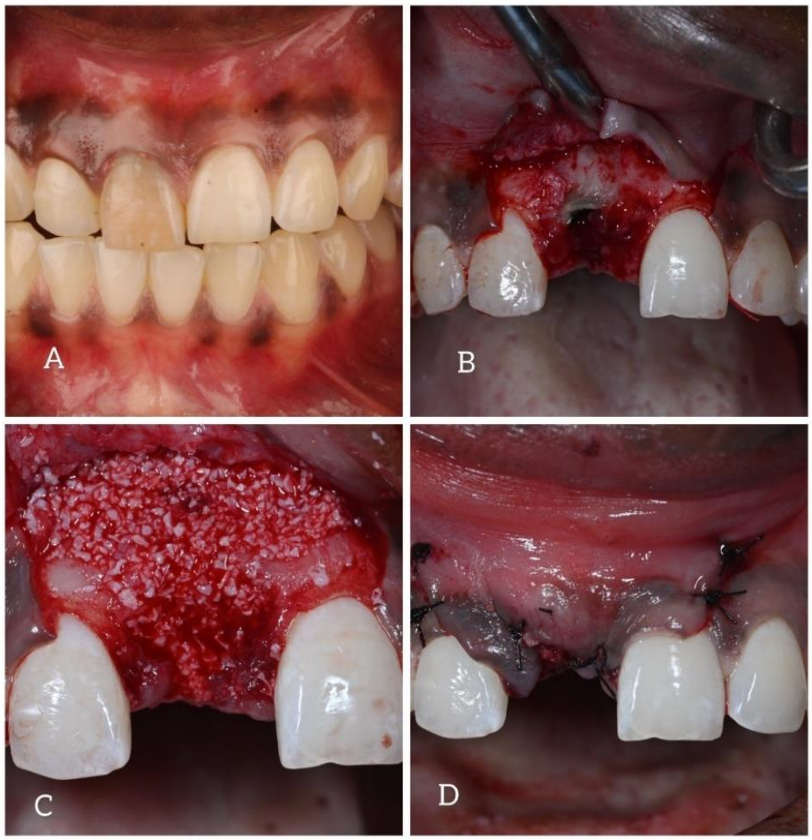

Figure 1. (a) Pre op (b) Intra op (c) Bio-Oss bone graft was placed in the extracted socket 11 (d) Primary closure was achieved

