Clinical and Radiographic Evaluation of Crestal Bone Loss Around Dental Implants with Buttress and V-Shaped Thread Designs Using A CBCT Study: A Randomized Controlled Clinical Trial

Abstract

Introduction
Crestal bone stability is a key determinant of long-term implant success. Implant thread design influences stress distribution at the bone–implant interface. This study clinically and radiographically evaluates crestal bone loss around buttress and V-shaped thread designs using CBCT.

Aim
This randomized controlled trial (RCT) aimed to compare crestal bone loss around implants with two different thread designs: buttress and V-shaped.

Materials and methods
A total of 20 patients requiring single-tooth implant placement in the posterior tooth region were randomly divided into two groups: Group A (V-shaped thread design) and Group B (Buttress-shaped thread design), with 10 patients in each group. Cone-beam computed tomography (CBCT) was used to assess crestal bone levels immediately after implant placement and at 9-month follow-up. Standardized surgical and prosthetic protocols were followed to minimize confounding factors.

Results
All implants demonstrated successful osseointegration with a survival rate of 100% at 9 months. While both groups showed some degree of crestal bone loss, Group A (V-shaped threads) exhibited slightly higher bone resorption compared to Group B (buttress threads). However, the difference in crestal bone loss between the two groups was not statistically significant ($p > 0.05$).

Conclusion
Within the limitations of this RCT, it can be concluded that although V-shaped thread design showed a greater tendency for crestal bone loss than the buttress design, the difference was not statistically significant. Long-term studies with larger sample sizes are recommended to validate these findings.

Authors

Charvi Kundu
Mayur Kaushik
Nazar Rana
Roopse Singh
Deepesh Saxena
Abhinav Sharma
Prajesh Dubey

University of Siena, Italy

* xxxx

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INTRODUCTION

The prosthodontic rehabilitation of partially or completely edentulous individuals remains central to restorative dentistry, aiming not only to restore mastication but also to re-establish facial esthetics and psychosocial well-being. Within this domain, osseointegrated dental implants have become the gold standard, noted for their long-term survival and ability to replicate the biomechanical and morphological features of natural dentition (1). Their success is biologically rooted in osseointegration, first described by Brånemark, as a direct structural and functional connection between bone and the implant surface without intervening connective tissue (2). Titanium, the principal implant material, demonstrates biocompatibility through the formation of a passivating titanium dioxide (TiO_2) layer that promotes cellular adhesion and osteogenesis (3).

The predictability of osseointegration, however, reflects not only material biocompatibility but also the interplay of implant macro- and microgeometry, surface modifications, host bone density, surgical technique, and biomechanical loading (4). Among these, thread design critically influences primary stability at placement and governs force distribution within peri-implant bone (5). V-shaped threads, with acute flank angles, predominantly generate shear stresses that may induce microdamage and marginal resorption (6). In contrast, buttress threads redirect loads into compressive vectors, biomechanically aligned with cortical and trabecular bone, thereby enhancing osseointegration and minimizing crestal bone loss (7).

Since preservation of crestal bone is vital for implant longevity, peri-implant soft tissue stability, and esthetic outcomes, accurate assessment is essential. Cone-beam computed tomography (CBCT) provides high-resolution, volumetric evaluation of peri-implant bone remodeling, enabling precise measurement of thread design influence under functional load (8).

Previous studies have demonstrated that implant thread design influences stress distribution at the bone–implant interface and may affect crestal bone preservation. Finite element and experimental studies have reported differences in stress patterns among V-shaped, square and buttress thread designs, suggesting a potential influence on peri-implant bone response (9). Clinical studies evaluating implant macro-design and marginal bone loss have shown variable results, often due to differences in implant systems, loading protocols, and radiographic assessment methods (10).Systematic reviews have further highlighted the lack of high-quality randomized clinical trials directly comparing specific thread designs and emphasized the need for well-controlled clinical studies to establish definitive conclusions.

Despite existing evidence, there is a paucity of randomized controlled clinical trials comparing crestal bone loss between buttress and V-shaped thread designs using three-dimensional radiographic assessment. Most available clinical studies rely on two-dimensional imaging, which may not accurately represent true crestal bone changes. The present study addresses this gap by employing a randomized controlled design with CBCT-based evaluation to provide clinical evidence on the influence of implant thread geometry on crestal bone stability.

Against this backdrop, the present CBCT-based clinico-radiographic study aims to compare crestal bone loss around implants with V-shaped and buttress thread designs, thereby elucidating their biomechanical implications for peri-implant bone preservation and long-term prognosis.

MATERIALS AND METHODS

This study was designed as a single-blinded, randomized, parallel-arm, prospective clinical trial conducted over a duration of two years and one month, from June 2023 to June 2025. Twenty patients aged between 18–50 years were recruited from the Outpatient Department of Periodontology. For calculating the sample size, following formula in figure 1.

The study protocol was approved by the Institutional Review Board of the University Ethics Committee Medical, SVSU (approval no: SMC/UECM/2023/639/296). All procedures followed the ethical standards of the Committee on Human Experimentation (institutional/national) and the Declaration of Helsinki as revised in 2013. All patients participating were informed and educated about the objectives and duration of the study. A written informed consent document was signed by each participant before inclusion in the study.

The study was registered in CTRI with registration number CTRI/2024/11/076940.

