

# A Study to Evaluate The Influence of Thread Designs Affecting Stability of Immediately Loaded Implant at Maxillary Posterior Region

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## Abstract

**Purpose:** For successful osseointegration of an immediately loaded implant, the fundamental element is primary stability. Establishment of primary stability is influenced by combination of various factors one of them being implant geometry. Evaluation of primary stability and the factors influencing it is essential for successful treatment outcome.

**Methods:** A total of 20 patients were divided into two groups. the implant placed in group I was with square thread designs (Ankylos® implant ,DENTSPLY, Sirona) and group 2 was V shaped thread design MIS seven implant( MIS implant Ltd, Israel) in the pre molar-molar region. The stability was assessed with the aid of resonance frequency analysis (Osstell™, Integration Diagnostics, Sweden) at the time of implant placement, at three months and at six months. A repeated measure ANOVA and Bonferroni Pairwise comparison was used to compare the ISQ within each group.

**Results:** There was a statistically significant difference in the stability at baseline to six months ( $p=0.006$ ), from baseline to three months ( $p=0.006$ ) and from three months to six months ( $p<0.001$ ) in both the groups. Correlation could be found between implant geometry and stability observing improved stability in group 1 compared to group 2.

**Conclusion:** The result from this material showed that the all implants were successfully osseointegrated with a mean ISQ of 80 and 71 at six months in group I and group II respectively. Implants with square threads showed a higher stability at baseline, at three months and at six months in comparison to the v shaped thread.

**Keywords:** *Isq, Ostell, V Shaped Impalnts, Implant Stability*

## Introduction

Tooth loss can result in functional as well as esthetic debilitation. With advance in implant design and surface

texture combined with a popular need for reduced treatment time immediate loading in implant supported prosthesis is a predictable treatment option. However the success of immediately loaded implants depends upon the integrity of the bone to implant interface that is essentially determined by primary stability.<sup>1</sup>

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Primary stability is the lack of motion of an implant after its installation into the surgical site influenced by quality of the bone and density, surgical bed and implant body design. Initial bone to implant contact is identified in prevention of interfacial micro movement, a crucial

factor in attaining increased primary stability which is a pre requisite for immediate loading

Therefore the aim of this study was to assess if the level of implant stability is affected by thread design in the maxillary posterior region.

### Aims and Objectives

To evaluate the stability of immediately loaded implants of V shaped tapered thread design and square shaped tapered thread design.

To compare and monitor the changes in implant stability of V shaped and square shaped thread designs at the time of placement, three and six months following placement

### Materials & Methods

The study was conducted on a total of twenty patients in a University set up Pre-operative assessment to evaluate adequate or optimal bone height was considered a pre requisite.

#### Inclusion Criteria:

- ž Maxillary posterior regions
- ž adequate bone height and width for implant placement
- ž Sufficient bone volume without the need for bone augmentation procedures.
- ž Healed maxillary edentulous region.

#### Exclusion Criteria

- Presence of systemic diseases:
  1. Uncontrolled diabetes mellitus
  2. Hypertension
  3. Hard and soft tissue pathology
- ž Use of medications detrimental to the process of healing.
- ž Harmful oral habits such as smoking and bruxism
- ž Presence of any active infection
- ž Limited mouth opening

Group I received the square shaped thread design implants. (ANKYLOS, Dentsply Sirona) and the group II received the V shaped thread design (MIS Implant Technologies Ltd, Israel)

#### Osstell-Implant Stability:

The resonance frequency analysis is determined by the Osstell™ (Integration Diagnostics, Sweden) device in assessing implant stability and osseointegration. The instrument is attached to a probe via a cable and the measurements are displayed on the backlit display. The instrument comes attached with a power supply, a smart peg mount and an ISQ probe.

#### SmartPeg:

The smartpeg resonates and measurements are made only when attached to the implant. The pegs are of single use and soft in material hence cannot be reused.

According to the SmartPeg reference guide, the smartpeg used for this study was: MIS SEVEN IMPLANT: Type 32 Article 10040

ANKYLOS IMPLANT: Type 16 Article 100388

#### Micromotion and Implant Stability Quotient:

There is a co-relation between lateral load and micro motion. Increase in the lateral load leads to resultant increase in the micro motion. However, this is also influenced by the different bone quality. Osstell™ (Integration Diagnostics, Sweden) thereby acts by measuring this micro motion with the aid of resonance frequency of smart peg.<sup>2</sup>

#### Surgical Protocol:

Prior to the operation patient were subjected to a prophylactic antibiotic therapy

A mid crestal incision was given in the edentulous area using a bard parker handle. A full-thickness mucoperiosteal flap was raised.