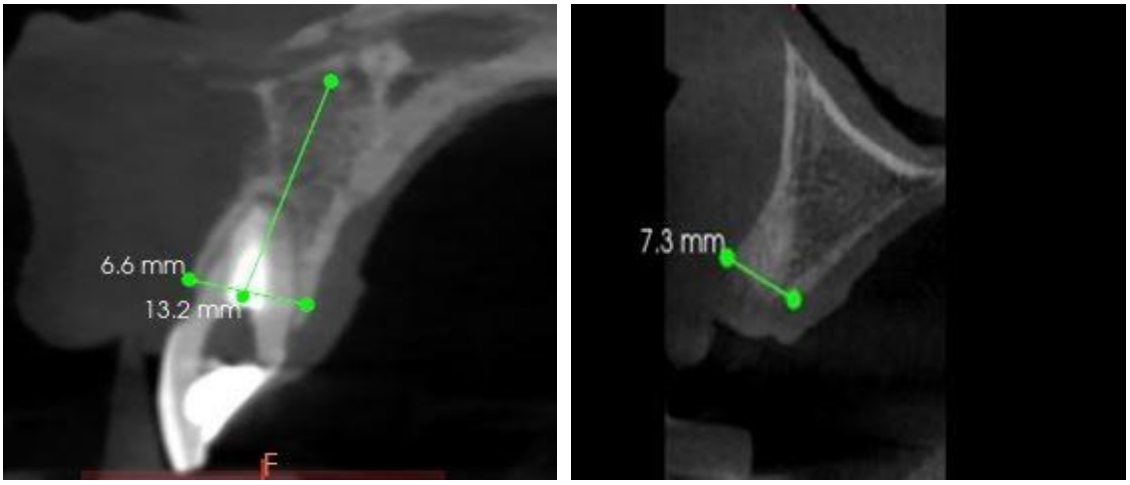

Figure 2 (a)Pre-extraction CBCT (b) CBCT after 3 months

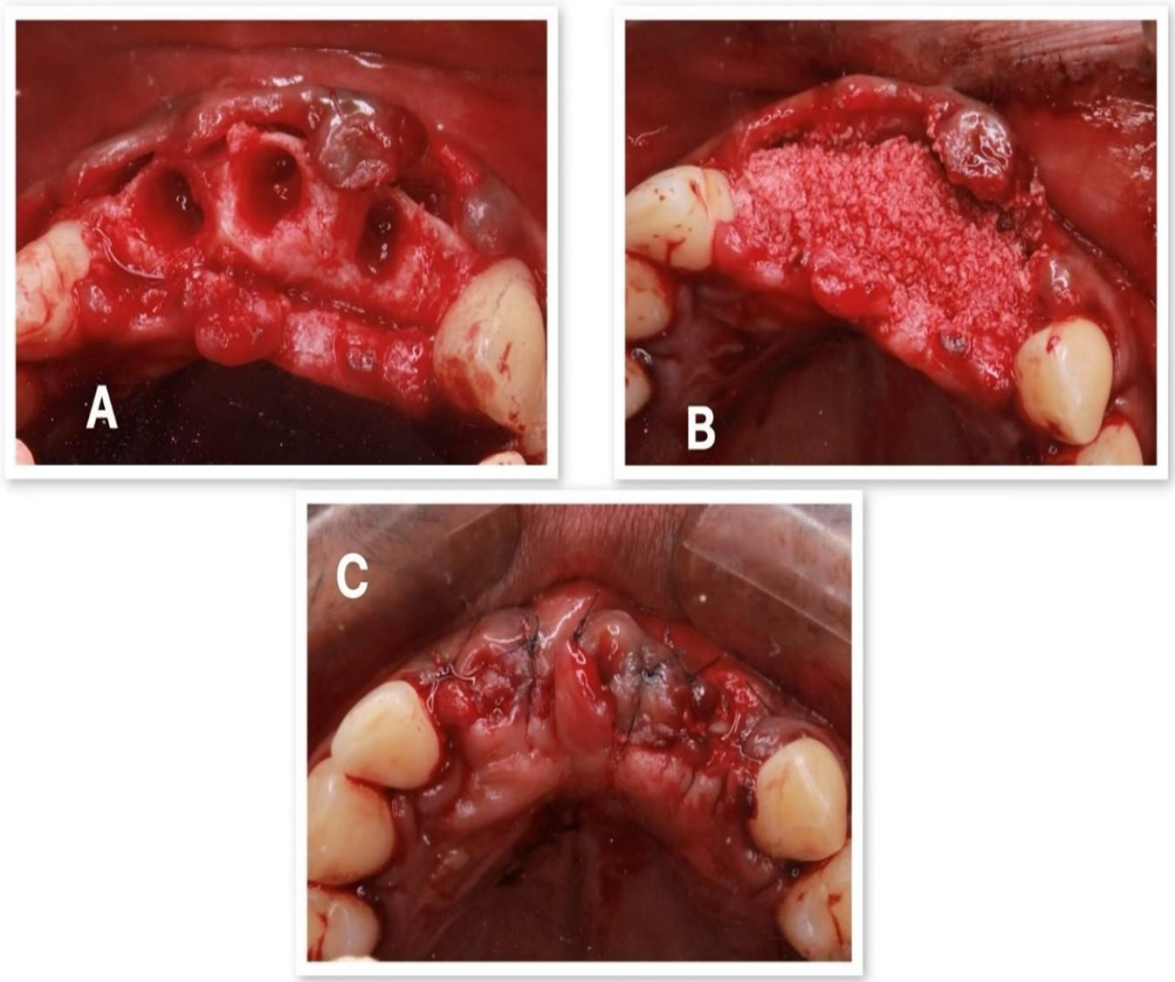

Figure 3. (a) extraction sockets (b) Osseograft was placed in the extraction sockets. (c) Primary closure was achieved.