Participants were randomly assigned to one of two intervention groups using a computer-generated

$$n = \frac{(\sigma_1^2 + \sigma_2^2)\,(z_{1-\alpha/2} + z_{1-\beta})^2}{\Delta^2}$$

σ_2^2= Standard deviation 2

$z_{1-\alpha/2}$= Z score - 1.96

$z_{1-\beta}$= Z score - 0.84

Fig. 1

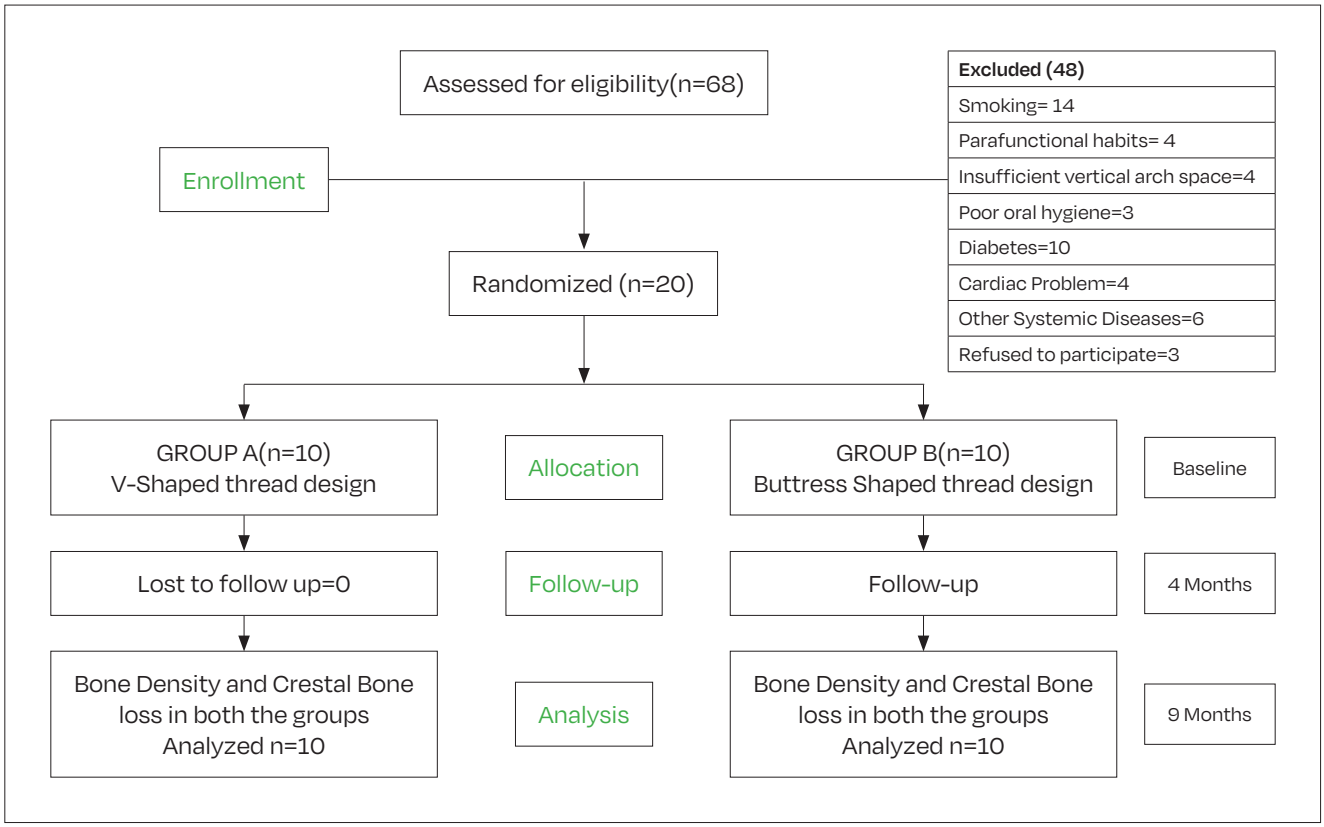

Fig. 2 Flowchart showing patient allocation

randomization sequence, ensuring equal distribution and minimization of selection bias. To maintain methodological integrity and ensure transparency in reporting, the study was conducted in strict accordance with the Consolidated Standards of Reporting Trials (CONSORT) guidelines.

A comprehensive overview of participant flow—including enrollment, group allocation, follow-up, and final analysis—is presented in the study flow diagram Fig. 2.

The sample size was determined based on estimates from previously published literature (11). Assuming a mean difference of 1.00 between the two groups, with standard deviations of 0.65 and 0.40, a two-tailed significance level (α) of 5%, and a statistical power of 80%, the minimum required sample size was calculated to be 9 subjects per group. After adjusting for an anticipated 10% dropout rate, the final sample size was rounded up to 10 participants per group.

Accordingly, a total of 20 systemically healthy patients, each requiring replacement of a single missing posterior tooth, were enrolled in the study.

Inclusion Criteria

Patients of either sex, aged between 18 and 50 years, were included in the study. Only patients presenting with a single-tooth edentulous space in the maxillary or mandibular arch were selected. The edentulous site was required to have adequate bone dimensions for implant placement, defined as a minimum alveolar ridge width of ⩾6 mm and a minimum vertical bone height of ⩾10 mm, allowing placement of a standard-diameter implant without the need for additional bone augmentation procedures. Furthermore, all selected edentulous sites had adjacent natural teeth intact on either side.

