



## EFFECT OF DIFFERENT INSERTION TORQUE TYPES ON STABILITY OF TAPERED IMPLANTS WITH KNIFE- EDGE THREAD DESIGN

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### ABSTRACT

**Objectives:** The present study evaluated the effect of different insertion torque types on stability of tapered implants with knife- edge thread design. **Subjects and methods:** Twenty four Patients were randomly assigned into three groups according to the peak torque value recorded during implant insertion: Group 1: low torque application (<30 N/cm). Group 2: medium torque application (30< IT <50 N/cm). Group 3: high torque application (>50N/cm). Dental implants were evaluated clinically and radiographically. (IT) and (ISQ) values were recorded during implant insertion for each group. ISQ values were recorded also at 3 and 6 months. Crestal bone level were recorded using RVG at baseline, 3months and 6months. Bone density were recorded by CBCT at baseline and at 6 months after surgery. **Results:** There was a positive correlation between Overall Torque and stability after 3 and 6 months. A general linear relationship between insertion torque and implant stability. High Torque group showed the higher crestal bone loss and bone density than the other groups. **Conclusion:** Knife edge threaded design implant showed a satisfactory stability including implants inserted with low torque. High torque group showed the highest stability and increasing in bone density, but also it showed the highest crestal bone loss.

**KEYWORDS:** Torque types, stability, tapered implants, knife- edge thread design.

### INTRODUCTION

Dental implants have been regarded as a reliable treatment option for both partial and total edentulism rehabilitation. Several noninvasive methods for evaluating implant stability have been proposed, including Periotest<sup>(1)</sup>, Dental Fine Tester, and Implatest conventional impulse testing<sup>(2)</sup>; however, implant insertion torque measurement (IT)<sup>(3)</sup> and resonance frequency analysis (RFA) are the most widely used techniques<sup>(4)</sup>. The frictional resistance that the implant encounters while moving forward

apically through a rotatory movement on its axis is measured by insertion torque. The response of a magnetic device screwed onto the implant when excited by small sinusoidal signals is measured by RFA<sup>(5)</sup>.

Numerous studies have investigated the relationship between IT and implant stability quotient (ISQ), but no clear findings have been found. It has been suggested that the two parameters have a direct relationship<sup>(6)</sup>, but another study found no statistically significant correlations<sup>(7)</sup>.

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As a result, knowing the individual response of each implant shape in terms of primary stability when inserted at various torques would be beneficial: knowing the ideal IT would allow the clinician to better adapt the site preparation procedure to the specific implant, optimizing primary stability without putting undue stress on the bone implant system<sup>(9,10)</sup>.

In view of these, the aim of this present study was to evaluate the effect of different insertion torque types on stability of tapered implants with knife- edge thread design.

## SUBJECTS AND METHODS

**Study Setting and Population:** Twenty-four patients (12 male and 12 female) were participated in this study. Patients, seeking for restoring missing teeth, were selected from outpatient clinic, Department of Oral Medicine, Periodontology, Oral Diagnosis and Oral Radiology, Faculty of Dental Medicine, Boys, Cairo, Al- Azhar University.

**Inclusion Criteria:** Patient age range (25-40 years), edentulous sites in posterior mandibular area indicated for dental implant treatment, based on accurate diagnosis and treatment plan, the minimum height of the residual bone crest in the programmed implant site  $\geq 11$  mm and the minimum thickness  $\geq 6$  mm. **Exclusion Criteria:** Heavy smokers<sup>(11)</sup>, patients those have allergy to any material or medication used in the study and medically compromised patients according to modified Cornell medical index<sup>(12)</sup>

**Sample size:** According to analyses of the implant stability quotient (ISQ)<sup>(13)</sup>, sample size calculation was undertaken via G power version 3.1 statistical software based on the following pre-established parameters: an alpha-type error of 0.05, a power test of 0.80, a total sample of at least 24 subjects (8 subjects for each group) appeared to be sufficient.

