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The Orientation Effect of Osstell Mentor's Transducer on Measuring Implant Stability

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الخلاصة

الاهداف: هو لإيجاد قوة كسر للسمنت الثنائي التصلب باستخدام الدايود والهالوجين كمصدر للضوء ولإيجاد تأثير كل من مدة الخزن والتصلب على قوة الكسر للسمنت الثنائي التصلب. المواد وطرائق العمل: استخدم الخزف لعمل قرص متناسق بقطر ١٠مم وسمك ١.٥مم . استخدم لون واحد من الخزف و السمنت الثنائي التصلب. استخدم قالب بأبعاد ٨×٦×٢مم لعمل نموذج الفحص. قسمة النماذج إلى ٨ مجاميع وبواقع ١٠ لكل مجموعة. استخدم مصدري الضوء لمدة ٢٠ و ٦٠ ثانية وتم فحص العينات إما بعد ١٥ دقيقة أو ٢٤ ساعة. النتائج: اضهر التحليل الإحصائي وجود فرق معنوي للنماذج التي تم تصليبها لمدة ٦٠ ثانية والتي تم فحصها بعد ٢٤ ساعة عن النمادج في المجاميع الأخرى. الاستنتاجات: يوصى بتصليب السمنت الثنائي التصلب لمدة كافية وإعلام المريض بعدم استخدام الحشوة المثبتة بواسطة السمنت الثنائي التصلب لمدة لاتقل عن ٢٤ ساعة.

ABSTRACT

Aims: To evaluate the direction dependence of osstell's transducer during the assessment of dental implant stability by wireless resonance frequency analyzer. **Materials and Methods**: Thirty tapered-SLA dental implants (Super line®) were installed in ten ribs of freshly slaughtered oxen of 2 - 2.5 years old. Three implants were installed in each rib using the fit-sized drilling protocol without countersinking. The stability was assessed by wireless resonance frequency analyzer and five records were taken for each implant by holding the Osstell's tip in different directions in respect to the long axis of the "smart peg". These directions were: (S=superior) parallel to long axis of the " smart peg" and superior to it. (A=anterior) perpendicular to long axis of the " smart peg" and anterior to it. (P=posterior) perpendicular to long axis of the " smart peg" and posterior to it. (M=mesial) perpendicular to long axis of the " smart peg" and mesial to it. (D=distal) perpendicular to long axis of the " smart peg" and distal to it. **Results**: The implant stability quotient values (ISQ) were almost identical in anterior and posterior directions of Osstell's tip and also closely comparable in mesial and distal directions. Although the ISQ values that recorded in superior directions were slightly higher than in other directions, no significant difference was found among the different directions of probe orientation (ANOVA $P > 0.05$).
Conclusion: Any direction of osstell's transducer will be suitable to assess implant primary stability.
Key words: Implant stability, Resonance frequency analysis, Osstell Mentor, Transducer directions.

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INTRODUCTION

Human beings lose their teeth due to many causes like advanced caries, periodontal disease, and trauma make the replacement of teeth an important concern. Different methods had been used to replace the missing teeth including fixed and removable bridges and conventional complete dentures but they have drawbacks whether in esthetic, function, or conservation of adjacent structures. Dental implant is the newest modality which provides better comfort.[1] The process of implant osseointegration involves a series of physiological processes of bone resorption and apposition, in which bone formation around the implant takes place, allowing better bone-implant joint. In order to make this process take place, it is necessary to achieve appropriate initial implant stability and control loadings acting on the implant with the aim of avoiding failure. Such stability is known as primary stability, which is defined as a lack of implant movement immediately after its placement in the bone and is mainly determined by initial bone- implant contact.[2,3] Primary stability is prerequisite for osseointegration process and implant survival. [4-6] Several tests are available to assess implant stability including the invasive test which is usually used to determine the extraction torque of the implant and is largely used in experimental studies,[7] and the noninvasive tests which are used to determine implant stability clinically and experimentally such as percussion test, radiographical evaluation, periotest, insertion torque measurement, and resonance frequency analysis (RFA). Meredith in 1996 developed an easy, noninvasive and reproducible method to measure implant stability. It can be used immediately after implant placement and during the osseointegration process, offering the possibility to know implant stability at any time during the healing process. This method is known as resonance frequency analysis.[8] It is more sensitive than other diagnostic methods, and it has gained in popularity for the last 10 years.[9] This measurement is carried out with a machine named Osstell® Mentor. The Osstell® system is considered as a type of electronic tuning fork that automatically converts kHz to ISQ values. The units of measurement used were kilohertz in a range from 3500 to 8500 kHz. The Implant Stability Quotient (ISQ) was subsequently developed, converting kHz units to ISQ values on a scale of 1 to 100, with high values indicating high stability. Osstell® Mentor is a portable, hand-held device that emits signals repeated by a transducer that is screwed directly into the implant [10] and the probe should hold in two directions (perpendicular and parallel) to the alveolar crest and calculating the resonance frequency (in ISQ values) from the response signal.[11] Previously, cable type electronic resonance frequency analyzer was used to measure the primary stability of dental implants. [9,12,13] The wireless magnetic version of the resonance frequency analyzer, which is recently manufactured, is used nowadays. It is more sensitive and predictable device to quantify implant stability.[14] Moreover, Few number of studies had been implemented with the wireless version. Therefore, the aim of the present study was to evaluate the direction dependence of osstell's transducer during the assessment of dental implant stability by wireless resonance frequency analyzer.