Exclusion Criteria

Patients with a history of smoking, systemic conditions such as diabetes mellitus or cardiac disorders, and those exhibiting bruxism or other parafunctional habits were excluded from the study. Patients with inadequate vertical inter-arch space, defined as insufficient restorative space to accommodate the implant prosthesis without compromising occlusal clearance, were also excluded. Pregnant and lactating females were not included in the study. Furthermore, patients with the absence of functional opposing occlusion at the intended implant site were excluded.

Patient Selection and Randomization

The clinician (SK) was responsible for the enrollment of participants according to predefined inclusion and exclusion criteria. After consent, participants were randomized into Group A (V-Shaped thread design implants) and Group B (Buttress-shaped thread design

implants) using a computer-assisted randomization software.

Allocation Concealment

To ensure allocation concealment, opaque, sealed envelopes containing the randomized treatment assignments were prepared by an independent team member not involved in the clinical procedures or outcome assessment. The envelopes were opened only after participant enrollment and consent, maintaining unpredictability in group assignments and minimizing selection bias. Given the limited sample size and one-year follow-up period, no interim analysis was conducted.

Blinding Protocol

In this trial, only the radiographic examiner (NT), responsible for measuring crestal bone loss and peri-implant bone density on CBCT scans, was blinded to the implant thread design used (Buttress or V-shaped). This blinding minimized measurement bias and ensured objectivity in outcome assessment. The operator (MR), who placed the implants, was necessarily aware of the thread design to perform the surgical protocol accurately. This arrangement maintained surgical integrity while allowing unbiased evaluation of radiographic parameters.

Examiner Calibration and Reliability

The blinded radiographic examiner (NT) was calibrated at multiple time points before the study. Intraexaminer reliability for CBCT measurements of crestal bone loss (CBL) and peri-implant bone density (BD) was assessed using the intraclass correlation coefficient (ICC). Reliability was found to be good to excellent (Table 1).

Outcome Measures

Primary Outcomes

- *Crestal Bone Loss (CBL):* Measured radiographically at mesial and distal sites using CBCT at baseline, 4 months, and 9 months (distance from implant platform to first bone-to-implant contact, fBIC) (12). Mean values compared between buttress and V-shaped thread designs.
- *Crestal Bone Density (CBD):* Evaluated in Hounsfield Units (HU) at coronal, middle, and apical thirds of implants on CBCT at 9 months to assess bone mineralization relative to thread design (13) (fig. 3A, 3B).

Secondary Outcomes

- *Soft Tissue Parameters:* Keratinized mucosa thickness (KM), probing pocket depth (PPD), gingival index (GI), plaque index (PI), and sulcular bleeding index (SBI) recorded pre-surgically, at 4 months, and 9 months.
- *Pain/Discomfort (VAS):* Postoperative pain assessed on a 10 cm Visual Analog Scale (0 = no pain,

Variable	Intraclass Correlation coefficient	Interpretation
Crestal Bone Loss (CBL)	0.91	Excellent agreement
Bone Density (BD)	0.88	Good agreement

Tab. 1

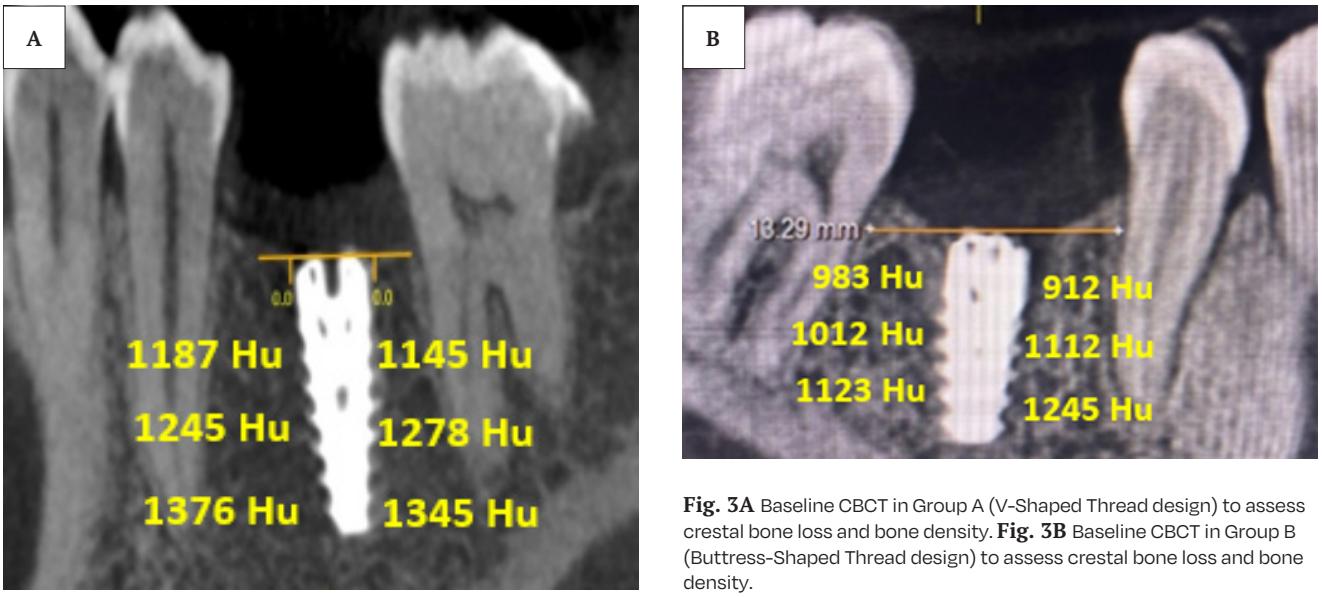

Fig. 3A Baseline CBCT in Group A (V-Shaped Thread design) to assess crestal bone loss and bone density. **Fig. 3B** Baseline CBCT in Group B (Buttress-Shaped Thread design) to assess crestal bone loss and bone density.

