ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 6, Issue – 5, October - 2023, Page No. : 155 - 162

Comparison of implant stability quotient (ISQ) values & insertion torque (IT) values for evaluation of stability of implants placed in immediate extraction socket - A clinical study.

[1]Diwakar Vasudev, Assistant Professor, Department of Oral and Maxillofacial Surgery, Dasmesh Institute of Research and Dental Sciences, Faridkot, Punjab

[2]Manoj Goyal, FDSRCS Professor, Department of Oral and Maxillofacial Surgery, Santosh Dental College and Hospitals, Ghaziabad, NCR, Delhi

[3]Sonia Chawla, MDS (Oral and Maxillofacial Surgery)

[4]Asheen Gupta, Assistant Professor, Department of Oral and Maxillofacial Surgery, Dasmesh Institute of Research and Dental Sciences, Faridkot, Punjab

[5]Akanksha Garg, Senior Lecturer, Department of Paedodontics & Preventive Dentistry, Inderprastha Dental College & Hospital, Ghaziabad, Uttar Pradesh

[6]Dhananjay Vasudeva, PG Student, Department of Prosthodontics Crown & Bridge, Desh Bhagat Dental College, Mandigobindgarh, Punjab

Corresponding Author: Diwakar Vasudev, Assistant Professor, Department of Oral And Maxillofacial Surgery, Dasmesh Institute of Research And Dental Sciences, Faridkot, Punjab

Citation of this Article: Diwakar Vasudev, Manoj Goyal, Sonia Chawla, Asheen Gupta, Akanksha Garg, Dhananjay Vasudeva, "Comparison of implant stability quotient (ISQ) values & insertion torque (IT) values for evaluation of stability of implants placed in immediate extraction socket - A clinical study", IJDSIR- October - 2023, Volume – 6, Issue - 5, P. No. 155 – 162.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Objective: The objectives of the study was to determine the reliability & utility of insertion torque (IT) values & implant stability quotient (ISQ) values for evaluation of stability of immediately placed implant in the extraction socket.

Material and methods: Resonance frequency analyser (RFA) and torque wrench devices were used for recording ISQ values & IT values respectively. 10 implants were placed in the 6 patients & all implants were placed immediately after extracting the tooth.

Results: Mean IT value was 33 Ncm at Stage I implant surgery mean ISQ values were 34.30 at stage I and 64.50 at stage II implant surgery. Pearson correlation was statistically significant when IT values were compared with stage I & Stage II ISQ values ($P < 0.001$). IT values and ISQ values are not affected by implant length and implant diameter.

Conclusion: Regarding the reliability and utility of both device values, IT values and ISQ values are equally reliable for assessing the primary stability of implant, but for assessing the secondary stability of implant IT is not as reliable as the ISQ. In case of utility, it seems to be more of ISQ as compared to IT as implant stability can be assessed at any stage of osseointegration by ISQ values which is not possible by IT values.

Keywords: Immediate implant, RFA, Torque wrench, Stage I implant surgery, Stage II implant surgery.

Introduction

Concept of immediate implant placement following tooth extraction was introduced in 1976 by Schulte & Heimke.[1] Osseointegration is essential for clinic success of the implant driven restoration, which is a measure of clinical immobility of an implant. The implant stability can be classified into 2 categories, primary stability which is acquired while inserting the implant, which we get after the mechanical engagement of implant with bone and secondary stability which is biological stability which we get when there is bone formation around the implant.[2]

Measuring implant stability is important for evaluating the success of implant. Many clinical and experimental methods of measuring osseointegration and implant stability have been developed. Histomorphic research, tensional test, push-out/pull-out and removal torque test are classified as ***destructive methods***. Whereas percussion test, radiography, cutting torque test while placing implants, periotest, and resonance frequency analysis (RFA) are ***non destructive methods***.[3]

In the present study insertion torque (IT) values and implant stability quotient (ISQ) values were used for assessing the stability of implant. For recording IT values and ISQ values **Torque wrench** device and **Resonance frequency analyser (RFA)** device were used respectively.