MATERIALS AND METHODS

Ten ribs of freshly slaughtered oxen of 2-2.5 years old were used in the present research. All animals were taken from the same farm to ensure that they were bred in the same environment (Figure 1).

Figure (1) Freshly slaughtered oxen ribs.

Thirty tapered, sand blasted acid etched (SLA) dental implants (Superline, Dentium, Korea) were used and measured 4mm in diameter and 10mm in length (Figure 2).

Figure (2) Tapered, SLA dental implants

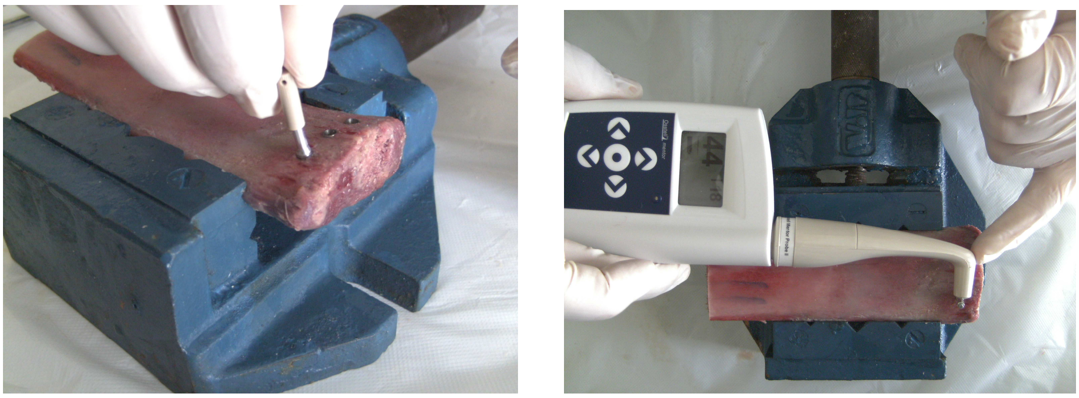
Three dental implants were installed in the proximal portion of each rib using the fit-sized drilling protocols for implant bed preparation and without countersinking. A distance of one centimeter was left between each dental implant bed and another.

Installation of dental implants:

Each rib was fixed by a parallel vise then the following sequence of drills were used: starting with a pilot drill (Lindermann guide) of 2.2mm in diameter, then the Lindermenn first drill of 2.6mm in diameter after that the 3.6mm drill and 3.8mm drill diameter were used subsequently. At completion of drilling, the final implant bed diameter was equal to that of implant diameter i.e. 4mm in diameter. Each implant was seated in its bed via the use of special adapter and then screwed gradually by the ratchet until the upper border of the implant be with level of the cortical bone.

Registration of Implant Primary Stability by wireless RFA:

Following installation of dental implant in its bed, the smart peg was screwed to the implant manually (Figure 3.A) and primary implant stability was recorded by Osstell® mentor bearing in mind that the probe tip of the device does not come in contact with the smart peg (Figure 3.B).



A. Smart peg fixed to the implant B. Recording ISQ by Osstell mentor

Figure (3) Resonance frequency analysis of dental implant stability.

Five records were taken for each implant by holding the osstell's tip in different directions in respect to the long axis of the "smart peg" creating five groups of study which were:

1. (S=superior) parallel to long axis of the " smart peg" and superior to it.
2. (A=anterior) perpendicular to long axis of the " smart peg" and anterior to it.
3. (P=posterior) perpendicular to long axis of the " smart peg" and posterior to it .
4. (M=mesial) perpendicular to long axis of the " smart peg" and mesial to it.
5. (D=distal) perpendicular to long axis of the " smart peg" and distal to it.

Statistical Analysis:

The implant stability quotient values for each dental implant were recorded.

The results were loaded on SPSS under windows program in Pentium IV computer. The following statistical analysis were used:

1. Descriptive statistic (Minimum, Maximum, Mean, Standard deviation).
2. Analysis of variance (ANOVA) test at $\alpha = 0.01$.

RESULTS

The ISQ values in different directions as measured by wireless RF analyzer are illustrated in Table (1).

Table (1):The ISQ values at different directions of osstell's tip in relation to the smart peg.