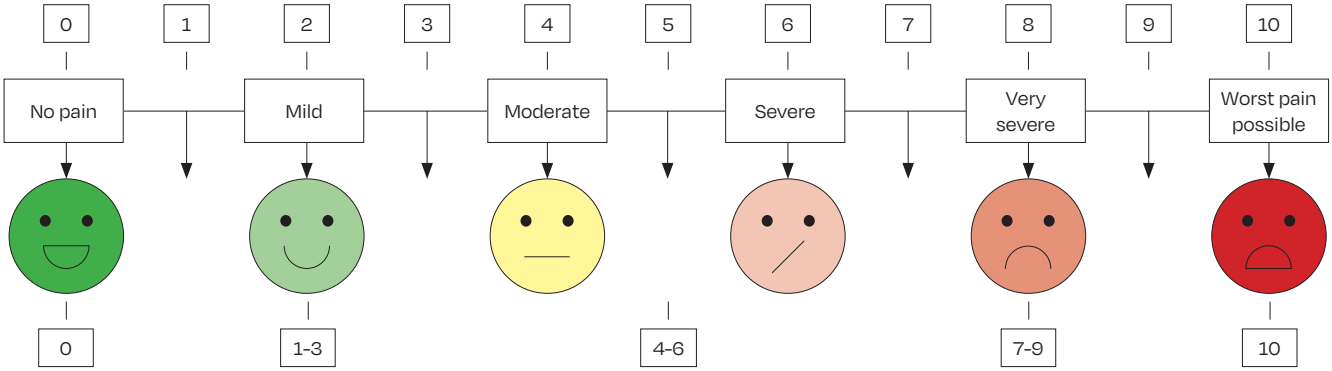

Fig. 4 Visual Analog Scale.

10 = worst pain) at 1 week, 1 month, and 4 months (14).

Pain scores showed a progressive reduction over time. The mean VAS score at 1 week was 3.8 ± 1.2, indicating mild to moderate pain. At 1 month, the mean pain score decreased significantly to 1.6 ± 0.7, reflecting minimal discomfort. By 4 months, pain scores were negligible, with a mean VAS score of 0.4 ± 0.3, suggesting complete or near-complete resolution of postoperative pain (fig. 4).

Prosthetic Outcomes

- *Success and Functionality:* Prosthesis were evaluated at delivery and at 4- and 9-month follow-ups. Stability, screw loosening or fracture, marginal fit, and occlusal contacts were assessed clinically. Throughout the follow-up period, all prosthesis remained stable with satisfactory marginal adaptation and optimal functional performance, with no evidence of mobility, screw loosening, or prosthetic fracture.
- *Complications:* They were monitored at each follow-up visit through clinical examination and patient interviews. Technical complications, including porcelain chipping, screw loosening, or fracture of prosthetic components, were assessed clinically, while biological complications such as peri-implant soft-tissue irritation or inflammation were evaluated by visual inspection, gentle probing, and patient-reported discomfort. No technical or biological complications were detected during the entire follow-up period.

Group A (Implant with V-shaped thread design)

