Sapporo Medical Journal
Volume 59, Issue 03, March 2025

Correlation of Different Devices for the Evaluation of Primary Implant Stability: A Randomized controlled Study

Mohamed Ahmed Elsholkamy[1], Ahmad Mohamed Elrawdy[2], Mohamed Hassan Eid[3]
Mohamed Kamel Attia[4*]

[1]Professor of Oral and Maxillofacial Surgery, Faculty of Dentistry - Suez Canal University
[2]Professor of Oral and Maxillofacial Radiology, Faculty of Dentistry - Suez Canal University
[3]Associate Professor of Oral and Maxillofacial Surgery, Faculty of Dentistry - Suez Canal University
[4]B.D.S Faculty of Dentistry, Sinai University.

Abstract— Background: The primary stability of the dental implant is a crucial factor determining the ability to initiate temporary implant-supported prosthesis and for subsequent successful osseointegration, especially in the maxillary posterior site. **Aim:** To assess the reliability of the insertion torque of dental implants by relating it to the implant stability quotient values measured by the Osstell device. **Material and methods:** This study included healthy, non-smoker patients with no history of diabetes or other metabolic, or debilitating diseases that may affect bone healing, having non-restorable fractured teeth and retained roots in the maxillary posterior site. Primary dental implant stability was evaluated using a torque ratchet from the dental implant kit and ISQ values generated from the Osstell device. **Results:** Sixteen male patients with an age range of 20-40 years received sixteen delayed dental implants. The insertion torque value in group (1) Mean (31.88±2.59) N/cm whereas group (2) Mean and (SD) for implant primary stability using torque ratchet are (39.38±7.29) N/cm. At the same time, the ISQ values ranged in group (1) Mean and Standard deviation (SD) for implant stability quotient are (66.90±1.81) immediately were group (2) Mean and Standard deviation (SD) for implant stability quotient are (74.75±8.28) ISQ values. The results showed a statistically significant positive correlation between the insertion torque of the dental implant measured by torque rachet and ISQ values checked with Osstell. **Conclusion:** The insertion torque can be used as a reliable method to estimate the primary stability of the sixteen delayed dental implants in the maxillary posterior site comparable to the Osstell device ISQ values. In addition, torque ratchet is readily available in the dental implant kit at no additional cost, making it a valuable choice over the Osstell device.

Keywords: primary stability; implant stability; socket preservation; ISQ; RFA; insertion torque; implant.

Introduction

Primary stability of dental implant can be defined as the resistance encountered during implant insertion into the bone bed. It depends significantly on the mechanical engagement of the dental implant threads into the alveolar bone(1, 2).

It is worth mentioning that multiple factors could affect the dental implant's primary stability, like the dental implant design, implant site drilling protocol used, and alveolar bone density (3-5).

Correct estimation of the primary stability of the dental implant is considered the critical factor for the subsequent bone healing, successful osseointegration, and esthetic outcome (6-8).

It is important to note that the optimal insertion torque may vary depending on the implant system, implant diameter, and bone quality. Therefore, clinicians should follow the manufacturer's guidelines for each implant system and consider the individual characteristics of every patient in order to determine the appropriate insertion torque (9-11).

A recent systematic review found that an insertion torque of 35 N/cm or greater was essential for achieving adequate primary stability for dental implants(12).

Another accurate and reliable noninvasive technique in measuring dental implant primary stability is the Resonance Frequency Analysis (RFA), where a transducer (multi peg) is screwed into the dental implant and excited by a range of sound frequencies, and the measurement of the dental implant stability expressed as ISQ value appeared on the digital screen of the device (13).

The correlation between the IT and RFA has been investigated in numerous studies but is still unclear. Some authors claim that the two parameters are in a direct relationship, while others have demonstrated that there are no statistically significant correlations between the two. These discrepancies concerning the clinical significance of the IT and RFA values could lead to miscommunication between clinicians regarding the appropriate implant loading time point(14).

The limited availability of the Osstell devices, primarily used for research purposes, raises the need for a trusted, readily available tool to estimate an implant's primary stability. This study assessed the reliability of the insertion torque of dental implant (IT) by relating it to the implant stability quotient (ISQ) values measured by the Osstell device for delayed dental implants in posterior maxilla after socket preservation. Moreover, insertion torque, and ISQ values from the Osstell device.

