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COMPARATIVE ANALYSIS OF DIFFERENT THREAD DEPTHS OF SHORT IMPLANTS IN REHABILITATION OF ATROPHIC POSTERIOR MAXILLA

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Abstract
Aim: the current study aimed to assess the performance of deep-threaded and conventional-threaded short implant in the rehabilitation of atrophic posterior maxillary region.
Methods: This randomized controlled clinical trial included 14 patients (6 males and 8 females, ages 37-60) divided into two equal groups and recruited from Al-Azhar University who required implants in posterior maxillary region with residual bone height of 6-8 mm. Clinical assessments and CBCT imaging were used during the preoperative evaluation to determine bone height and density. Implants were inserted under local anesthetic, and osteotomies were made with OXY KIT drills. Osstell ISQ was used to assess the implant stability from the buccal and mesial directions. Clinical and radiographic evaluations, including CBCT imaging for crestal bone loss and bone density were carried out immediately and after six months.
Results: The study findings revealed non-significant differences in both age and gender distributions between the groups. There were no incidences of infection or implant failure documented, indicating a 100% success rate. Group II (deep-threaded implants) had significantly higher primary stability and periimplant bone density immediately after surgery than Group I (conventional-threaded implants) although secondary stability at six months was comparable between the two groups. Both groups showed considerable improvements in bone density over time, with Group II maintained higher levels.
Conclusion: Deep-threaded short implants offer superior primary stability and peri-implant bone density, while both implant types achieved similar secondary stability and improved bone density over time, making deep-threaded implants ideal for atrophic posterior maxilla challenging cases.

Keywords: short; implant; maxilla; atrophy; osseointegration; thread.

Introduction

The posterior maxilla frequently had complications due to decreases bone height and density caused by maxillary sinus pneumatization, which complicated conventional implant insertion [1,2]. Short implants provided a less invasive alternative, avoiding complex operations like sinus lifting and ridge augmentation. Short implants are those that have an intraosseous length of 8 mm or less and a diameter of 3.75 mm or more, according to a 2016 European Consensus Conference definition [3–6]. However, in regions with poor bone density, such the posterior maxillary region, primary implant stability is very essential for implant success, and this could be affected by short implant length. Meanwhile, implant thread geometry could affect the load distribution and implant-bone interaction, which are key factors in achieving successful implant osseointegration. It is also known that deep-threaded designs may engage the trabecular bone more effectively, enhancing stability and load transfer [2,7–9]. While short implants have been extensively investigated, few studies have compared the effectiveness of various thread patterns in the context of atrophic posterior maxilla. The current study aimed to address this gap by directly comparing the performance of deep-threaded and conventional-threaded short implants. Furthermore, this could have clinical benefits in choosing the ideal implant tread design to resolve the challenging posterior maxilla cases, providing better clinical outcomes and reducing complications through improved implant stability and bone adaptation, which could lead to higher success rates and patient satisfaction in addition, short implants are thought to be less expensive [10,11]. Therefore, the study's hypothesis is that deep-threaded short implants perform better than conventional-threaded short implants in the posterior maxillary atrophic regions, particularly in terms of primary stability, osseointegration, and bone remodeling.

Methods

Study Setting and Design

The present research was a clinical trial that was randomized and controlled with 14 patients (six males and eight females) aged 37 to 60 years . They were divided into two equal groups (group I : control group is 7 patients with conventional-threaded dental implants whereas group II : study group is 7 patients with deep-threaded dental implants) . All participants satisfied the eligibility requirements and were selected from the Maxillofacial Surgery and periodontology Outpatient Clinics at Al-Azhar University, Faculty of Dentistry. Every patient received comprehensive information about the study's goals and methodology, and they all signed an informed consent form acknowledging their understanding. The permission form provided information about the surgical procedures and the post-operative follow-up process.