Following aseptic preparation of the surgical field,

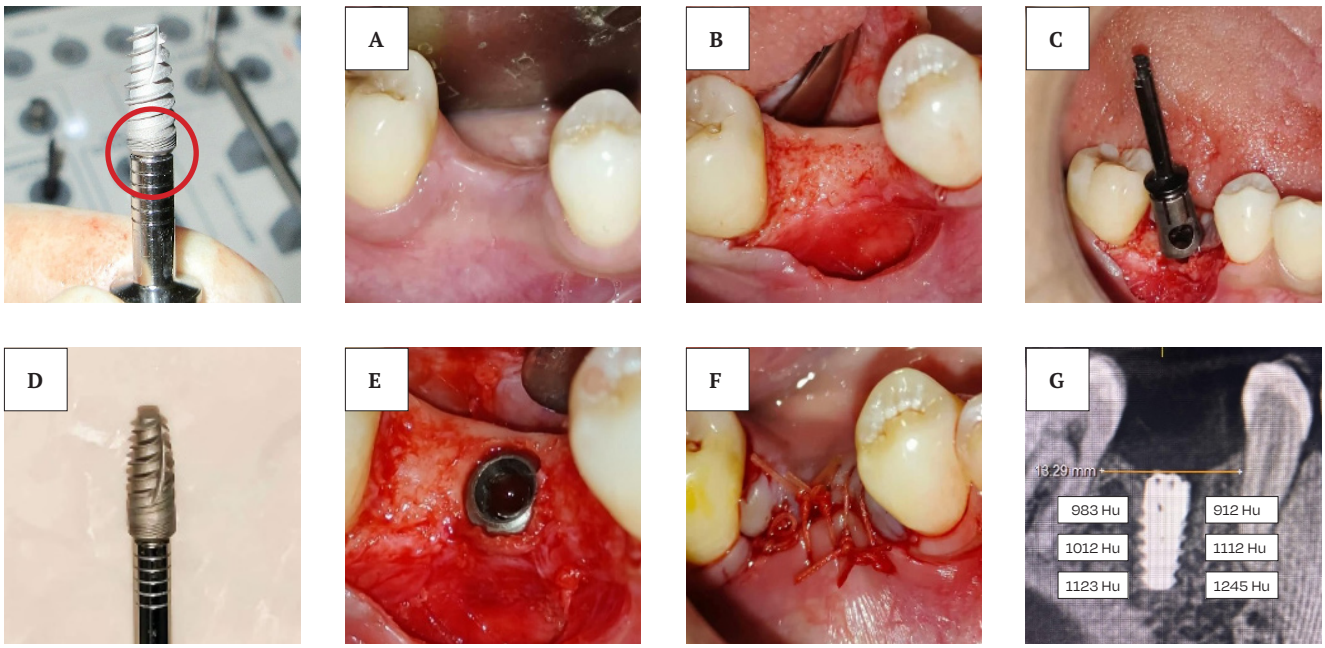

Fig. 5 V-Shaped Implant Design. **Fig. 5A-5G** Steps in V-Shaped Thread Design. (**A**) Pre-operative View, (**B**) Flap Reflected (**C**) Parallelism checked with osteotomy drill (**D**) V-Shaped Implant (**E**) Implant Placed (**F**) Sutures Given (**G**) Baseline CBCT showing Crestal bone loss and Bone Density.

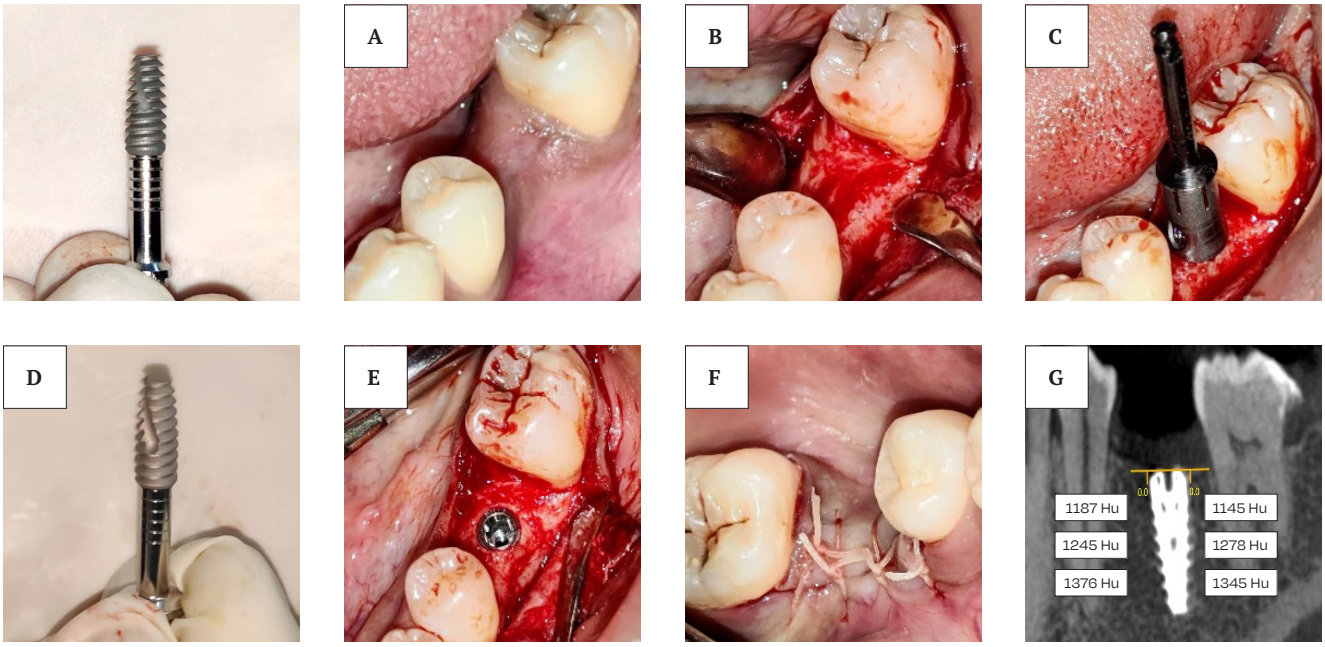

Fig. 6 Buttress Shaped Implant Design. **Fig. 6A-6G** Steps in Buttress Shaped Thread Design. (**A**)Pre-operative View, (**B**) Flap Reflected (**C**) Parallelism checked with osteotomy drill (**D**) Buttress-shaped implant (**E**) Implant Placed (**F**) Sutures Given (**G**) Baseline CBCT showing Crestal Bone loss and Bone Density.

local anaesthesia was administered at the designated implant site (Fig. 5A) using articaine hydrochloride with epinephrine (Septanest with adrenaline 1:100,000, Septodont). A full thickness mucoperiosteal flap was reflected (Fig. 5B) with subsequent site preparation involved the use of sequential drilling systems to progressively expand the osteotomy to the desired diameter, maintaining the recommended speed and torque parameters throughout the procedure. The final drill was employed to verify the parallelism (Fig. 5C) and alignment of the osteotomy relative to the planned prosthetic axis. Following, confirmation of osteotomy orientation, V-shaped threaded implant (Fig. 5D) was inserted into the prepared site (Fig. 5E) with controlled insertion torque. A cover screw was then placed over the implant fixture to ensure protection during the osseointegration phase and then sutures were given (Fig. 5F). A Baseline CBCT was recorded (Fig. 5G).