Materials and Methods

A randomized controlled clinical study was conducted at the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry - Suez Canal University, in accordance with the ethical principles and in compliance with the Declaration of Helsinki and its later amendments. This study had been ethically approved by the institutional Research Ethics Committee (protocol number 545:2022).

Any patient with non-restorable fractured teeth or retained roots in the maxillary posterior site. All these patients were healthy non smokers with no history of diabetes or other metabolic, debilitating diseases that may affect bone healing.

All the procedures were performed under local anesthesia using local infiltration into labial/buccal and lingual/palatal mucosa of the planned surgical field using with 4% articaine hydrochloride (Artinibsa) with 1:100.000 epinephrine. A full thickness mucoperiosteal flap was reflected with a 15 blade (flap design was made depending on the case demand).All

patients received NeoBiotech implant IS-II active Fixture.After marking the drilling site, a pilot drill (D1: Ø1.2 -D2: Ø2.3) which was indexed with markings (6mm, 8mm, 10mm, 11.50mm, 13mm, 16mm) corresponding to the desired implant length was used for creating the osteotomy site of approximate depth for implant placement (Clockwise drill speed 1000 rpm with copious irrigation).When approximate depth was reached with the pilot drill, the implant probe was used for tactile perception of intact bony plates and for perforations and the confirmation of the desired osteotomy depth. Once the desired depth was confirmed, paralleling pins were placed to check the proper alignment of the implant with adjacent teeth & opposing occlusion.The implant was installed into the osteotomy site using the motorized method with the engine set at 50 rpm and 35-50 N/cm torque. A ratchet was used to place the implant to the desired depth when the insertion torque was more than 35N/cm torque.Implant stability was measured initially at time of implant placement with the Osstell device by using the smart beg attached to the implant.

Ethical Consideration

The data acquired from participants are confidential. The identities of the investigation's participants will remain anonymous in all reports or publications related to it. Prior to the participants' admission to this investigation, the investigation's purpose, nature, and risk–benefit evaluation has been explained to them. Informed consent was acquired.

Statistical analysis: All gathered data was calculated, tabulated, and statistically analyzed using suitable statistical tests as follows. A normality test (Shapiro-Wilk) was done to check the normal distribution of the samples. Descriptive statistics were calculated in the form of Mean ± Standard deviation (SD). independent sample T test was used to compare between different two groups and paired sample T test was used to compare between time interval in each group. P value ≤ 0.05 is considered statistically significant. Statistical analysis was performed using the computer program SPSS software for windows version 26.0 (Statistical Package for Social Science, Armonk, NY: IBM Corp) at significant levels

Results

Sixteen implants were inserted in the present study from those who attended to the outpatient clinic of Oral & Maxillofacial Department, Faculty of Dentistry, Suez Canal University, Egypt. The selected delayed implant cases were subjected to implant placement.

Implant stability quotient: In group (1) Mean and Standard deviation (SD) for implant stability quotient are (66.90±1.81) were group (2) Mean and Standard deviation (SD) for implant stability quotient are (74.75±8.28)

Intergroup comparisons: There was statistically significant difference between control and study group regarding implant stability quotient at immediate (P=0.02)

Table1 , comparison between control and study group regarding clinical stability using OSSTELL measured at immediate and 4 months

	Control			Study			T test	P value
	Mean	SD	Min-Max	Mean	SD	Min-MaX		
Immediate	66.90	1.81	64.6-70.0	74.75	8.28	65.6-86.6	2.618	0.020*
P value	0.001*			0.002*				