Sample Size determination

The sample size was determined using the G*Power software (version 3.1.9.4), based on data from the previous study. Using a two-sided hypothesis test with a large effect size (d = 1.66), a total of 14 patients (7 for each group) were required to achieve 80% study power (1−β1-\beta1−β) at a significance level of 5% (α=0.05\alpha = 0.05α=0.05).

Criteria for inclusion included: 1) Patients aged 25 and more, in good physical and oral health. 2) Patients seeking implant placement in the posterior maxillary areas with bone height remaining of 6-8 mm, as measured by CBCT. 3) At least three months following extraction. **Exclusion Criteria** involved: 1) maxillary bone height < 6 mm. 2) Poor dental hygiene or untreated periodontal disease. 3) Uncontrolled diabetes, metabolic bone diseases, or other systemic conditions preventing implant surgery. 4) Heavy smokers.

Preoperative Assessment

A detailed Clinical evaluation included a thorough medical and dental history was obtained, along with comprehensive intraoral and extraoral examinations. Radiographic Assessment involved CBCT imaging (Blue Sky Plan 4 software) was used to evaluate residual alveolar bone height, bone density, and to rule out any pathologies involving the alveolar bone.

Surgical procedures

Patients were instructed on oral hygiene and received prophylactic antibiotic therapy (Augmentin 1g) before surgery. Under local anesthesia, a mucoperiosteal flap was designed, incised at a mid-crestal location, and elevated. For the control group, implant osteotomy was prepared using OXY KIT drills, starting with a 2.2 mm pilot drill. Sequential stepped drilling was performed under copious irrigation, guided by CBCT-planned dimensions. Implants were manually seated into the osteotomy to the maximum torque.

A smart peg was attached to each implant, and primary implant stability was measured using Osstell ISQ in two directions (buccal and mesial). The average ISQ values were recorded for statistical analysis. Cover screws were placed, and the mucoperiosteal flaps were repositioned and sutured using 3/0 silk sutures.

Postoperative Assessment and Follow-Up

Patients were given standard postoperative instructions and medications. Follow-up appointments were scheduled 7–10 days postoperatively for suture removal and clinical evaluation.

Clinically, Patients were assessed immediately and at six months postoperatively for pain (using a Visual Analog Scale), edema (measured with a tape), and other complications, such as infection or implant loss. Implant stability was re-evaluated using Osstell ISQ.

Radiographic Evaluation involved CBCT imaging was performed immediately and at six months postoperatively to assess crestal bone loss and bone density around the implants using Blue Sky Plan 4 software.

Statistical Data Assessment

The Microstat7 program for windows was used to code, process, and analyze the data. A one-way ANOVA was employed to assess time-related changes within each group, while paired comparisons between groups at each interval were performed using the Post-Hoc Tukey test. P-values less than 0.05 were regarded as statistically significant.

Results

Demographic Data outcomes

The mean age did not differ significantly between Group I (47.14±7.28 years) and Group II (45.29±7.95 years) (p=0.328), showing that the groups were age-matched. There was no significant variation in the groups' gender distribution. (p=0.280). Group I had a higher proportion of females (63%) than Group II (38%), although males were more frequent in Group II (62%), compared to Group I (37%) (Fig. 1).

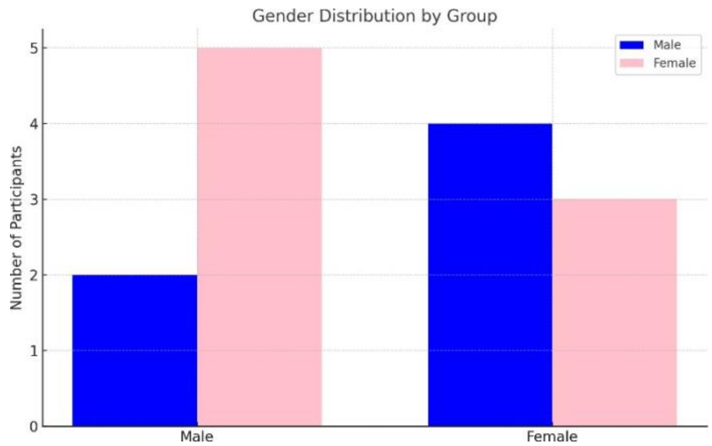

Fig. 1: Gender distributions among groups.