GROUP B (Buttress Shaped Thread Design)

Following local anaesthesia, to the desired implant site (Fig. 6A), a subcrestal incision was made and a full-thickness mucoperiosteal flap was elevated (Fig. 6B) to expose the alveolar ridge. Osteotomy was prepared using sequential drilling and parallelism was checked with the final drill (Fig. 6C). Buttress Shaped implant (Fig. 6D) was placed into the osteotomy site (Fig. 6E) and placement of the cover screw, the flap was repositioned and sutured using resorbable PGA/PLA sutures (Fig. 6F). A baseline CBCT was recorded (Fig. 6G).
All patients received written postoperative instructions and were advised to rinse with 2% povidone-iodine (Betadine) solution 4–5 times daily for two weeks. Antibiotic coverage with amoxicillin (500 mg TDS) and clavulanic acid (125 mg TDS) was prescribed for 5 days. Analgesic therapy comprising diclofenac sodium (100 mg), paracetamol (325 mg), and serratiopeptidase

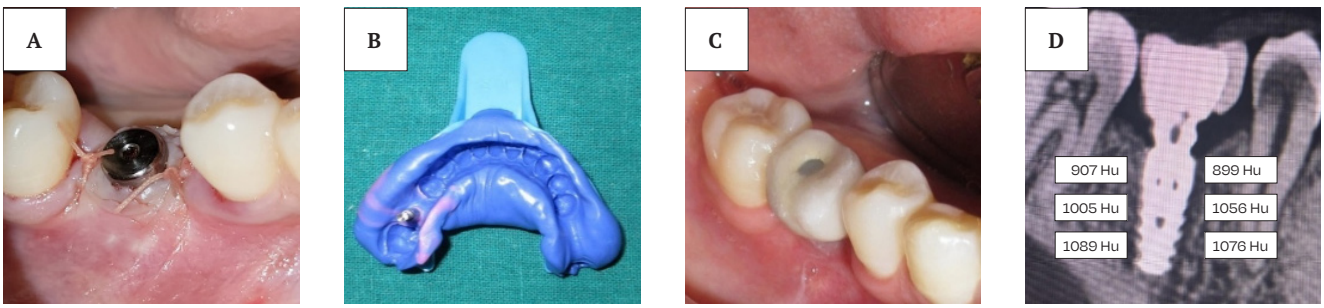

Fig. 7 Group A (V-Shaped thread design). Second Stage Surgery and final prosthesis in V-Shaped Thread Design (**A**) Gingival Former Placed (**B**) Elastomeric Impression (**C**) Crown Delivery Done (**D**) 9 Months Post-CBCT.

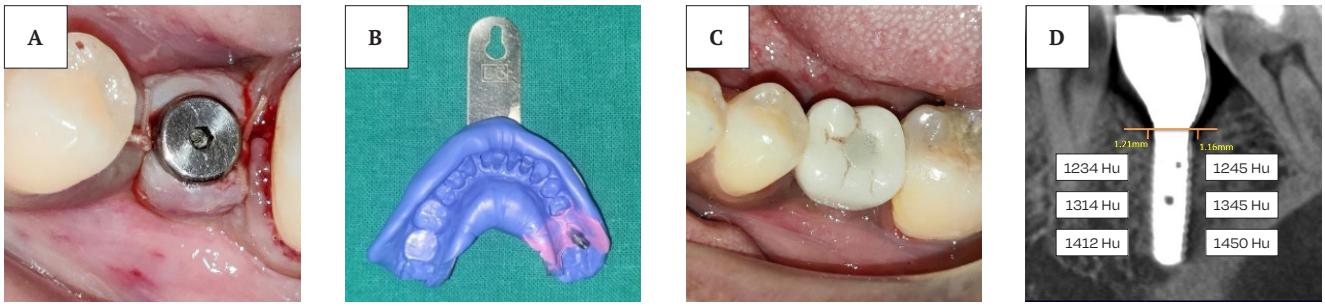

Fig. 8 Second Stage Surgery and final prosthesis in Buttress Shaped Thread Design (**A**) Gingival Former Placed (**B**) Elastomeric Impression (**C**) Crown Delivery Done (**D**) 9 Months Post-CBCT.

$$n = \frac{(\sigma_1^2 + \sigma_2^2)(z_{1-\alpha/2} + z_{1-\beta})^2}{\Delta^2}$$

σ_2^2= Standard deviation 2

$z_{1-\alpha/2}$= Z score - 1.96

$z_{1-\beta}$= Z score - 0.84

Fig. 9

(50 mg) was administered to manage postoperative discomfort and swelling.

Patients were recalled after 3 months for second-stage surgery. The healing phase was assessed as 5 months for maxillary and 3 months for mandibular implants. A midcrestal incision was made to expose the implant site, followed by flap elevation and removal of the cover screw. A healing abutment (gingival former) was placed (Fig. 7A and Fig. 8A), and the surrounding soft tissue was sutured to contour around the abutment. The healing abutment remained in situ for 14 days.

Subsequently, an elastomeric impression was taken using polyvinyl siloxane (Fig. 7B and Fig. 8B) and casts were poured with high-strength die stone. A wax pattern was fabricated and sent for final prosthesis construction. Once received, the prosthesis was evaluated intraorally, occlusion was adjusted, and definitive cementation was performed using a composite resin-based luting agent (Fig. 7C and Fig. 8C).