IT values are calibrated over the Torque wrench from 1 to 45 Ncm which can be noted while inserting the implant. After 45 Ncm IT value is calibrated as infinity.[4] Where as ISQ values are generated from 1-100 electronically in RFA device, which can be recorded at any stage of osseointegration after implant placement.[5]

IT values and ISQ values of each implant were taken and compared scientifically. With this reliability & utility of both IT values and ISQ values were checked for evaluating implant stability in immediate extraction socket.

Materials And Methods

In the Department of Oral and Maxillofacial surgery at Santosh Dental College and Hospital NCR, Delhi 10 implants were placed in 6 patients. 7 implants were placed in maxilla & 3 implants were placed in the mandible. The minimum follow up period was of 6 months. When implants were placed during stage I implant surgery both the IT values and ISQ values were noted, and when implants were loaded that is during the stage II implant surgery only ISQ were noted.

Criteria for the selection of the patients

The inclusion criteria:

Patients of age between 20 to 60 years, fractured tooth or avulsed tooth following trauma, all those cases of a recurrent failure of endodontic therapy and any chronic inflammatory periodontal disease.

The exclusion criteria:

Systemic factors: Heavy smokers, blood dyscrasias, tobacco chewers, drug abusers, psychiatric individuals with disorders, immunocompromised candidates, uncontrolled diabetes mellitus (DM), alcoholics.

Local factors: Insufficient interarch distance, unfavourable implant axis orientation, inadequate bone

apical to proposed extraction, acute periapical pathology at the site of extraction.

Torque Wrench

Torque wrench is an implant ratchet which is calibrated with different torque values from 5-45 Ncm. It is used to insert the implant in the prepared anatomical site. The force used to insert a dental implant is called insertion torque. It tells us about the bone quality and also tells us about the primary stability of the implant. Higher the insertion torque higher is the primary stability of the implant.

Insertion torque measurement procedure

Torque wrench was taken, and implant was placed using mount driver, final torque was noted with which implant was completely inserted. This final torque value was insertion torque.

Resonance Frequency Analyser (RFA)

Resonance frequency analyser (RFA) is an electronic device which is used to check the stability of the dental implant. It comes with a display unit, a magnetic probe and a smart peg.

Stability is displayed as an implant stability quotient (ISQ) value. The instrument translates resonance frequency values ranging from 3500 to 8500 Hz to an ISQ value of 0 to 100. The higher the ISQ value, more stable the implant is.

The RFA value is determined by changes in the implant bone interface stiffness.

ISQ Measurement procedure

The smart peg was attached inside the implant threads.

Magnetic probe was placed near to smart peg and measurement were taken at different angles (90 degrees). The hand-held probe stimulates the smart peg magnetically, without actually being connect to it - or even touching it.

An ISQ value was generated and shown on the display unit, from 1-100.

Surgical Protocol

A strict asepsis protocol was performed. The face of the patient and oral cavity was cleaned with Betadine solution, after obtaining informed consent all procedure was performed under local anesthesia, teeth were extracted atraumatically and implant were placed immediately in the extraction socket.

Observations And Results

Results showed that 33.3% of the cases were males and 66.6% were females, 66.6% were between the age group of 21-30 years and 33.3% were 31-40years of age.

None of the patient experienced pain at stage I, after 1 month and at stage II.

None of implant showed infection/pus discharge 1 month after placement and at stage II.

None of implant showed mobility at stage I and at stage II.

Soft tissue dehiscence/cover screw exposure was seen in 30 percent of cases and all were showed at stage I.

Mean insertion torque (IT) was 33.00 Ncm (Table 1).

Table 1: Mean IT values

Torque value	Mean	Std Deviation
	33.00	3.49

The mean ISQ, at stage I was 34.30 and at stage II was 64.50, paired t test shows that ISQ significantly increased from stage I surgery to stage II surgery (t-test value = -84.120; P < 0.001) (Table 2).

