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ASSESSMENT OF DEEP THREADED SHORT IMPLANT VERSUS CONVENTIONAL THREADED SHORT IMPLANT IN ATROPHIC POSTERIOR MAXILLA (CLINICAL AND RADIOGRAPHIC STUDY)

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ABSTRACT

Objectives: Successful osseointegration in regions with cancellous bone, such as the posterior atrophic maxilla, relies heavily on the stability of short dental implants. Implant macro design plays a crucial role in determining implant stability, particularly with regards to thread design. Implants with deeper threads tend to engage better with the cancellous bone, resulting in higher primary stability. **Subjects and Methods**: The study included fourteen patients between the ages of 39 and 60 who had one or more missing teeth in the posterior maxilla and had at least 6-8mm of residual bone height. The patients were randomly divided into two equal groups: group (I) received conventional threaded short dental implants, while group (II) received deep threaded short dental implants. Preoperative and postoperative clinical and radiographic evaluations were conducted at immediate and 6-month post-surgery intervals. Implant stability was assessed clinically using Osstell, while bone density measurements were obtained using CBCT in the radiographic evaluation. **Results:** fourteen patients with fourteen implant site seven implants (conventional threads) were inserted in group I and seven implants (deep threads) were inserted in group II. No implants and prostheses failed. No biological complications were identified. No significant differences were found between both groups in the incidence of postoperative pain, facial swelling, bone resorption, and peri-implant bone density Group II implants had higher primary stability than group I with significant improvement in secondary stability measured 6 months postoperatively in both groups. **Conclusions:** The use of a newly developed implant with a deep thread in posterior region of maxilla, showed high primary stability.

KEYWORDS: Short implant, posterior maxilla, implant stability, deep threaded implant

INTRODUCTION

An effective way to restore missing teeth is through dental implants, which have a proven track record of delivering positive functional outcomes over the long term. However, rehabilitating the posterior edentulous maxilla with dental implants can be challenging, as it is often associated with reduced alveolar bone height and density due to post-extraction ridge atrophy and maxillary sinus pneumatization [1, 2].

Restoring missed teeth can be accomplished without complex procedures like ridge augmentation, sinus lifting, and other options such as a zygomatic implant, pterygoid implant, and tilted implant by opting for a short dental implant[3]. The definition of a short implant has been a subject of debate in the literature. Initially, short implants were defined as those with a length of less than 11 mm. However, the definition has evolved, and some authors consider them to be short if their length is less than 7 mm, while others define them as short if the length

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is less than 8 mm. In 2016, the European Consensus Conference established that short implants are those with an intraosseous length of 8 mm or less and a diameter of 3.75 mm or more(4).

Short implants have several advantages over standard implants. They can reduce the time and cost of treatment and cause less discomfort for patients(5). Additionally, they may lower the risk of surgical complications such as perforating the maxillary sinus or causing paresthesia due to dental nerve injury. Less bone grafting is required this can result in a quicker and less expensive treatment. Therefore, short implants can be a good option for patients who want to reduce their treatment time and cost, as well as the risk of complications(6).

When estimating implant stability, bone density is an important consideration. Sufficient stability and a well-executed surgical approach can facilitate implant osseointegration (7). The main stability of the implant for mechanical support from the surrounding bone in the early stage and osseointegration between the surrounding bone and implant through bone regeneration and remodeling in the later stage are critical to the long-term effectiveness of implant therapy(8). In low-quality bone, primary stability is very important. Failure to establish osseointegration and fibrous encapsulation are caused by the instability of dental implants(9).

Enhancing primary stability in posterior maxillary sites can be achieved during implant site preparation by using smaller drills or bone condensing procedures. But improving stability in soft bone densities also heavily depends on implant design (10). The way the threads are positioned along the implant body and how they respond to functional stresses can have an impact on how those pressures are transmitted to the surrounding bone tissue (11). It has been suggested that a recently created implant with a certain knife thread geometric macro design will increase stability through improved interaction with the cancellous bone. In order to evaluate deep threads of short dental implants and conventional ones in the posterior atrophic maxilla, a clinical and radiological research was created.

