The Effect Of Treatment Protocol and Implant Dimensions on Primary Stability Utilizing Resonance Frequency Analysis

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ABSTRACT

Background: According to Branemark's protocol, the waiting period between tooth extraction and implant placement is 6–8 months; this is the late placement technique. Achieving and maintaining implant stability are prerequisites for a dental implant to be successful. Resonance Frequency Analysis (RFA) is a noninvasive diagnostic method that measures implant stability. The aim of this study was to investigate the influence of treatment protocol and implant dimensions on primary implant stability utilizing RFA.

Materials and methods: This study included 63 Iraqi patients (37 male, 26 female; ranging 22-66 years). According to treatment protocol, the sample was divided into 2 groups; A (delayed) & B (immediate). Dental implants were inserted and the implant stability quotient (ISQ) measures for primary stability documented by Osstell device.

Results: For both groups fixtures introduced in the mandible showed a higher stability (74 and 71.85) respectively and was lower in maxilla. The mean primary stability of group A was 70.21 (ranged from 51-83), while for group B was 68.55 (46.5-81).

Conclusion: primary stability influencing osseointegration and subsequent long term success. It was higher in association with delayed implant placement, mandible, and increased implant diameters.

Keywords: Primary stability, immediate implant, ISQ. .**(J Bagh Coll Dentistry 2017; 29(1):111-116).**

INTRODUCTION

According to Branemark's protocol, the waiting period between tooth extraction and implant placement is 6–8 months; this is the late placement technique. Series of biological processes such as bone resorption (vertically and horizontally), gingival collapse and migratory movements of the adjacent teeth to the extraction space occur during this period. Other concerns about this protocol include the increased time of edentulism, longer treatment time and additional surgical procedure. In 1993 Wilson and Weber used the terms immediate, recent, delayed and mature, to describe the timing of implant placement after tooth extraction or the extraction socket's healing process [1].

Some scholars proposed immediate implant technique, namely extracting the worthless remnant root and immediately embedding implant in situ at the same time. The clinical effect of this technique is accepted well [2]. Implants placed immediately into extraction sockets have been shown to have a high rate of clinical success [3].

Achieving and maintaining implant stability are prerequisites for a dental implant to be successful. Implant stability can be defined as the absence of clinical mobility, which is also the suggested definition of osseointegration. Primary implant stability at placement is a mechanical phenomenon that is related to the local bone quality and quantity, the type of implant and placement technique used [4].

Successful osseointegration is prerequisite for functional dental implants and primary implant stability is a prerequisite for successful osseointegration [4].

Primary implant stability is widely regarded as the central determinant of implant osseointegration success; how it is measured and quantified is not viewed with similar universal acceptance. Clinical investigations involving large numbers of patients are vitally important to defining objective measures of primary implant stability related to dental implant success and the variables that modify success [5].

The methods to determine implant stability clinically are clinical perception, percussion test, and reverse torque test, cutting torque resistance analysis, periotest and RFA [4].

Resonance Frequency Analysis (RFA)

It is a noninvasive diagnostic method that measures implant stability and bone density at various time points using vibration and structural principle analysis. Two commercially devices have been developed to assess implant stability. The original (electrical) method uses a direct connection (wire) between the transducer and the resonance frequency analyzer. The second method uses magnetic frequencies between transducer and resonance frequency analyzer.

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The new magnetic RFA device has a transducer, a metallic rod with a magnet on top, which is screwed onto an implant or abutment. The electronic device and the magnetic device are capable of measuring similar changes; however the magnetic device results in higher implant stability quotient (ISQ) value when measuring the stability of nonsubmerged dental implant [4].

The ISQ is a measure of interfacial stiffness presented by the implant bone interface. ISQ-based evaluations of primary implant stability have inferred that a number of variables affect stability. Such variables include the following: (1) bone quality, (2) implant site (anatomic position), (3) age, (4) gender, (5) smoking status, (6) periodontal status, (7) implant diameter, (8) implant length and (9) implant design [5].

The present study was performed to investigate the influence of certain variables (treatment protocol and implant dimensions) on primary implant stability utilizing RFA test.

MATERIALS AND METHODS

In the period between October 2015 and June 2016, this study was conducted in the Implantology Unit at the Department of Oral & Maxillofacial Surgery, College of Dentistry, University of Baghdad, Iraq. Sixty three patients participated in this clinical prospective study (37 male, 26 female; ranging 22-66 years) needed one or more dental implant were selected. The whole sample was divided into 2 groups:

1- Group A: dental implants placed with the delayed protocol (at least 6 months after tooth extraction).
2- Group B: dental implants placed with immediate post extraction protocol.