### Intervention

Preoperative CBCT were taken to assess the bone height and thickness to aid in implant site analysis. In all groups, two-stage implant surgical technique were utilized. Implant surgery were done under

local anesthesia with minimal flap reflection as much as possible. The future implant osteotomy was prepared according to manufacturer's guidelines to receive the appropriate dental implant.

Patients were randomly assigned into three groups according to the peak torque value recorded during implant insertion:

Group 1: low torque application (<30 N/cm)

Group 2: medium torque application (30 < IT < 50 N/cm)

Group 3: high torque application (>50 N/cm).

### Observations and follow up:

Dental implants were evaluated clinically and radiographically.

I- Clinical parameter including: (IT) and (ISQ) values were recorded during implant insertion for each group. ISQ values were recorded also at 3 and 6 months.

II- Radiological assessment:

Crestal bone level were recorded using RVG at baseline, 3months and 6months. (Figure 1)

Bone density were recorded by CBCT at baseline and at 6 months after surgery.

**Ethical Consideration:** Nature of the study were explained to patients, upon their agreement they were asked to sign a written consent form.

**Statistical analysis of the data:** The significance of the difference in ISQ among the tested groups at different time intervals was assessed by Two-way ANOVA test followed by Tukey's test for pairwise comparisons: The significance of the difference in ISQ among groups at base-line was assessed by One-way ANOVA test followed by Tukey's test for pairwise comparisons: The strength of the association between IT and ISQ was assessed by Spearman Rho correlation coefficient: this analysis was performed for the whole sample and within each experimental group. Paired t-test for comparison of crestal bone loss at medium toque at 3- and 6-months' time intervals. Age and gender by Chisquare test.

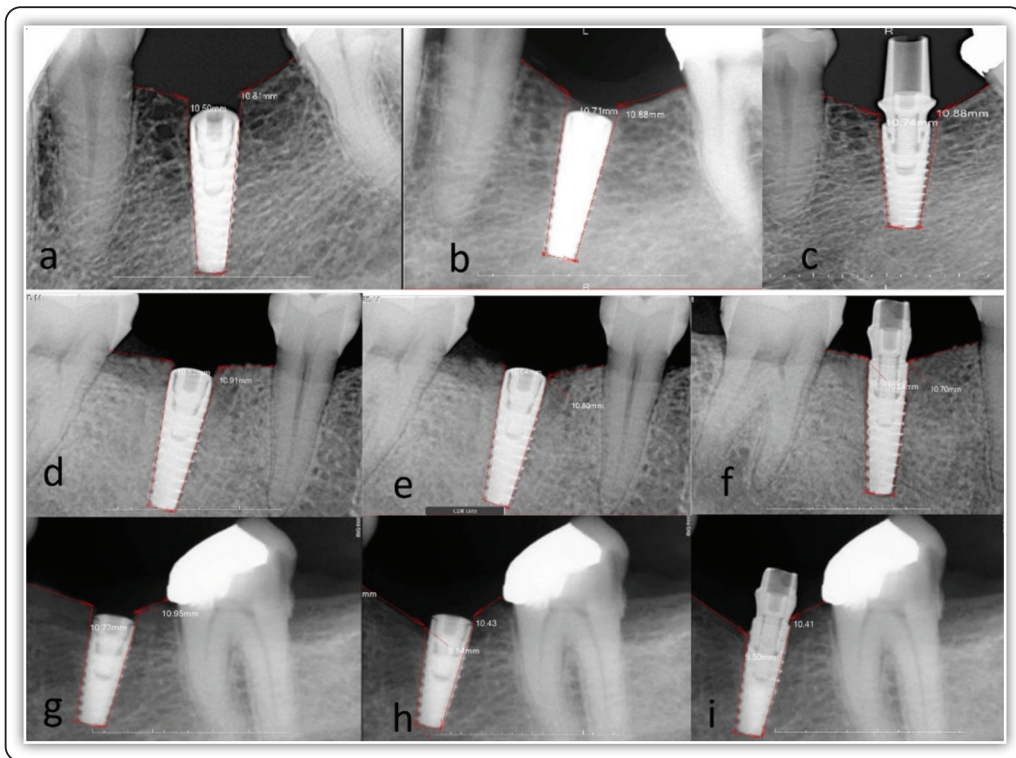


FIG (1) a-c, A periapical radiograph measuring crestal bone level at base line, 3, and 6 months of low torque group. d-f, A periapical radiograph measuring crestal bone level at base line, 3, and 6 months of medium torque group. g-i, A periapical radiograph for measuring crestal bone level at base line, 3, and 6 months of high torque group.