Sequential drills were used and osteotomies were performed following the manufacturers drilling sequence for each implant system. The implant length and diameter to be placed were based on the pre-assessed availability of bone height and width at a speed of 25 Ncm assessed by a physio dispenser. Immediately after implant placement,

the implant stability quotients were assessed with the aid of Osstell™ (Integration Diagnostics, Sweden) device. Followed by the measurement of the ISQ, an abutment were inserted and manually torqued. A provisional prosthesis made with temporary acrylic resin (3M ESPE, Protemp 4) was cemented

**Measurement of Implant Stability:**

After implant insertion, the resonance frequency analysis was assessed using the Osstell™ (Integration Diagnostics, Sweden) for establishment of implant stability quotient. The SmartPeg is tightened with 4-5Ncm finger tight pressure using the mount. The SmartPeg acts as a sensor for the vibration induced by the transducer probe held at a distance of 3-4 mm which is attached to the instrument via a cable and measurements are displayed on the back-lit display. In the current study measurement are obtained in one direction, buccolingually.

At each follow up sessions, the abutments were untorqued and the Smartpeg was re-inserted and stability was assessed followed by radiographic assessment.

**Prosthetic Procedure:**

**Fabrication of Provisional Prosthesis:**

Diagnostic impression was made prior to the implant surgery and a mock up template of the tooth being replaced were custom made. The silicone putty index of the prepared mock up guide was carried into the patients' mouth with a high fracture resistance temporization material (3M ESPE PROTEMP 4). The prosthesis was then analyzed and evaluated for no occlusal contacts in centric and excursive movements

Patient was recalled six months after surgery for final prosthesis.

**Results**

Descriptive statistics mean, standard deviation were calculated. Unpaired t test was used to calculate ISQ values between the Square shaped and V shaped design. Repeated measures ANOVA was used to compare ISQ values within the square shaped and also within V shaped design. P<0.05 is considered to be statistically significant. Microsoft Excel and IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp was used for statistical analysis.

**Table 1: Implant Stability between two groups at baseline, three months and six months-Buccal**

	Group	N	Mean	Std. Deviation	t	P	95% Confidence Interval of the Difference	
							Lower	Upper
Baseline	Square shaped thread design	10	78.20	5.245	3.726	0.002	3.838	13.762
	V shaped thread design	10	69.40	5.317				
3 months	Square shaped thread design	10	75.20	5.712	2.821	0.011	1.864	12.736
	V shaped thread design	10	67.90	5.859				
6months	Square shaped thread design	10	80.00	4.807	3.473	0.003	3.279	13.321
	V shaped thread design	10	71.70	5.832				

**Buccal**

The mean and standard deviations of the implant stability at baseline, three months and six months was compared. The mean ISQ increased in square shaped thread design and it differed significantly at baseline (P=0.002), three months (0.0110) and at six months (0.003)

**Table 2: implant stability between two groups at baseline, three months and six months-lingual**

Group	N	Mean	Std. Deviation	t	P	95% Confidence Interval of the Difference		
						Lower	Upper	
Baseline	Square shaped thread design	10	78.00	5.375	3.535	0.002	3.448	13.552
	V shaped thread design	10	69.50	5.380				
3 months	Square shaped thread design	10	75.30	5.908	2.627	0.017	1.501	13.499
	V shaped thread design	10	67.80	6.828				
6months	Square shaped thread design	10	80.00	4.807	3.713	0.002	3.777	13.623
	V shaped thread design	10	71.30	5.638				

**Lingual**

The mean and standard deviation of the implant stability at baseline, three months and six months was evaluated. The mean ISQ increased in square shaped thread designs compared to vshaped thread designs and it differed significantly between the groups at baseline (P=0.002), three months

(P=0.017) and at six months (P=0.002)

**Table 3: implant stability in square shaped thread design from baseline to six months- Buccal**

	Mean	Std. Deviation	N
Baseline	78.20	5.245	10
3 months buccal	75.20	5.712	10
6months buccal	80.00	4.807	10

F=47.250 P<0.001

The data obtained from the group 1 so revealed that ISQ in square shaped thread design differed significantly from baseline to six months.

**Table 4: Implant stability in square shaped thread design from baseline to six months- Lingual**

	Mean	Std. Deviation	N
Baseline	78.00	5.375	10
3months lingual	75.30	5.908	10
6 months lingual	80.00	4.807	10

F=41.609 P<0.001

The data obtained in table 4 so revealed that the mean ISQ in square shaped thread design lingually differed significantly with a P value of 0.001.

**Table 5: Implant stability in V shaped thread design from baseline to 6mths-Buccal**

	Mean	Std. Deviation	N
Baseline	69.40	5.317	10
3 months buccal	67.90	5.859	10
6months buccal	71.70	5.832	10

F=11.101 P=0.001

The data obtained from table 5 revealed that ISQ in v shaped thread design from baseline to six months differed significantly

**Table 6: Implant stability in V shaped thread design from baseline to 6 months- Lingual**

Lingual

	Mean	Std. Deviation	N
Baseline	69.50	5.380	10
3months lingual	67.80	6.828	10
6 months lingual	71.30	5.638	10

F=6.457 P=0.008

The data obtained in table 6 so revealed that the ISQ lingually differed significantly with a P value of 0.008 in group II.