Patients were followed up at 9 months post-loading for clinical and radiographic evaluation of crestal bone level (CBL) changes (Fig. 7D and Fig. 8D)

Statistical analysis

The collected data were compiled and subjected to statistical analysis using SPSS® Statistics software, version 20.0 (IBM Corp., Armonk, NY, USA). Intragroup comparisons were evaluated using the paired t-test, while intergroup comparisons were analyzed using the unpaired t-test. A p-value >0.05 was considered not statistically significant.

For calculating the sample size, following formula in figure 9.

RESULTS

The mean age of the enrolled patients was 34.6 ± 6.2 years. There was no statistically significant difference in the mean age between the two groups (p = 0.462). Of the 20 patients included in the study, 10 underwent implant placement with V-Shaped thread design, while the remaining 10 received implants with Buttress Shaped thread design.

This study aimed to clinically and radiographically evaluate the impact of implant thread design on peri-implant tissue health and bone behavior over 9 months (tab. 2).

Clinical Parameters: Thread Design Makes No Mark on Soft Tissue Health

Across both groups, peri-implant soft tissue health

Parameter	Group A:V-shaped thread (n =10)	Group B: Buttress thread (n=10)
Mean age (years ± SD)	34.6 ± 6.2 years	35.1 ± 5.8 years
Age range (years)	22–48 years	24–49 years
Male [n (%)]	5 (50%)	6 (60%)
Female [n (%)]	5 (50%)	4 (40%)

Tab. 2 Demographic Data for Mean Age, Gender and Distribution.

S No	Time interval	p values b/w Test group 1 and Test group 2 by unpaired t test
1	Baseline	0.762** p > 0.05 (N.S.)
2	4 months	0.399** p > 0.05 (N.S.)
3	9 months	0.687** p > 0.05 (N.S.)
* shows a significant difference between different time intervals at 0.05 level of significance p < 0.05 ** shows no significant difference between different time intervals at 0.05 level of significance p > 0.05		

Tab. 3 Intergroup comparison of keratinized mucosa between group B and group A at different time intervals.

S No	Time interval	p values b/w Test group 1 and Test group 2 by unpaired t test
1	4 months	0.410** p > 0.05 (N.S.)
2	9 months	0.630** p > 0.05 (N.S.)
* shows a significant difference between different time intervals at 0.05 level of significance p < 0.05 ** shows no significant difference between different time intervals at 0.05 level of significance p > 0.05		

Tab. 4 Intergroup comparison of plaque between group b and group a at different time intervals.

S No	Time interval	p values b/w Test group 1 and Test group 2 by unpaired t test
1	4 months	0.13** p > 0.05 (N.S.)
2	9 months	0.224** p > 0.05 (N.S.)
* shows a significant difference between different time intervals at 0.05 level of significance p < 0.05 ** shows no significant difference between different time intervals at 0.05 level of significance p > 0.05		

Tab. 5 Intergroup comparison of sulcular bleeding index between group b and group a at different time intervals.

S No	Time interval	p values b/w Test group 1 and Test group 2 by unpaired t test
1	Baseline	-
2	4 months	0.824** p > 0.05 (N.S.)
3	9 months	0.202** p > 0.05 (N.S.)
* shows a significant difference between different time intervals at 0.05 level of significance p < 0.05 ** shows no significant difference between different time intervals at 0.05 level of significance p > 0.05		

Tab. 6 Intergroup comparison of gingival index between group b and group a at different time intervals.

S No	Time interval	p values b/w Test group 1 and Test group 2 by unpaired t test
1	4 months	0.913** p > 0.05 (N.S.)
2	9 months	0.501** p > 0.05 (N.S.)
* shows a significant difference between different time intervals at 0.05 level of significance p < 0.05 ** shows no significant difference between different time intervals at 0.05 level of significance p > 0.05		

Tab. 7 Intergroup comparison of pocket probing depth between group b and group a at different time intervals.

improved progressively over time. Clinical parameters including keratinized mucosa width (KM), Modified Plaque Index (MPI), Modified Gingival Index (MGI), probing pocket depth (PPD), and sulcular bleeding index (mSBI) were recorded at baseline, 4 months, and 9 months. Although slight improvements were observed within each group, none of these changes were statistically significant between Group A (V-shaped thread design) and Group B (Buttress thread design) at any time point (P > 0.05). This indicates that both thread designs performed similarly in maintaining peri-implant soft tissue health, and thread geometry had negligible impact on plaque accumulation, gingival inflammation, bleeding tendency, probing depth, or keratinized mucosa width (tab. 2-6).

Crestal Bone Loss: V-Shaped Threads Show More Resorption

CBCT analysis revealed a distinct difference in bone remodeling patterns between the two thread designs. Implants in Group A (V-shaped threads) exhibited a mean crestal bone loss of 0.93 ± 0.17 mm, Whereas Group B (buttress threads) showed a lesser bone loss of 1.12 ± 0.07 mm at 9 months.

This difference was statistically significant (P=0.005), indicating greater crestal stability around buttress thread designs (tab. 7A-7D).

Bone Density: Buttress Threads Outperform in Osseointegration

Evaluation of bone density (in Hounsfield Units) revealed a mild and non-significant increase in Group A from 1052.0 HU to 1090.3 HU (P=0.093). In contrast, Group B showed a substantial and significant increase from 1238 HU to 1341 HU (P=0.001).

The intergroup difference at 9 months was statistically significant (P=0.016), favoring buttress-shaped threads for enhanced bone densification and potential osseointegration (tab. 8A-8D).