Table 2: Mean ISQ values

ISQ value	Mean	Std. Deviation	Mean difference	t-test value	p-value
Stage I	34.30	3.52	-30.20	-84.120	< 0.001*
Stage II	64.50	3.31			

Mean IT value for maxillary implants was 31.42 Ncm and for mandibular implants 36.66 Ncm

Mean ISQ value at stage I for maxillary implants was 32.71 and for mandibular implants was 38, and mean ISQ at stage II for maxillary implants 63.14 and for mandibular implants was 67.66.

Mean IT value in D2 bone was 35 Ncm and D3 bone was 30 Ncm, unpaired t test showed that mean IT was significantly more in D2 bone than D3 bone (Table 3)

Table 3: Mean IT values in various bone types

	D2		D3				
	Mean	Std. Deviation	Mean	Std. Deviation	Mean difference	t- test value	P-value
Insertion torque	35	3.16	30	0.00	5	4.335	0.001*

Mean ISQ value in D2 bone at stage I and stage II was 37.20 and 55.56 respectively and mean ISQ value in D3 bone at stage I and stage II was 31.40 and 47.77 respectively, unpaired t test showed that mean ISQ was significantly more in D2 bone than D3 bone (Table 4)

Table 4: Mean ISQ values in various bone types

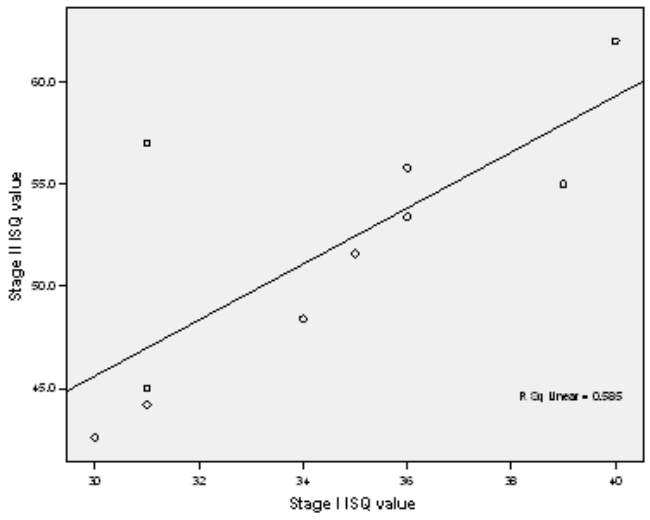
	D2		D3				
	Mean	Std. Deviation	Mean	Std. Deviation	Mean difference	t-test value	p-value
Stage I ISQ value	36.67	2.34	30.75	0.50	5.92	4.892	0.001*
Stage II ISQ value	66.83	1.83	61.00	0.00	5.83	6.230	< 0.001*

When stage I ISQ was compared with stage II ISQ it showed a significant pearson correlation ($r = 0.947$; $p < 0.001$), which means higher the Stage I ISQ higher will be the Stage II ISQ. (Table 5) (Graph 1)

Table 5: Comparison of stage I ISQ with stage II ISQ

Stage I ISQ Value (avg.)	Number	Pearson Correlation	p-value
Stage II ISQ Value (avg.)	10	0.947	0.001*

Graph 1: Graphical representation of comparison of stage I ISQ with stage II ISQ



Insertion torque showed significant pearson correlation with both stage I ISQ ($p < 0.001$) and stage II ISQ ($P = 0.009$), which means ISQ values are affected by the insertion torque values, and which also means that higher the insertion torque higher is the ISQ value (Table 6,7) (Graph 2,3)

Table 6: Correlation of IT with stage I ISQ

		Insertion torque
Stage I ISQ Value (avg.)	Pearson Correlation	0.910
	p-value	< 0.001**