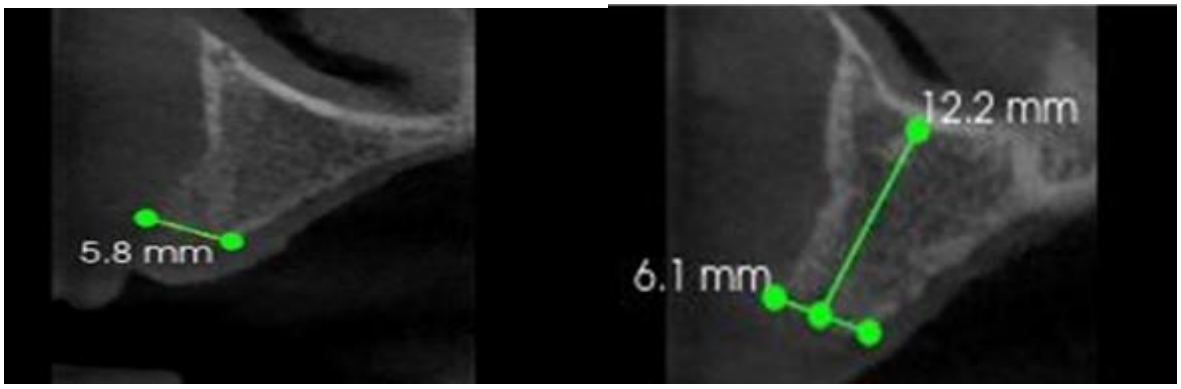

Figure 4 (a)Post-extraction CBCT. (b) after 3 months

2.5 Statistical Analysis

The collected data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 25.0. Descriptive statistics were computed and expressed as mean ± standard deviation (SD). To assess intra-group differences in socket dimensions (bucco-lingual and mesio-distal) from baseline to 3 months, paired *t*-tests were applied. Inter-group comparisons between the Bio-Oss and Osseograft groups were evaluated using independent *t*-tests. A *p*-value of < 0.05 was considered statistically significant.

Group1

Measurements of sockets –

- Bucco-lingual width- 6.6 mm
- Mesio-Distal width- 7.3mm

Group 2

Measurements of sockets -

- Bucco-lingual width- 5.8mm
- Mesio-Distal width- 7.2mm

3. RESULTS

In this randomized controlled trial, a total of 30 extraction sockets were analyzed—15 in the Bio-Oss group and 15 in the Osseograft group—to evaluate and compare post-extraction ridge preservation. In the Bio-Oss group, the mean bucco-lingual dimension increased from 5.58 ± 0.39 mm to 6.12 ± 0.38 mm, and the mean mesio-distal dimension increased from 6.85 ± 0.36 mm to 7.23 ± 0.31 mm after 3 months (table 1). These changes were statistically significant with $p < 0.001$, indicating effective socket preservation. In contrast, the Osseograft group showed a marginal and statistically non-significant change in bucco-lingual width from 5.18 ± 0.49 mm to 5.26 ± 0.45 mm ($p = 0.274$), while the mesio-distal width increased from 7.05 ± 0.57 mm to 7.31 ± 0.50 mm, which was statistically significant ($p = 0.033$) (table 1). When comparing the dimensional changes between the two groups (table 2), Bio-Oss demonstrated significantly greater gains. The mean change in bucco-lingual width was 0.54 ± 0.20 mm for Bio-Oss compared to 0.08 ± 0.32 mm for Osseograft ($p < 0.001$), while the mesio-distal change was 0.38 ± 0.15 mm versus 0.26 ± 0.23 mm, respectively ($p = 0.003$).

These findings suggest that Bio-Oss is superior to Osseograft in preserving both bucco-lingual and mesio-distal socket dimensions post-extraction.

Intra-group analysis (Table 1) indicated that Bio-Oss showed significant preservation of both bucco-lingual and mesio-distal ridge dimensions over 3 months ($p < 0.001$), while Osseograft showed a significant change only in mesio-distal width ($p = 0.033$).Inter-group analysis (Table 2) revealed that Bio-Oss demonstrated significantly greater dimensional preservation compared to Osseograft for both bucco-lingual ($p < 0.001$) and mesio-distal widths ($p = 0.003$), indicating superior performance of Bio-Oss in maintaining alveolar ridge dimensions post-extraction.

Below, the bar diagram (Fig 5) compares the preservation in bucco-lingual and mesio-distal dimensions for Bio-Oss and Osseograft, emphasizing Bio-Oss's superior performance in socket preservation.