Implant Stability

Primary Stability:

Group II (deep-threaded implants) had considerably higher primary stability (71.71±3.99) than Group I (conventional-threaded implants) (61.29±7.16) (p=0.0008*), indicating that deep-threaded implants provided better primary stability.

Secondary Stability

Six months following surgery, there was no-significant difference in the groups' secondary stability (Group I: 70.57±3.26, Group II: 72.43±1.99, *P* =0.361). Both groups experienced comparable secondary stability throughout time.

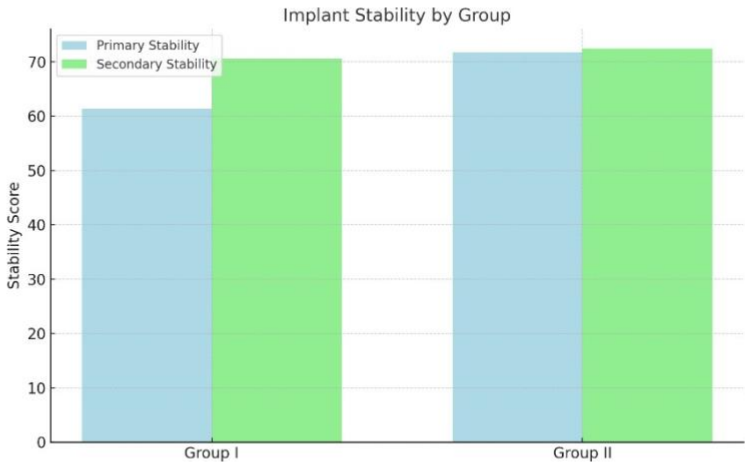

Fig.2: Implant stability scores

Regarding Intra-Group Changes: While Group II did not show significant intra-group variations (*P* =0.111), Group I had a significant increase in stability from primary to secondary measurement (*P* =0.003) (Fig. 2).

Bone Density

Group II showed statistical significant higher immediate postoperative bone density (458.00±34.24) compared to Group I (446.23 ± 31.29) (*P* =0.001).

Bone Density at 6 Months:

After six months, Group II had significantly higher bone density (567.07±9.36) than Group I (543.46±44.61) (*P* =0.001).

Both groups showed significant increases in bone density between the immediate postoperative period and six months interval (*P*=0.001) (Fig. 3).

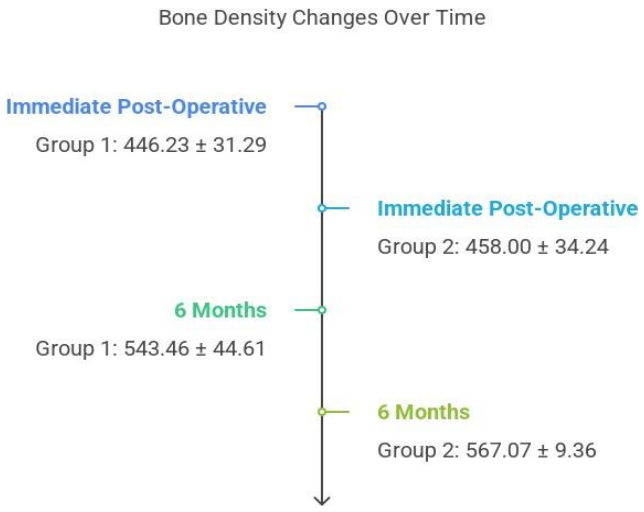

Fig. 3: Bone density changes during follow up intervals.