SUBJECTS AND METHODS

I. Ethical consideration:

The study was approved by the ethical committee at the Faculty of Dental Medicine (Boys - Cairo)Al-Azhar University with ethical code 806/2850. All patients were informed about the aim and protocol of the study and signed the Al-Azhar University informed consent form, which contained all information about the surgical procedure and post-operative follow-up.

II. Study design:

It is a randomized controlled clinical study

III. Sample size calculation:

To evaluate the effect of deep threaded short implants versus conventional threaded short implants in atrophic maxilla on stability and osteointegration by bone density, an independent t-test was used for comparison between groups. According to Saleh et al (2021) (12), bone stability was (70.57 ± 5.74) in comparison to (60.29 ± 6.58).

Using the G power statistical power analysis tool (version 3.1.9.4) and Saleh et al. (2021) as a basis, the sample size was determined (13). With a two-sided hypothesis test, a total sample size of 14 (split into 7 groups) will be enough to detect a big effect size (d) = 1.66, with an actual power (1-β error) of 0.8 (80%) and a significance level (α error) of 0.05 (5%). Study population and environment:

The study included 14 patients (6 males and 8 females) aged between 37 and 60 years. Patients were selected from the Outpatient Clinic of the Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Boys, Cairo, Al-Azhar University. All patients satisfied the eligibility criteria.

IV. Eligibility criteria:

o Inclusion criteria:

The inclusion criteria for this study included patients aged 25 years or older with good physical and oral health who required implant treatment in the posterior maxilla and had a residual bone height of 6-8 mm as measured on preoperative CBCT scans. Additionally, patients were required to have undergone a post-extraction healing period of at least 3 months.

o Exclusion criteria:

Exclusion criteria included bone height less than 6mm. Untreated periodontal disease. Poor oral hygiene. Uncontrolled diabetes, metabolic bone disease or other systemic disorders contraindicating implant surgery. Heavy smokers.

Preoperative evaluation:

- Clinical evaluation of the patient including medical and dental history and a complete intra-oral and extra-oral examination were carried out for each patient.
- Radiographic evaluation using CBCT (Blue Sky Plan 4 software) to pre-operative residual alveolar bone height and bone density, and other pathologies that may involve the alveolar bone.

Intervention fig (1)

Patients received oral hygiene protocol and antibiotic therapy with Augmentin 1g before the surgery. Surgical procedures were performed under local anesthesia. A Mucoperiosteal flap was then designed at a mid-coastal location, incised using a scalpel, and elevated using a periosteal elevator.

Mucoperiosteal flaps were raised for placing dental implants. The control group used OXY KIT drills to prepare the implant osteotomy site. A pilot drill (2.2 mm) was used to drill to the desired depth, and a radiograph was taken for verification of the drilling location and angulation to the adjacent teeth.

The implant site was prepared using sequential stepped drilling with OXY KIT drills under copious irrigation until the osteotomy was finalized based on the predetermined diameter and length planned by CBCT.