**RESULTS**

ISQ after 3 and 6 months among the tested groups was significant. High Torque group showed higher ISQ values than the other two groups.

After 3 and 6 months, there was a positive correlation between overall torque and stability in the current study. A general linear relationship between insertion torque and implant stability was

found to be statistically significant across the entire sample. (Table 1)

Crestal bone loss after 3 and 6 months among the tested groups was significant. High Torque group showed higher crestal bone loss than the other two groups. Bone density after 3 and 6 months among the tested groups was significant. High Torque group showed higher bone density than the other two groups. (Table 2)

**TABLE (1)** Correlation coefficient between insertion torque and implant stability at baseline.

Variable	IT	ISQ	Rho coefficient ( $r_s$ )	$p$ (2-tailed)
Low Torque	21.625±2.326	73.5± 2.928	0.9448	0.0004*
Medium Torque	44.75±2.252	79.13±2.850	1	0*
High Torque	62.5±6.887	88.75±5.258	0.98795	0*
Overall Torque	42.96±17.603	80.46±7.407	0.77315	0.00001*

**TABLE (2)** Comparison of Age, ISQ, Crest bone loss, Bone density among the tested groups at different time intervals.

	Low Torque	Medium Torque	High Torque	P value
<b>Age</b>	31.0±2.507	30.25±4.1662	30.5±3.1168	0.900861
<b>ISQ</b>				
Baseline	73.5±2.928	79.13±2.850	88.75±5.258	
3 months	75.0±2.673	80.5±2.879	83.5±3.586	
6 months	79.13±2.850	85.13±3.603	83.13±3.357	0*
		<i>p</i> -value= 0*		
<b>Crest bone loss</b>				
After 3 months	0.400 ± 0.107	0.500 ±0.076	0.725 ±0.149	0.000042*
After 6 months	0.538 ± 0.092	0.750 ±0.093	0.975 ±0.175	< 0.00001*
	0.0038*	0.0001*	0.0001*	
<b>Bone density</b>				
After 3 months	326.25±35.03	490±44.72	845±77.83	< 0.00001*
After 6 months	596.25±56.30	651.11±35.862	836.25±42.741	< 0.00001*
	0.0001*	0.0001*	0.5905	

## DISCUSSION

The presence of sufficient primary stability of the implant, along with other factors such as minimally traumatic surgical technique<sup>(14-17)</sup> and the macro- and micro-geometry of the fixture<sup>(18-20)</sup>, has been considered as critical factor in achieving and maintaining implant osseointegration. However, it is more difficult to define and control the various variables that influence the achievement of sufficient primary stability.

The ultimate goal of surgery is common to all implant systems, but there is no universal technique for preparing the implant bed, as several factors can contribute to the surgical stability of the fixation. These include preparation undersizing<sup>(21,22)</sup>, implant microgeometry<sup>(23,24)</sup> and microgeometry<sup>(21-25)</sup>, together with the qualitative and quantitative properties of the host bone (especially the cortical thickness)<sup>(21)</sup>.

The most commonly used parameters in this regard are insertion torque and RFA, and their

relationship has been extensively studied. A systematic review of over 2000 studies found that insertion torque and RFA were both independent and unrivalled methods for determining implant primary stability<sup>(25)</sup>.

Bone density dictates the mechanical properties of the bone bed, which may suffer changes during healing depending on the surgical protocol, since the more porous, more elastic, and well vascularized trabecular bone favors the formation of a dense cortical bone near the surface of the implant, guaranteeing the achievement of biological stability and successful osseointegration<sup>(26,27)</sup>.