***, mean significant at P<0.05**

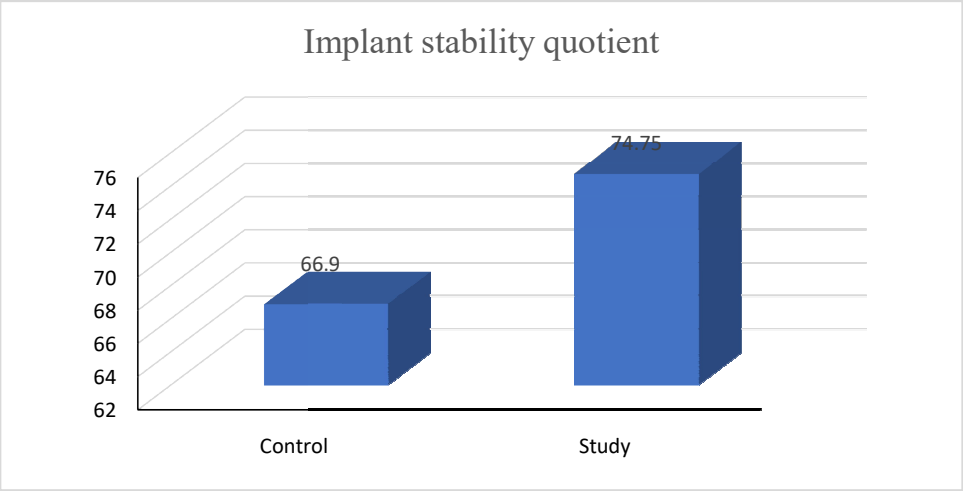

Figure: shows the comparison between control and study group regarding ISQ values using OSSTELL

Primary stability assessment by using torque ratchet:

In group (1) Mean and Standard deviation (SD) for implant primary stability using torque ratchet are (31.88±2.59) whereas group (2) Mean and Standard deviation (SD) for implant primary stability using torque ratchet are (39.38±7.29)

There was statistically significant difference between control and study group regarding stability assessment by insertion torque ratchet(P=0.016), the mean of primary stability by torque ratchet was higher in study group (39.38±7.29) than control group (31.88±2.59).

Table 2, comparison between control and study group regarding primary stability assessment by torque ratchet

	Control	Study	T test	P value
Mean	31.88	39.38	2.743	0.016*
SD	2.59	7.29		

Min.	30.0	30.0		
Mx.	35.0	50.0		
***, mean significant at P<0.05**				

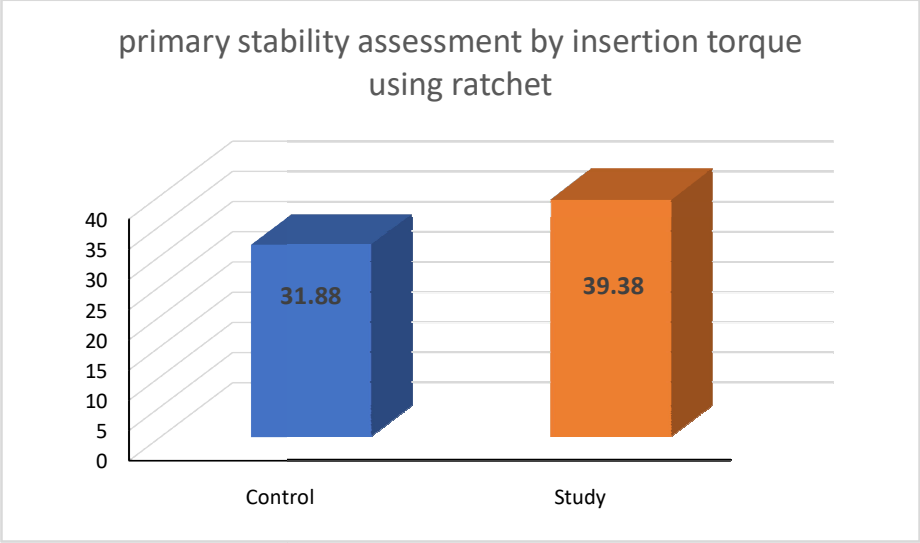

Figure: shows the comparison between control and study group regarding primary stability assessment by torque ratchet

Discussion

A recent systematic review assessing the relationship between the dental implant insertion torque and resonance frequency analysis with the Osstell device concluded that there was no correlation between these measurements at the time of dental implant placement (15).

The authors stated that 11 out of 12 studies included in this review had a severe risk of bias. The evidence level of these studies needed to be higher, which makes it more difficult to generalize the findings of this study. Furthermore, only one retrospective study was included in this review investigating the correlation between these two measurement methods in the delayed inserted dental implants in posterior maxilla with the same conclusion (16).

The retrospective nature of this study, performed with additional surgeries (bone condensation, sinus lifting) in maxillary and mandibular non-molar sites (with different bone densities), may influence their results and conclusion.

While this study showed a statistically significant positive correlation between the insertion torque values measured by torque rachet and Resonance frequency analysis (ISQ values) checked with Osstell. These results can be explained by the strict inclusion criteria of patients with dental implant in posterior maxilla site.

The ISQ value may be affected by the bone rebounding phenomena and visco-elastic behavior after dental implant placement in different ranges, which may lead to a discrepancy between torque rachet and osstell readings (16)
In contrast to this study, the limited bone volume engaged by the dental implant in the immediate cases compared to the delayed implant may reduce this discrepancy. This study is limited by its observational design. Also, the torque rachet did not provide an exact measurement of the insertion torque, and the amount of the subapical bone engagement by the dental implant was not standardized.