Graph 2: Graphical representation of correlation of IT with stage I ISQ

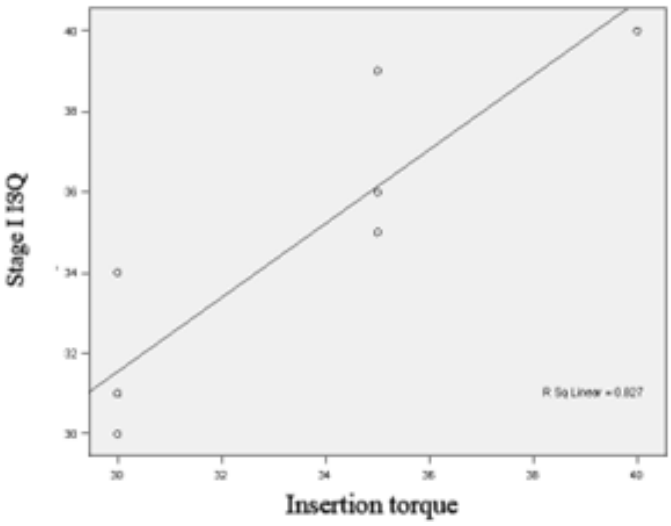
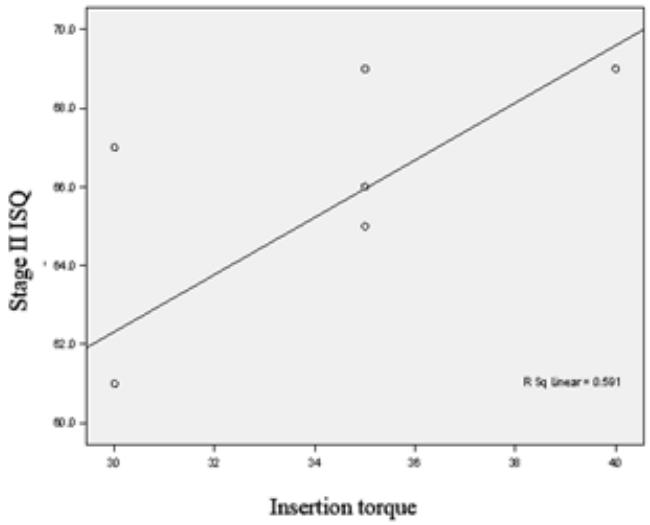


Table 7: Correlation of IT with stage II ISQ

		Insertion torque
Stage II ISQ Value (avg.)	Pearson Correlation	0.769
	p-value	0.009*

Graph 3: Graphical representation of correlation of IT with stage II ISQ



Implant diameter has non-significant pearson correlation with stage I ISQ (p = 0.628), stage II ISQ (p = 0.197) and with insertion torque (p = 0.891) (Table 8)

Table 8: Correlation of implant diameter with IT and ISQ

Implant diameter (in mm)	Pearson Correlation	p-value
Stage I ISQ Value (avg.)	-0.183	0.628
Stage II ISQ Value (avg.)	-0.310	0.197
Insertion torque	0.044	0.891

Implant length has non-significant Pearson correlation with stage I ISQ (p = 0.953), stage II ISQ (p = 0.403) and with insertion torque (p = 0.656). (Table 9)

Table 9: Correlation of implant length with IT and ISQ

Implant length (in mm)	Pearson Correlation	p-value
Stage I ISQ Value (avg.)	-0.014	0.953
Stage II ISQ Value (avg.)	-0.255	0.403
Insertion torque	0.084	0.656

Table 8 and Table 9 showed that stage I ISQ, stage II ISQ and insertion torque were not affected by implant length and implant diameter.

Discussion

Implant stability is achieved at two different stages: primary and secondary. Primary stability of implant comes from mechanical engagement with cortical bone. This primary stability has been acknowledged as an essential criterion for achievement of osseointegration. Bone quality, quantity, surgical technique, implant geometry, length, diameter and surface characteristics affect the primary stability. Where as secondary stability of implant comes from biological stability through bone regeneration and remodelling after the healing period.[6] It is important for the clinician to know the implant stability at various time of osseointegration.[7]

Presently, various diagnostic analysis are available for assessing the implant stability, but in this study we have taken IT values and ISQ values to assess the implant stability and for that we used 2 devices which were torque wrench and resonance frequency analyser (RFA) respectively. Implant stability was assessed objectively with these devices after the placement of implant and prior to loading of implant. We have evaluated any correlation if present between IT and ISQ values, utility of both the devices, and out of them which device is more reliable for assessing the implant stability.