Rib Number	**Dental Implants**	**Implant stability quotient value**				
		S	**D**	**A**	**M**	**P**
1	1st implant	72	72	75	72	76
	2nd implant	71	72	74	72	67
	3rd implant	75	71	75	71	75
2	1st implant	73	70	69	70	73
	2nd implant	73	73	73	73	73
	3rd implant	72	72	63	72	64
3	1st implant	70	66	61	66	70
	2nd implant	71	71	70	71	72
	3rd implant	75	70	69	70	69
4	1st implant	70	70	73	70	73
	2nd implant	70	70	68	70	68
	3rd implant	75	70	75	70	75
5	1st implant	70	71	74	71	74
	2nd implant	72	69	74	69	74
	3rd implant	68	72	68	72	68
6	1st implant	75	72	75	72	75
	2nd implant	74	73	75	74	70
	3rd implant	73	74	73	74	73
7	1st implant	68	68	67	68	68
	2nd implant	67	61	67	61	67
	3rd implant	68	72	68	72	68
8	1st implant	74	71	75	71	75
	2nd implant	74	74	71	74	71
	3rd implant	72	71	72	71	71
9	1st implant	66	66	67	66	67
	2nd implant	64	69	64	69	64
	3rd implant	67	75	68	75	67
10	1st implant	77	74	70	74	75
	2nd implant	75	69	75	69	75
	3rd implant	75	71	75	71	75

S: Superior., A: Anterior., P: Posterior., M: Mesial., D: Distal.

In group (S), the lowest recorded ISQ value was 64 while the highest value was 77. Meantime, the lowest ISQ value recorded in group (D) was 61 and the highest one was 75. Concerning groups (A), (M), and (P), the lowest and highest ISQ values were (61, 75), (61, 75), and (64, 76) respectively. In Summary, the results elucidate that the mean of ISQ values was greater in group (S) (71.553) compared with the other groups of study. However, the least ISQ values (70.633) was recorded in group (D) (Table 2).

Table (2) Descriptive statistics of the mean of ISQ values.

Transducer Direction	N	Minimum	Maximum	Mean	Sd.
S	30	64.00	77.00	71.5333	3.23487
D	30	61.00	75.00	70.6333	2.80988
A	30	61.00	75.00	70.7667	4.04017
M	30	61.00	75.00	70.6667	2.84464
P	30	64.00	76.00	71.0667	3.60013

Sd= Standarad deviation

Using analysis of variance (ANOVA test) at α=0.05 , no significant difference was shown among the five groups of study (Table 3).

Table (3) One way ANOVA test of ISQ values of different transducer's directions.

Transducer Direction	Sum of Square	df	Mean Square	F	Sig.
Between groups	17.401	4	4.350	0.390	0.815
Within Groups	1615.932	145	11.144		
Total	1633.333	149			

DISCUSSION

Endosseous implants are successful treatment options for the replacement of missing dentition. It is apparent that primary stability is a pivotal factor at the time of insertion, which depends on the surface geometry of the dental implant, surgical technique used and local bone quantity and quality, for the long-term success of endosseous dental implants.[9,15]

Previously, cable type electronic resonance frequency analyzer was used to measure the primary stability of dental implants. [9,12,13] The new wireless magnetic version of the resonance frequency analyzer is a recently manufactured which is more sensitive and predictable device to quantify implant stability .[14] Moreover very limited number of studies had been implemented with the wireless version. [16] In the current study, the new wireless generation of magnetic resonance frequency analyzer had been chosen since lower implant stability quotient values were achieved with wire than with wireless type in which these discrepancies may be related to the different design of the devices because the transducer of the wire type is screwed on the top of the implant in a higher position compared to the transducer of wireless type that is screwed inside the internal hex of the implant. [17]

When the direction of the probe orientation of the RF analyzer is considered, Veltri *et al.*[18] performed a clinical study which measured the stability of dental implants using the previous cable device. They measured the stability for dental implants by placing the transducer buccally, distally, palatally and mesially, and reported that the mean ISQ values for different orientations demonstrated different results.

A recent human fresh cadaver study by Seong *et al*. [19] also measured the stability of implants by placing the transducer buccolingually and mesiodistally. They presented similar conclusions with the previous study that mesio-distal positioning of the transducer resulted with increased ISQ values compared with buccolingual orientation.

According to the available literatures, two studies have been conducted to demonstrate the sensitivity of the wireless type RFA device with varying magnetic probe orientations.[20,21] Kahraman *et al*.[20] preferred to measure implant stability by holding the wireless probe buccolingually and repeated the measurements three times to get the mean of ISQ values. The finding of the present study was in agreement with that of Ohta *et al*.[21] This wireless device may allow the operator to measure implant stability at any magnetic probe orientation during the operation. In the present experiments, ISQ values obtained by the wireless RFA device were not affected by probe orientation from parallel to perpendicular in respect to the long axis of the smart peg.

CONCLUSION

The direction of Osstell® mentor transducer seems to have no effect for the assessment of dental implant primary stability.

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