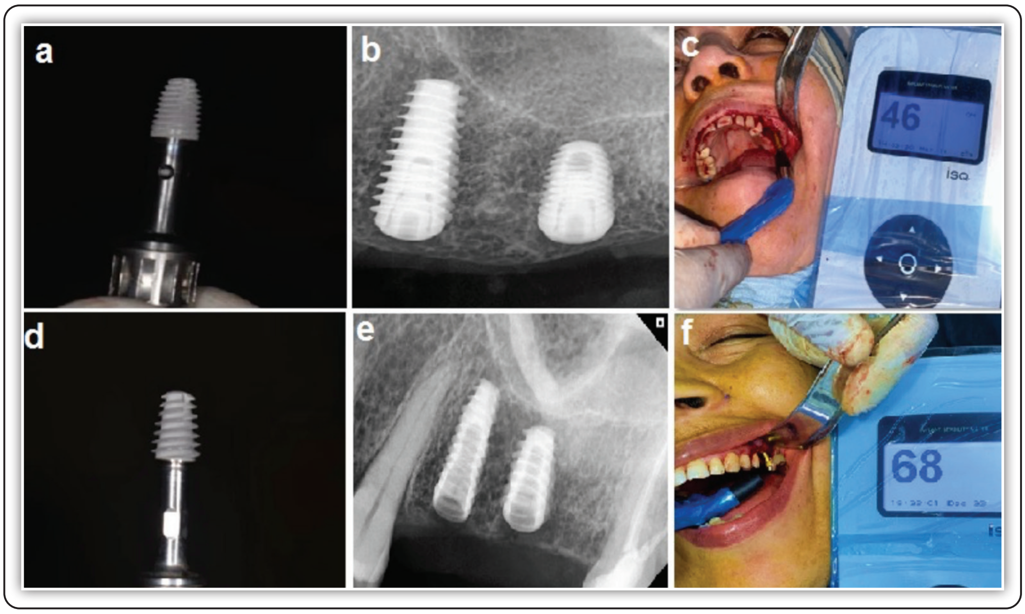

FIG (1) (a, b) conventional threaded implant clinical and Radiographical photo (C) conventional threaded implant stability (d, e) deep threaded implant clinical and radiographic photo (e) deep threaded implant stability

The implant was seated in the prepared socket and screwed manually to reach the maximum torque. A smart peg was then attached to the implant and Ostell® was conducted to measure baseline stability. The measurements were performed with the probe detecting from two different directions (e.g., from buccal and mesial directions with a 45o angle) at each evaluation.

Two ISQ values were recorded and used for statistical analysis. Primary stability was measured, then the peg was removed and the cover screw was adopted. The flap was repositioned and sutured using 3/0 silk.

Postoperative care and medication:

Regular postoperative instructions were given to the patients, and postoperative medications were prescribed. The patients were instructed to attend for the follow up 7-10 days postoperatively for suture removal and checkup.

Post-operative assessment:

o Clinical evaluation:

All patients were clinically evaluated at the following intervals; immediate, and six months postoperatively for evaluation. Postoperative complications such as pain using a Visual Analog scale (VAS) [16], edema using a measuring tape, and other complications such as infection or implant loss. Implant stability was measured immediately after implant installation before flap closure and six months postoperatively using Osstell ISQ.

o Radiographic evaluation:

All patients were examined radiographically immediately and six months after implant placement by CBCT for assessing crestal bone loss and bone density around the implant using Blue Sky Plan 4 software.

Statistical analysis:

For statistical analysis, coding, processing, and analysis of the collected data, the current study used the Statistical Package for Social Sciences program Microstat7 for Windows Statistical Package (Microstat Co).

A one-way ANOVA was used to evaluate the effect of time on certain parameters in each group, and the Post Hoc Tukey test was used for paired comparisons between the two groups within each interval. A criterion of $P < 0.05$ was determined to be significant. Each test comprised two tails.

RESULTS

A. The patient and implant-related characteristics:

In the present study, the mean age of the patients was (47.14±7.28) for group I and (45.29±7.95) for group II, without significant difference (P= 0.328). There was also no statistically significant difference in gender distributions between the two groups, with group I having 2 males and 5 females, and group II having 4 males and 3 females. Both groups were compared under similar local conditions in terms of RBH (6-8) mm the two investigated groups used the same type of installed dental implants with (7mm) in length and (5-5.5) Table (1).