DISCUSSION

Preservation of crestal bone is a key determinant of long-term success in dental implant therapy. It

S. No	4 Months	9 Months	4m–9m
1	902	935	-33
2	945	988	-43
3	973	1103	-130
4	1084	1076	8
5	1074	1163	-89
6	966	1071	-105
7	1097	1185	-88
8	1222	1158	64
9	1195	1157	38
10	1062	1067	-5
MEAN	1052	1090,3	-38,3
S.D.	105,71	81,07	64,54
SEM	33,45	25,65	20,42

Tab. 8A Mean, standard deviation, standard error of mean of crestal bone loss at different time points and their differences between successive time points in test group a (v- shaped thread design).

S. No	4 Months	9 Months	4m–9m
1	965	1024	-59
2	1058	1203	-145
3	1237	1375	-138
4	1396	1488	-92
5	1364	1563	-199
6	1345	1439	-94
7	1419	1482	-63
8	1334	1404	-70
9	1122	1181	-59
10	1149	1259	-110
MEAN	1238,9	1341,8	-102,9
S.D.	157,26	169,1	45,97
SEM	49,76	53,51	14,55

Tab. 8B Mean, standard deviation, standard error of mean of crestal bone loss at different time points and their differences between successive time points in test group b (buttress- shaped thread design).

S No	Time interval	p values b/w Tsuccessive time intervals by paired t test	
		Test Group 1	Test Group 2
1	Baseline - 9 months	0.093**	>0.001**
2	% increase from baseline to 9 months	3.6%	8.3%
* shows a significant difference between different time intervals at 0.05 level of significance p < 0.05 ** shows no significant difference between different time intervals at 0.05 level of significance p > 0.05			

Tab. 8C Intragroup comparison of bone density between successive time intervals in each test group.

S No	Time interval	p values b/w Test group 1 and Test group 2 by unpaired t test
1	Baseline	0.006* p < 0.05 (S.)
2	9 months	0.001* p < 0.05 (S.)
3	9 months (adjusted)	0.016* p < 0.05 (S.)
* shows a significant difference between different time intervals at 0.05 level of significance p < 0.05 ** shows no significant difference between different time intervals at 0.05 level of significance p > 0.05		

Tab. 8D Intergroup comparison of bone density between group a and group b at each different time intervals.

reflects both the biological stability of the peri-implant tissues and the mechanical integrity of the implant-bone interface. Numerous studies have emphasized the influence of thread design on stress distribution, initial stability, and crestal bone remodelling (15).

In the present study, implants with Buttress thread design exhibited less crestal bone loss compared to those with V-shaped threads, although the difference was not statistically significant. This finding supports results from Ghahroudi et al (16), who demonstrated superior stress modulation and reduced micromotion with square and buttress thread profiles under immediate loading conditions. Similarly, Kong et al (17) highlighted that thread pitch and shape significantly affect the strain distribution, with optimal values enhancing bone formation and reducing crestal resorption.

Thread modifications near the implant neck, such as microthreads, have also been shown to contribute to marginal bone preservation. Bozkaya et al (18) reported that implants incorporating microthreads at the coronal region prevented marginal bone loss by improving load distribution of plaque control and soft tissue health in preventing peri-implantitis and maintaining bone levels.

Motoyoshi et al (19) observed that reduced thread pitch (0.5 mm) improved load distribution and decreased crestal stress concentrations. Ma et al (20) supported these findings, suggesting that thread pitch in the range of 0.8 mm offers stronger resistance against functional loads. These biomechanical insights underscore the importance of thread architecture in optimizing implant integration.

The role of bone density, assessed in this study using CBCT in Hounsfield units (HU), also plays a pivotal role in implant success. Studies by Chun et al (21) have established that HU values correlate well with bone quality classifications, with higher values indicating denser bone and improved primary stability. The use of CBCT allowed precise, non-invasive evaluation of bone quality and crestal bone levels in this study, reinforcing its utility in both preoperative planning and postoperative monitoring (22).

Clinical indices such as OHI-S, mPI, mGI, and SBI remained within healthy limits across both groups, supporting findings from Apse et al (23), who emphasized the importance of plaque control and soft tissue health in preventing peri-implantitis and maintaining bone levels.

Adell et al (24) proposed that up to 1.5 mm of bone loss during the first year is acceptable, followed by less than 0.2 mm annually. The current study findings fall well within these parameters, further validating the clinical success of both implant types, though favoring Buttress threads in terms of bone preservation.

Overall, the integration of previous clinical and biomechanical studies with the current findings highlights the multifactorial nature of crestal bone maintenance. Thread design, surgical technique, bone quality, and patient compliance with oral hygiene collectively. determine the long-term stability of implants (25).

Limitations and future directions

This study is limited by a small sample size (n=20), which may restrict the generalizability of results. Clinically, V-shaped threads demonstrated a tendency for greater crestal bone loss due to higher shear stresses, whereas buttress threads favored compressive loading and bone preservation. Nonetheless, V-shaped designs may remain advantageous in specific scenarios, such as knife-edge ridges or low-density bone in the anterior maxilla. These findings highlight the need for individualized implant selection based on biomechanical demands and anatomical conditions.

CONCLUSION

All implants showed successful osseointegration with 100% survival at 4 months. While V-shaped threads demonstrated comparatively greater crestal bone loss than buttress threads, the difference was not statistically significant. Further studies with larger cohorts and longer follow-up are warranted to clarify the role of thread geometry in peri-implant bone preservation.

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