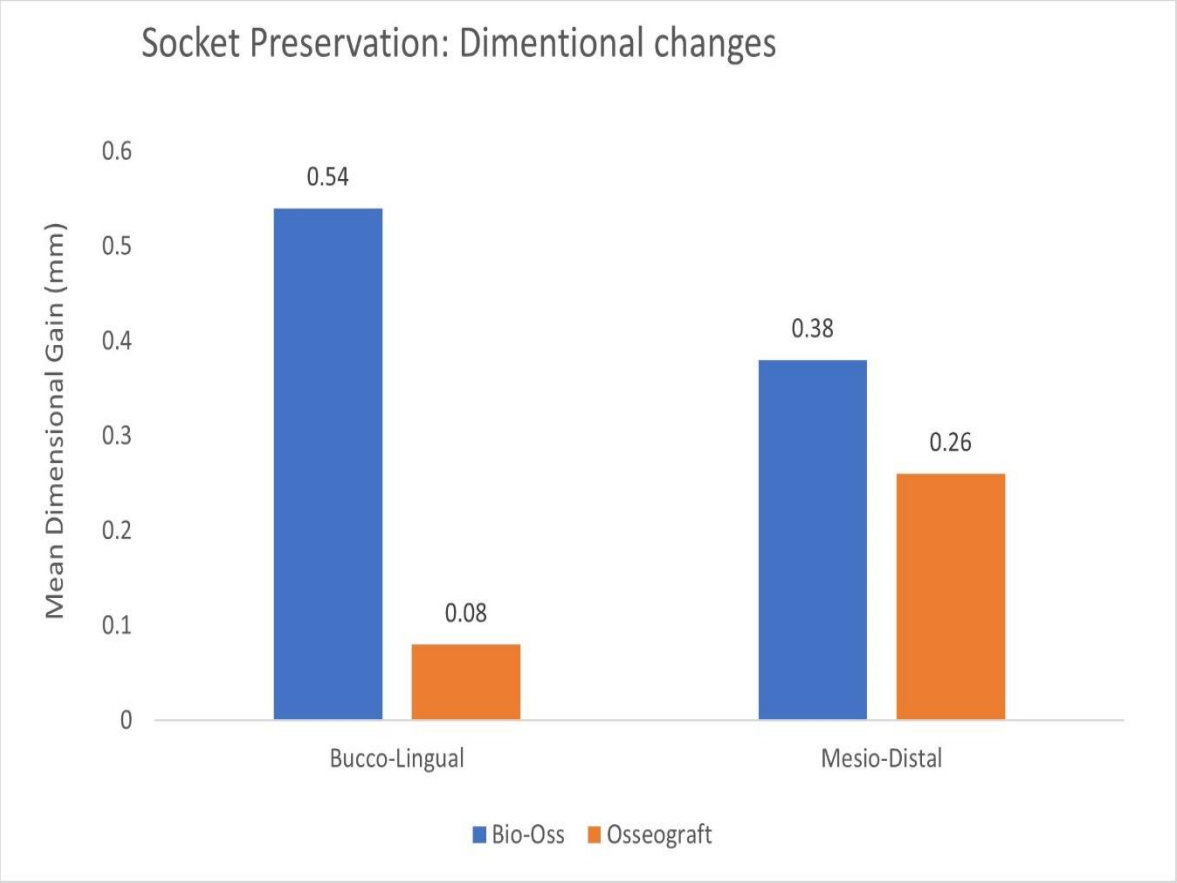

Figure 5. Bar graph comparing post-extraction changes in bucco-lingual and mesio-distal widths between Bio-Oss and Osseograft groups

These findings suggest that Bio-Oss may be more effective for socket preservation after extraction, as it better maintains alveolar ridge width, which is essential for future implant placement and aesthetic outcomes. Further studies with larger sample sizes and extended follow-up are recommended to confirm these findings and guide clinical decisions.

Table 1. Dimensional Changes Within Groups (in mm)

Group	Dimension	Pre-op (Mean ± SD)	Post-op (Mean ± SD)	Mean Gain (mm)	*p*-value
Bio-Oss	Bucco-Lingual	5.58 ± 0.39	6.12 ± 0.38	0.54	<0.001
	Mesio-Distal	6.85 ± 0.36	7.23 ± 0.31	0.38	<0.001
Osseograft	Bucco-Lingual	5.18 ± 0.49	5.26 ± 0.45	0.08	0.274
	Mesio-Distal	7.05 ± 0.57	7.31 ± 0.50	0.26	*0.033*

Table 2. Inter-group Comparison (Post-op Dimensional Gain)

Dimension	Bio-Oss (Mean ± SD)	Osseograft (Mean ± SD)	*p*-value
Bucco-Lingual	0.54 ± 0.20	0.08 ± 0.32	<0.001
Mesio-Distal	0.38 ± 0.15	0.26 ± 0.23	0.003

DISCUSSION

Preservation of the alveolar ridge following tooth extraction remains a fundamental objective in modern periodontal and implant therapy. In the present randomized controlled clinical trial utilizing CBCT analysis, Bio-Oss demonstrated a statistically significant gain in both bucco-lingual (0.54 ± 0.20 mm) and mesio-distal (0.38 ± 0.15 mm) socket dimensions after three months. In contrast, Osseograft resulted in a modest mesio-distal gain (0.26 ± 0.23 mm) and negligible bucco-lingual change (0.08 ± 0.32 mm). These results highlight the superior dimensional stability of deproteinized bovine bone mineral (DBBM), such as Bio-Oss, which functions as a slow-resorbing scaffold that preserves the ridge contour during the critical early phase of healing.