The characteristics of the recipient site played a crucial role in the current study, in which implant site preparation followed a standardised protocol; higher IT values were recorded in sites with dense cortical bone (mandible). During the early stages of healing, excessive bone compression may result in a significant reduction in bone-to-implant contact. As Initial stability depends on bone density and the implant geometry<sup>(28)</sup>.

As it has been postulated that primary stability of the implant depends on bone density and quality, optimal implant dimensions, implant macrostructure and under preparation of the osteotomy site; in the present study, implants with standard length and diameter were used. These implants characterized by an adequate design, mainly due to the deepness and the cutting performance of the threads. The screwing of self-tapping implants in the underprepared osteotomy causes the engagement of the threads in the peri implant bone together with bone compaction. They have knife-edge thread pattern. The thread design was said to provide "maximum bone-to-implant contact, maximum compressive force resistance, and minimal shear force production," ensuring stability<sup>(29)</sup>.

The present study was conducted to evaluate these implants and to assess primary stability by RFA when inserted at different torque levels. The implants examined showed a satisfactory primary stability, even when they were inserted with low torque values, which was reported previously for the same type of implant<sup>(30)</sup>.

In present study, patients were divided into three groups: low, medium and high torque groups. Implants placed with adjusted torque motor and ISQ recorded at base line. High Torque group showed the higher ISQ than the other groups. A general linear relationship between insertion torque and implant stability; the strength of this correlation resulted statistically significant level for the entire sample. These results are consistent with previous research that found a link between insertion torque (IT) and implant stability quotient (ISQ) in tapered implants with knife-edge threads<sup>(13)</sup>.

Additionally, ISQ was recorded after 3 and 6 months among the tested groups. Regarding Overall Torque, there was a positive correlation with stability after 3 and 6 months. Low and medium torque group showed increasing stability after 3 and 6 months than high torque group. These findings

matched those of a study that looked at the primary and secondary stability of implants in the posterior maxilla. They came to the conclusion that assessing primary and secondary implant stability could help improve implant survival/success rates in crucial locations<sup>(31)</sup>.

Rodrigo et al. demonstrated that the evaluation of RFA values (ISQ) had a statistically significant correlation with implant outcome<sup>(32)</sup>. Turkyilmaz et al.<sup>(33)</sup> found a positive strong correlation between bone density (and IT/ISQ insertion torque, as well as a positive correlation between IT and ISQ.

Crestal bone level was recorded for each implant after 3 and 6 months and among the tested groups was significant. High Torque group showed the higher crestal bone loss than the other groups. These findings are consistent with observations that implants inserted with high IT had invariably considerable crestal bone loss and soft tissue recession at 3-year follow-up compared to implants placed with standard IT<sup>(34)</sup>. In previous follow-ups at 1 and 2 years, a similar pattern was observed for the same type of implants<sup>(35)</sup>. Aldahlawi et al.<sup>(36)</sup> compared crestal bone levels (CBLs) of self-tapping bone condensing implants placed with high insertion torque (IT) to those placed with low IT. Barone et al.<sup>(37)</sup>, on the other hand, studied and compared the clinical outcomes of implants placed in healed ridges with high insertion torque (50 Ncm to 100 Ncm) versus regular insertion torque (within 50 Ncm). The study found no differences in the marginal bone between the two groups .

Additionally bone density was recorded for each implant at base line and after 6 months and among the tested groups was significant. High Torque group showed higher bone density than the other groups. Accordingly, a study found that as bone density increased, the IT and initial stability increased as well, resulting in a strong positive correlation. To put it another way, initial stability was found to be highly reliant on bone density<sup>(38,39)</sup>.

## CONCLUSION

1. Knife edge threaded design implant showed a satisfactory stability including implants inserted with low torque values.
2. High torque group showed higher ISQ and in bone density values, but also showed the higher crestal bone loss when compared with the other two groups.

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