Discussion

The goal of the current study was to evaluate the performance of deep-threaded and conventional-threaded short implants for reconstructive purposes of atrophic posterior maxillary areas. The study findings revealed that deep-threaded implants (Group II) demonstrated superior primary stability and higher bone density immediately postoperatively compared to conventional-threaded implants (Group I), but both groups achieved comparable secondary stability after six months. Bone density increased significantly in both groups over time, but Group II consistently had higher values, indicating improved osseointegration and bone interactions with deep-threaded implants.

Research studies has investigated into implant design's effect on primary stability, specifically for short dental implants. Thread depth has a significant influence on stability, with shorter pitch and deeper threads offering superior primary stability in low-density bone [11–13]. Novel thread designs in small implants (6 mm) demonstrated comparable stability to longer implants, indicating that implant macro-design, diameter, and surface treatment are more important for initial anchoring than length [11]. However, insertion depth influences stability, with subcrestal placement potentially lowering the primary stability, especially in poor-quality bone [14,15]. These findings support using short implants with optimized thread designs as a feasible therapy option for individuals with restricted bone height. However, short implants with deep-threaded fixture showed comparable primary stability to standard implantation in the posterior mandible. These findings suggest that short implants could be a viable option to standard implants in the atrophic posterior maxilla, lowering treatment time and morbidity [10].

In addition, recent research have investigated the impact of implant threading depth on osseointegration and primary stability. Deeper threads have been found to increase insertion torque values, especially in low-density bone [16]. Implants with deeper thread depth had better values for the Implant Stability Quotient (ISQ). However, the effect on bone-implant surface contact (BIC) and bone volumes (BV) varies with thread design and insertion torque. Muktadar et al. (2018) found that power-shaped threads with deeper depths increased BIC at high torque, whereas V-shaped threads promoted new bone formation [13]. Sun et al. (2016), on the other hand, found no significant advantage of deep-threaded implants over shallow-threaded ones in dog mandibles, with deep-threaded implants having lower BIC values at 4 weeks but similar outcomes at 8 weeks [17]. These results indicate that thread depth influences primary stability, but its long-term effects on osseointegration may be less evident.

Short implants (≤8 mm) and normal implants (>8 mm) in atrophic posterior maxilla were compared in other investigations. A thorough review demonstrated non-significant difference regarding the implant survival rate between short and conventional implants during a 5-year period. Weerapong et al., 2019. Short implants showed less biological problems and similar marginal bone loss to conventional implants [10]. A retrospective cohort analysis found that both procedures had equal medium-term results, however short implants caused less surgical problems [18]. Another study found that short implants enhanced bone density and implant stability in posterior atrophic maxillas during a 6-month period [19]. While others reported that short implants are regarded a predictable treatment option, those shorter than 8mm should be utilized with caution due to increased failure chances [20]. In posterior jaws with low bone height, these results validate the use of short implants as a viable substitute for normal implants.

According to LEE, Sun-Young, et al., dental implants with deeper thread depth have higher primary stability, which promotes successful osseointegration and reduces implant failure in areas of poor bone quality. These findings were in line with other studies that found that shorter thread pitch and deeper thread depth can improve the primary stability of short dental implants on D4 bone density [16]. In addition this study agrees with the conclusions of other authors as well. Gehrke et al, [21] who observed that broad pitches had greater primary stability than tight pitches, whereas Elitsa et al, [22] found that higher thread profiles had greater primary stability. According to McCullough and Klokkevold, [23]implant stability as measured by RFA appears to be influenced by macro-thread structure during the early post- operative healing period. In contrast to the results of Saleh et al. [(12)], which demonstrated that the deep thread implants exhibit excellent primary stability and that the micro thread design implants exhibit more stability (as determined by ISQ) than the macro thread design in the lower jaw.

Conclusion

Although the present study was limited by the small sample size, other studies could be performed to evaluate other factors as long term prosthetic performance we could conclude that deep-threaded short implants showed greater peri-implant bone density and primary stability in the atrophic posterior maxilla when compared to traditional threaded short implants., making them a favorable option for cases with limited bone height. Both implant designs achieved comparable secondary stability at six months, with significant improvements in bone density over time.

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