We observed that Torque wrench tells only primary stability of implant, and it does not tell about the secondary stability of implant and stability of implant during the osseointegration period. On the other hand RFA device tells not only about the primary stability of implant but also tells about the secondary stability of implant whose assessment is essential for loading the implant, and the stability of implant at any time during the osseointegration.

According to the present results both of the device values are equally effective in determining the primary implant stability. But for assessing the secondary

implant stability torque wrench is not effective as RFA as we cannot measure the secondary stability with torque wrench, secondary stability can only be assumed with torque wrench. On the other hand RFA can measure both the primary stability and the secondary stability of implant or stability of implant at any stage of osseointergration.

Regarding the reliability and utility of both the device values, both IT values and ISQ values are equally reliable for assessing the primary stability but for assessing the secondary stability IT values are not as reliable as the ISQ values because we cannot get any objective value of IT during secondary stability, secondary stability can only be assumed if operator is using torque wrench. In case of utility, it seems to be more of Ostell RFA device as compared to torque wrench as implant stability can be assessed at any stage of osseointegration by RFA which is not possible by the torque wrench.

Our study showed that there is statistically significant correlation between ISQ values for stage I and stage II ($r = 0.947$; $p < 0.001$). This clearly suggests that higher primary stability of implant during insertion leads to higher secondary stability of implant. Similar study results has been reported by **Huang HM, Chiu Cl et al (2003)**[8] that implants with better initial stability would results in higher secondary stability. Same results were shown by **M.Granic et al (2016)**[9] in their study that higher initial stability results in higher secondary stability.

Various studies have been reported which showed that size (length and diameter) of implant affects the IT and ISQ values. A study by **L.Vidyasagar et al (2004)**[10] showed that increasing implant length did not affect the ISQ statistically both at stage I and stage II, but in a study done by **Anwar B. Bataineh and Ala M.Dakes (2017)**[11] showed that implants of longer length has significantly higher primary ISQ than implants with shorter length.

Study conducted by **Miguel Gomer, Rocio Ortega et al (2016)** showed that implant with larger diameter has significantly higher ISQ both at stage I and stage II as compared to smaller diameter implant.

In the present study it is observed implant size does not affects the IT values and ISQ values both at stage I and stage II, it seems that our study sample size is insufficient for relating all the parameters with both device values. A larger sample size is required to compare IT and ISQ more effectively and for showing relation of implant size and other parameters with these device values.

Our results clearly showed that mean IT value for the maxillary implants (31.42 Ncm) was less as compared to mandibular implants (36.66 Ncm). Mean ISQ values both at stage I and stage II were less in the maxillary implants and compared to mandibular implants. This may be explained by good bone quality observed in the mandible, it has good dense cortical bone as compared to maxilla which results in good primary stability.[12] Similar result were obtained by **A.Stepanek, J. Strnad et al (2005)**[12] which showed that stage I ISQ of mandibular implants were higher in comparison to maxillary implants. Results obtained by **Stephen Balshi, Fred Allen et al (2005)**[13] were also similar which showed that ISQ both at Stage I and Stage II were significantly higher in the mandibular implants as compared to maxillary implants.

Of the total number of implants placed 6 implants were placed in D2 bone quality and 4 were placed in D3 bone quality.

Unpaired t test showed that mean insertion torque was significantly higher in D2 (35 Ncm) bone quality as

compared to D3 (30 Ncm) bone quality. Study published by **Miguel Gomez, Rocio Ortega et al (2016)**[14] showed that IT was significantly higher in D2 bone as compared to D3 bone. Unpaired t test showed that implants has significantly higher ISQ at both stage I and stage II in D2 bone as compared to D3 bone. It indicates that implants has both primary and secondary stability higher in the D2 bone quality as compared to type D3 quality.