B. Postoperative complications:

1. Postoperative Pain: Both implant groups used in the present study was associated with mild VAS scores for pain, with the peak of the pain intensity recorded on the 2nd day after surgery with a mean score was (3.43±0.53) and (3.57±0.53) for the conventional and deep threads implant groups, respectively. Pain intensity decreased significantly during the 3rd day and mostly disappeared at the end of 1st week after surgery.
2. Postoperative facial edema: All patients suffered from grade 1 facial edema (mild swelling less than 1cm) reaching its peak in the second day, without significant difference between both groups. Facial edema was resolved completely 7-10 days postoperatively in both groups.

3. Other complication: the result of the present study demonstrated no complications associated with the surgical procedures, such as infection and swelling over implant site. All implants showed good clinical and radiographic results, with a 100% success rate and no implant loss during the studyperiod in both groups.

C. Implant stability:

The results of the study confirmed that the group II showed a higher primary stability than group I. Group I showed a significant increase in secondary while group II showed insignificant increase in primary stability measured 6 months postoperatively. There was no significant difference between the two groups in terms of secondary stability.

D. Bone density:

Data on mean values of peri-implant bone density were acquired. As a baseline, the mean was ascertained both shortly after the procedure and six months after the surgery. Immediately following surgery, group I had a mean peri-implant bone density of 446.23±31.29 HU, while group II had a mean of 458.00±34.24 HU. P<0.001 indicates that these differences were statistically significant. At the six-month mark, group I's mean peri-implant bone density was 543.46±44.61 and group II's was 567.07±9.36. A statistical analysis of the bone density measurements for each patient is presented in Table 1.

E. Crestal bone loss (CBL):

In comparison of both groups, there was statistically in-significant difference between both groups regarding buccal and palatal mean change of crestal bone loss during the follow up period.

TABLE (1) Descriptive statistics of age, gender, implant stability and bone density of both groups

Age & Gender					
		Group I	**Group II**	**"t"**	**p**
Age		47.14 ±7.28	45.29 ± 7.95	0.455	0.328 NS
Gender	Male	2(37%)	4(62%)	χ2= 1.670	0.280 NS
	Female	5(63%)	3(38%)		
Implant Stability					
1ry		61.29 ± 7.16	71.71 ± 3.99	5.373	0.0008*
2^{nd}		70.57 ± 3.26	72.43 ± 1.99	0.373	0.361 NS
p		0.003*	0.111 NS		
Bone density					
Immediate post-operative		446.23 ± 31.29	458.00 ± 34.24	0.671	0.001
6 Months		543.46 ± 44.61	567.07 ± 9.36	1.371	0.001
p		p = 0.001 *	p = 0.001 *		

P: p value for comparing between the studied groups.

χ2: Chi square test.

"t": independent student "t" test

DISCUSSION

Fourteen individuals with missing maxillary premolars and molars participated in the current investigation. They were chosen from the Al-Azhar University Faculty of Dentistry's Oral and Maxillofacial Surgery Department's Outpatient Clinic.

The Oxy implants were utilized in this investigation. They have an original knife-edge thread pattern. According to the claim, this thread design maintains stability by allowing for "maximum bone-to-implant contact, maximized compressive force resistance, and minimized shear force production [14].

In terms of the surgical process, a delayed implant placement strategy was used to perform delicate surgery on all of the included patients. All implants were put at 0.5 below crestal level in accordance with the manufacturer's instructions, and the drilling was done under heavy irrigation with regular saline to ensure adequate cooling and prevent overheating of the bone structures.

During the follow-up period, none of the other patients experienced any ongoing pain, soreness, infection, or swelling. Per implant microsites at the implant site, wound dehiscence, peri-implantitis, and damage to the maxillary sinus were not noted as postoperative problems.

Resonance frequency analysis (RFA), developed by Meredith in 1996[15], was used in the current investigation to examine implant stability using the Osstell ISQ technique. RFA was selected as a trustworthy and non-invasive tool to evaluate changes in implant stability over time. The stability of the implant in the surrounding bone is closely correlated with RFA registrations; during healing, new bone apposition at the implant-bone interface may manifest and raise ISQ values.