A recent randomized clinical trial evaluated post-extraction sockets grafted with xenograft alone versus xenograft combined with hyaluronic acid (HA). The study reported significantly higher bone density in the HA group (879.09 ± 118.76 HU) compared to the control group (546.18 ± 123.61 HU) after three months, as measured by CBCT ($p < 0.001$).[20] While these findings underscore the potential of HA to enhance bone density, the study did not assess dimensional changes in ridge width or height. In contrast, the current study specifically

examined horizontal and vertical socket dimensions, with Bio-Oss showing significant preservation in both planes. This distinction is critical, as dimensional integrity is essential for ideal implant site development.[21]

The current findings align with several high-quality studies in the literature. A notable randomized clinical trial comparing demineralized freeze-dried bone allograft (DFDBA) plus collagen membrane to DBBM plus collagen membrane in sockets with buccal dehiscence revealed that DBBM preserved horizontal ridge width by an average of 1.76 mm more at six months ($p = 0.0256$), supporting the material's long-term dimensional stability.[22] Although the absolute gain in our study was smaller, the overall trend remains consistent. Similarly, an animal study using Bio-Oss collagen in post-extraction sockets demonstrated superior preservation of ridge contour compared to ungrafted sites, despite limited new bone formation. This emphasizes the structural role of DBBM as a space-maintaining material during early healing. [23]

Histologic evidence further supports the long-term integration of DBBM. Studies have shown that DBBM particles integrate intimately with newly formed bone, maintaining ridge architecture over 6–7 months when used in combination with collagen membranes.[14] In contrast, demineralized bone matrix (DBM) materials, such as Osseograft, are known to resorb more rapidly. A clinical trial evaluating injectable DBM with or without recombinant human bone morphogenetic protein-2 (rhBMP-2) found no significant difference in ridge width or height after three months ($p > 0.05$), indicating limited dimensional benefits during the early healing phase.[24]

Materials like Osseograft, despite their osteoinductive potential, may demonstrate inconsistent results in volumetric preservation. This was further corroborated by a study showing that DBM alone is less effective in maintaining ridge dimensions without the support of a barrier membrane. The findings from our study echo this variability, as the Osseograft group failed to exhibit significant bucco-lingual preservation at three months. Although the use of platelet-rich fibrin (PRF) and the HA-xenograft likely contributed to enhanced soft tissue healing, it is evident that the choice of graft material remains the most critical factor influencing hard tissue dimensional outcomes.[20,25]

Although our sample size was limited ($n = 15$ per group) and the follow-up period was relatively short (three months), the results are consistent with larger, long-term trials. However, these limitations should be considered when interpreting the findings. Future studies should include larger sample sizes, extended follow-up durations (e.g., 6–12 months), and incorporate histomorphometric assessments to evaluate the quality of regenerated bone in addition to volumetric changes. From a clinical standpoint, Bio-Oss may be the preferred choice in cases where delayed implant placement is planned, due to its superior dimensional stability. Osseograft may still be appropriate in cases where faster remodeling is desired, particularly when used in combination with biologically active agents like PRF or HA. Further research into combining DBM with slower-resorbing carriers or using hybrid grafts may help achieve an optimal balance between biological activity and structural integrity.

CONCLUSION

In conclusion, Bio-Oss demonstrated superior effectiveness over Osseograft in preserving alveolar socket dimensions post-extraction, indicating its suitability as a reliable graft material for socket preservation. The findings support the application of Bio-Oss in clinical settings, particularly when a stable foundation is crucial for future implant placement. However, further studies involving larger sample sizes, extended follow-up periods, and comparisons with a broader array of graft materials are warranted to validate these results and refine clinical protocols for socket preservation.

DECLARATIONS

Ethics Approval and Consent to Participate: Approved by IHEC/SDC/PERIO-2305/23/172 Trial Registration: CTRI/2024/11/076550

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Conflict of Interest: The authors declare no conflicts of interest.

Consent for Publication: Not applicable.

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