This may be because according to Lekholm and zarb, 1985, D2 quality is more dense than D3 bone, D2 bone has thick layer of compact bone surrounding a core of dense trabecular bone, this type of bone usually takes 4 months to integrate with an implant, whereas D3 bone quality contains a thin layer of cortical bone surrounding dense trabecular bone of favourable length, it is less dense as compared to D2 bone and usually take 5-6 months to integrate with implant[15].

Conclusion

From the present study we can conclude that

Both IT values and ISQ values are equally reliable for assessing the primary implant stability, but for assessing secondary stability ISQ values are more reliable than IT values.

Regarding utility, it seems to be more of Ostell RFA as compared to Torque wrench as implant stability can be assessed at any stage of osseointegration with Ostell RFA device which is not possible by torque wrench.

References

1. Rajiv Saini. Dental implants: A review. Research and Reviews: Journal of Dental Sciences 2013;1(4):8-11.
2. Polasani Laxman, Amreena Gill. Primary stability: The password of implant integration. Journal of Dental Implants. 2012; 2(2):103-109.
3. Gaurang Mistry, Omkar Shetty, Shreya Shetty, Raghuwar singh: Measuring implant stability: A review of different methods. Journal of Dental Implants. 2014; 4:165-169.
4. Javier Gil, Carmen Maria, Jose Vicente, Pedro Lazaro, Mariano Herreo Climent. The relationship between resonance frequency analysis (RFA) and insertion torque of dental implants: an in virto study. Advances in Dentistry and Oral Health. 2016; 3(5):1-5.
5. Mihoko Atsumi, Sang Hoon Park, Hom lay Wang. Methods used to assess the implant stability: Current status. The International Journal of Oral and Maxillofacial Implants. 2007; 22:743-754.
6. Nazish Alam, Nithya Anand. Is primary stability the gold standard factor in implant success. Dental Hypotheses. 2017; 5:70-74.
7. Ratnadeep Patil, Dimple Bharadwaj. Is primary stability a predictable parameter for loading implant. Journal of Int Clin Dent Res Organ. 2016; 8:84-88.
8. Huang HM, Chu CL et al. Early detection of implant healing process using resonance frequency analysis. Clin Oral Implants Res. 2003; 14:437-43.
9. Marko Granic, Davor Katanec, Vanja Boras, Mato Susic, Ivona Bago, Dragna Gabric. Implant stability comparision of immediate and delayed maxillary implants placement by use of resonance frequency analysis- A clinical study. Acta Clin Croat. 2015; 54:3-8.
10. Linish Vidyasagar, Girts Satms, Peteris Apse, Uldis Teibe. Dental implant stability at stage I and stage II surgery as measured using resonance frequency analysis. Baltic Dental and Maxillofacial Journal. 2004; 6:67-72.
11. Anwar B. Bataineh, Ala M. Dakes. The influence of length of implant on primary stability: using resonance frequency analysis. J Clin Exp Dent. 2017; 9:1-6.

12. A Stpanek, J Strand, Z Strand. Early loading of dental implants in maxilla and mandible- monitoring of the healing process using RFA. Quintessenz International. 2005; 14:1-9.
13. Stephen Balshi, Fred Allen, Glenn Wolginger, Thomas Balshi. A RFA anlysis assessment of maxillary and mandibular immediately loaded implants. Int J Oral Maxillofac Implants. 2005; 20:584-594.
14. Miguel Gomez-Polo, Rocıo Ortega, Cristina Gomez-Polo, Cristina Mart, Alicia Celem, Jaime Del. Does lengh, diameter, or bone quality affect primary and secondary stability in self tapping implants. J Oral Maxillofac Surg. 2016; 74:1344-1353.
15. Fawad Javed, Hamedda Bashir, Roberto Crespt, Georgios Romanos. Role of primary stability for successful osseointegration of dental implants: Factors of influence and evaluation. Interventional Medicine and Applied Science. 2013; 5(4):162-167.