Conclusion

Despite the limitations of this study, it can be concluded that the insertion torque can be used as a reliable method to estimate the primary stability of the immediately inserted dental implants in the maxillary non molar sites comparable to the Osstel device ISQ values. In addition, torque ratchet is readily available in the dental implant kit at no additional cost, making it a valuable choice over the Osstell device.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to privacy and ethical concerns but are available from the corresponding author on reasonable request.

References:

[1] Alsaadi G, Quirynen M, Michiles K, Teughels W, Komárek A, Van Steenberghe D. Impact of local and systemic factors on the incidence of failures up to abutment connection with modified surface oral implants. Journal of clinical periodontology. 2008;35(1):51-7.

[2] Noaman AT, Bede SY. The relationship of implant stability quotient and insertion torque in dental implant stability. Journal of Baghdad College of Dentistry. 2022;34(1):29-35.

[3] Monje A, Ravida A, Wang H-L, Helms JA, Brunski JB. Relationship Between Primary/Mechanical and Secondary/Biological Implant Stability. International Journal of Oral & Maxillofacial Implants. 2019;34.

[4] Hindi AR, Bede SY. The effect of osseodensification on implant stability and bone density: a prospective observational study. Journal of Clinical and Experimental Dentistry. 2020;12(5):e474.

[5] L'Homme-Langlois E, Yilmaz B, Chien H-H, McGlumphy E. Accuracy of mechanical torque-limiting devices for dental implants. The Journal of prosthetic dentistry. 2015;114(4):524-8.

[6] Al-Quisi AF, Mohammed Aldaghir O, Al-Jumaily HA. Comparison between Rolled and Nonrolled U-Shaped Flap in the Second Stage of Dental Implant Surgery: A Randomized Clinical Trial. International Journal of Dentistry. 2022;2022(1):1329468.

[7] Testori T, Gaul F, Capelli M, Zuffetti F, Esposito M. Immediate nonocclusal versus early loading of dental implants in partially edentulous patients: 1-year results from a

multicenter, randomized controlled clinical trial. International Journal of Oral & Maxillofacial Implants. 2007;22(5).

[8] Nkenke E, Fenner M. Indications for immediate loading of implants and implant success. Clinical oral implants research. 2006;17(S2):19-34.

[9] Orenstein IH, Tarnow DP, Morris HF, Ochi S. Factors affecting implant mobility at placement and integration of mobile implants at uncovering. Journal of periodontology. 1998;69(12):1404-12.

[10] Hof M, Pommer B, Strbac GD, Vasak C, Agis H, Zechner W. Impact of insertion torque and implant neck design on peri-implant bone level: A randomized split-mouth trial. Clinical implant dentistry and related research. 2014;16(5):668-74.

[11] Dhahi AY, Bede SY, Khachadourian H. Reliability of the multipeg™ transducer in measuring dental implant stability by using a resonance frequency analysis device (Osstell®): An observational clinical study. Journal of Baghdad College of Dentistry. 2023;35(3):58-66.

[12] Cheng Q, Su Y-Y, Wang X, Chen S. Clinical Outcomes Following Immediate Loading of Single-Tooth Implants in the Esthetic Zone: A Systematic Review and Meta-Analysis. International Journal of Oral & Maxillofacial Implants. 2020;35(1).

[13] Snijders R, van Wijk A, Lindeboom J. A comparative study of the Osstell™ versus the Osstell Mentor™ to evaluate implant stability in human cadaver mandibles. Journal of oral rehabilitation. 2013;40(10):774-9.

[14] Raz P, Meir H, Levartovsky S, Peleg M, Sebaoun A, Beitlitum I. Reliability and correlation of different devices for the evaluation of primary implant stability: an in vitro study. Materials. 2021;14(19):5537.

[15] Lages FS, Douglas-de Oliveira DW, Costa FO. Relationship between implant stability measurements obtained by insertion torque and resonance frequency analysis: A systematic review. Clinical implant dentistry and related research. 2018;20(1):26-33.

[16] Açil Y, Sievers J, Gülses A, Ayna M, Wiltfang J, Terheyden H. Correlation between resonance frequency, insertion torque and bone-implant contact in self-cutting threaded implants. Odontology. 2017;105:347-53.