RFA was examined twice in this study: first, just after implant implantation, to assess primary stability (mechanical stability), and again, six months later, to assess secondary stability (biological stability). The outcomes are presented in ISQs (ISQs). The ISQ unit is a measurement that goes from 1 (lowest stability) to 100 (greatest stability). Measurements below 45 are considered warning indications, while acceptable ranges are between 55 and 75 [16].

The current study showed that the mean value of the primary stability was (61.29 ± 7.16) ISQ for the conventional threaded implant group and (71.71 ± 3.99) IS Q for the deep threaded implant group, with a significant increase in primary stability of deep threaded implant than conventional threads (P-value=0.0008).

these results were consistent with the study by Reinaldo, et al.[17)], which concludes shorter thread pitch and deeper thread depth can improve the primary stability of short dental implants on D4 bone density., and the study by LEE, Sun-Young, et al [18], which showed that Dental implants with deeper thread depth have higher primary stability lead to successful osseointegration and decrease implant failure in areas of poor-quality bone.

This study is consistent with the findings of other authors as well. Gehrke et al. [19] examined a related relationship and discovered that broad pitches had higher primary stability than tight pitches, while Elitsa et al. [20] discovered that higher thread profiles had better primary stability. According to McCullough and Klokkevold [21], implant stability as determined 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 showed that the Micro thread design implants show higher stability (as calculated using ISQ) than the Macro thread design in the lower jaw, the deep thread implants show high primary stability.

The difference between the two studies is that the lower jaw is different from than upper jaw in bone nature lower jaw has a higher bone quality than the upper jaw which explain why implant with macro threads show a high value of primary stability.

Furthermore, there was a significant improvement in the secondary stability measured 6 months in both groups with no significant difference between both groups in secondary stability (P value=0.361). The mean value of the conventional implant group was (70.57±3.26) ISQ, and for the deep threaded implant group, it was (72.43±1.99). An increase in ISQ values for secondary stability indicates that the osseointegration process gradually gained at the implant-bone interface.

Several methods used in the assessment of bone alveolar bone density such as histological and morphometrically measurement, micro-computed tomography, quantitative-computerized tomography, dual-energy x-ray absorptiometry scan, magnetic resonance imaging torque-measuring micrometer and cone beam computed tomography[22].

Bone density is a crucial parameter that indicates bone quality and influences the initial stability and survival rate of implants. In the current study, bone density was assessed using CBCT. According to Razi et al.[23], there is a high connection between the HU in CT scans and the voxel grayscale in CBCT, indicating that bone density may be estimated using the voxel value in CBCT.

On the preoperative CBCT, group I's bone density values were (415.50 ± 32.63) and group II's bone density values (423.50 ± 49.45). This outcome was consistent with prior research conducted by Sogo et al.[24], which found that the majority of the posterior maxilla's bone was categorized as D3 (350-850 HU) or D4 (150-350 HU) according to Misch's classification.

There was no significant difference in the bone density values on the immediate postoperative CBCT between the two groups. The mean density value of bone density was (446.23±31.29) for the conventional threaded implant group and (458.00 ± 34.24) for the deep threaded implant group.

After 6 months of implant installation, our sample's mean bone density rose considerably during the six months following surgery (543.46±44.61 for group I and 567.07±9.36 for group II). The findings indicate that the mean bone density increased significantly over the course of the two follow-up periods in both groups for every case. These findings are in line with those of a prior study conducted by Naser et al.[25], which compared continuous films taken over time at various time scales to investigate changes in alveolar bone and bone density surrounding dental implants. The average density obtained at various standard densitometry stages revealed a gradual increase in bone density throughout the phase.

CONCLUSION

The current study's findings shown that: When compared to conventional threads, dental implants with deeper threading demonstrated greater primary stability, with a statistically significant difference. There were no discernible variations between the two implant morphologies in terms of discomfort and swelling of the face, peri-implant bone density, or bone resorption over time. In implant sites where bone quality is poor, deeper threads may be beneficial.

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