## Discussion

The field of implant dentistry has undergone rapid evolution in the last two decades. The original machined surface implant advocated by Branemark required a healing period of three to six months prior to placement of a definitive prosthesis. Advances in surface texture and implant geometry coupled with patient's demand for a faster treatment, have resulted in shorter healing periods and predictable osseointegration.<sup>3</sup> Thus loading protocols have also been modified. It is a well-known fact that dense bone provides better stabilization of the implant fixture leading to a more predictable osseointegration. In cases of immediate loading any occlusal or muscular forces applied to the prosthesis is transmitted to the surrounding bone through its implant fixture. Thus in case of immediate loading with areas of dense bone such as the maxilla factors such as implant design assumes a greater role.<sup>45</sup>

The angle formed between the lines drawn from the long axis of the implant to the thread face is termed the face angle.<sup>15</sup> It has been reported that with increase in the face angle, shear stress is increased. According to various studies, V shaped thread design has an angle of 30 degree. Thus Greater forces are generated by the V shaped thread design and due to the decreased face angle of square shaped threads they minimize the stress acting on an implant.<sup>4,6,7</sup>

Interspace between the major and minor thread diameter is the thread depth. It is agreed that shallow thread depth aids in easier implant placement. Enhanced bone contact can be achieved due to the increase in the functional surface area of the threads frequently seen in square shaped threads.<sup>4</sup> Deeper threads also proved beneficial for the placement of implant in soft bone and regions of high occlusal load.

The current study included a total of 20 patients divided into two groups of 10 each. Implant stability was later assessed at baseline, three months and at six months. An initial ISQ of  $78.20 \pm 5.245$  for group I and a mean ISQ of  $69.40 \pm 5.317$  was achieved respectively which was appreciable for immediate loading as suggested by studies done previously. Several studies have proved the influence high primary stability on the success rate of implants thus providing information in detecting failing implants.<sup>8</sup>

It was also observed that the stability at baseline was considerably higher for group I when measured buccally and lingually with a mean ISQ of  $78.20 \pm 5.245$ . The result obtained was in level with the study performed by Torrella et al which achieved a higher primary stability with tapered square shaped thread in comparison to the cylindrical implants with v shaped thread design. Thus it can be concluded that implant design plays a crucial role in implant stabilization the reason being deeper thread patterns that allows for a large surface area for bone to contact. Thus thread design has an influence on osseointegration.<sup>46</sup>

The mean ISQ for group I and group II comparatively decreased at 3 months  $75.20 \pm 5.712$  and  $67.90 \pm 5.859$  respectively when measured buccally and  $75.30 \pm 5.908$  and  $67.80 \pm 6.828$  when measured lingually. The results obtained were in relation to the study conducted by Glauser et al where the implant stability quotient dropped at three months due to the extensive remodelling that takes place.<sup>8</sup>

However all implants were clinically stable at six months with a mean ISQ of  $80 \pm 4.807$  and  $71.70 \pm 5.832$  when measured buccally with no difference in the lingual measurement ISQ of  $80 \pm 4.807$  and  $71.3 \pm 5.638$

The stability of implant fixture in the bone was assessed using resonance frequency analysis. The results obtained revealed a significant rise in stability of group I and group II implants from baseline to six months i.e. the mean ISQ for group I was observed to increase from 78.2 to 80 and 69.4 to 71.7 for group 2.

The results reported were in accordance to the study conducted by Sennerby et al where after the drop in ISQ at three months there was a gradual increase in between 3-12 months which is the possible time for bone remodelling cycle to occur. Glauser et al have reported that this change was due to the interfacial stiffness of the bone and the bone to implant interface. The probable reason given by the authors for low implant stability at three months was due to the relaxation of the stress between the bone and implant that was created during implant insertion.<sup>8</sup> Sennerby et al claim that this can be also due to the regular healing pattern of the cortical bone in response to the surgical wound created. According to a study the entire time frame for bone remodelling takes about 4 months.<sup>28</sup>

Other than the mechanical determinants required for stabilizing the implant bone density also plays an essential role in immediate loading. In the present study both the group of implant were placed in the maxillary posterior region and the bone is said to be softer in this region. Thus it was found that the fixtures showed a higher initial stability contradicting various other studies. With regards to the assessment of stability no errors were detected in the resonance frequency analysis. The stability quotients were consistent at initial, third and six months post implant insertion. Thus in accordance to the study conducted by Huang et al it can be concluded that magnitude of load in regions with poor density can be effectively estimated by resonance frequency analysis.

### Conclusion

In conclusion the data obtained from the present study reveals establishment of a good primary stability is essential for the success of immediate loading and thereby is influenced by various other factors such as the quality of bone and implant geometry. It can also be concluded that in regions of unpredictable initial stability increasing the surface area of an implant with deeper thread design with a smaller pitch or face angle can aid in a predictable outcome. The stability assessed by resonance frequency was reliable and reproduced the implant stability with accuracy. The device showed a decrease in ISQ in region of compromised implant positions thereby reporting that it was greatly influenced by bone density and implant position.

**Conflicts of Interest:** There are no conflicts of interests.

**Ethical Clearance:** Taken from the institutional committee

**Source of Funding:** Self

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