An informed written consent was secured from all patients using their data for research purposes. A number of exposure variables were evaluated in multivariate analyses including age, gender, implant dimensions and location.

Inclusion criteria

1- Fair oral hygiene.
2- Implants to be placed at least 6 months after teeth extraction and/or immediate post extraction placement of hopeless teeth or retained roots.
3- Patients age > 18 years.
4- Sufficient bone width and height to accommodate conventional implant therapy without alveolar bone augmentation.

Exclusion Criteria

1- Poor oral hygiene.
2- Smoking more than 20 cigarettes/day and excessive alcohol consumption.
3- High degree of bruxism.
4- Any systemic chronic disease affecting bone healing potential (localized radiotherapy of the oral cavity, antitumor chemotherapy, liver pathologies, immunosuppressed status, and current corticosteroid therapy, inflammatory and autoimmune disease of the oral cavity).
5- Current pregnancy.

Preoperative clinical and radiographical examination following detailed previous medical and dental history was taken for each patient using a special form of case sheet for the implant center. For radiological assessment, Orthopantomogram (OPG) was made for each candidate, (Fig 1).

Surgical procedure

For both groups treatment began for both groups with local anesthesia xylocaine/adrenaline 2% which was induced by block or infiltration technique. After elevation of mucoperiosteal flap, all implants were inserted according to a strict protocol that followed the manufacturer's instructions. For group B, immediate extraction of hopeless teeth/retained roots was performed as atraumatically as possible prior to implant installation, (Fig 2). Sutures were removed 10 days after surgery. For both groups, 150 implants (Dentium, Korea) were installed. With 100 implants for group A and 50 for group B. The actual ISQ (implant stability quotient) were collected for both groups with the aid of RFA (resonance frequency analysis) using Osstell device (Goteborg, Sweden) with maximum insertion torque values of 35 N/cm during low speed insertion by means of a transducer attached to implant body (smart peg) and readings for the primary stability were scored, Fig 4. ISQ values were considered as follows: low (0-50), medium (51-70) and high (71-100). Patients instructed to take the following drug regimen: Amoxicillin 500 mg + metronidazole 250 mg + Paracetamol 500 mg /thrice daily for 5 days postoperatively.

Fig 1: Diagnostic preoperative OPG revealed hopeless tooth No.8.

Fig 2: A. Atraumatic extraction of hopeless tooth No. 8 presented with severe periodontitis prior to immediate implant placement.
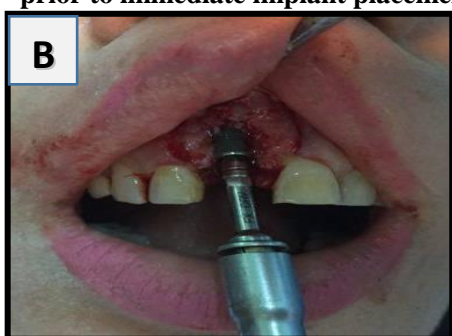
B. Installation of dental implant into the socket of the extracted tooth.

Statistical analysis

Two independent sample t-test, paired t-test and Pearson correlation (R) were the statistical method used to analyze the data. The level of significance tested according to the P-value, were: P>0.05 (Not significant), P<0.05 (Significant), P<0.01 (Highly significant).

The analyses were accomplished using computer software program: Statistical Package for Social Sciences (SPSS version 18).

RESULTS

The mean primary stability of group A was 70.21 (ranged from 51-83), while for group B was 68.55 (46.5-81). High ISQ values (>70) observed in 57% of dental implants placed in group A; however it was less for group B which recorded 42%.

The 5th decade of life (40-49 years) was the dominant one for both groups, group A occupied (35.13%) and group B (30.77%).

The prominent sex in this study were females (37 patients, 58.73%), while males attended with less number (26 patients, 41.27%) as clarified in table 1.

Regarding treatment protocol and site of placement: the mean primary stability for the group A was 70.21 ISQ, in which the anterior mandible recorded the highest value 75.5 ISQ, while the stability in anterior maxilla was the lowest 65.5 ISQ.

On the other hand; for group B, the mean stability was lower than group A which was 68.55 ISQ, with predominance for the posterior mandible 76.37 ISQ, with also the least figures reported in anterior maxilla. For both groups fixtures introduced in the mandible showed a higher stability (74 and 71.85) respectively and was lower in maxilla. All these data exemplified in table 2.

Table 1: Age and sex distribution.

Sex	Delayed (Group A)	Immediate (Group B)	Total
Female	22 (34.92%)	15 (23.81%)	37 (58.73%)
Male	15 (23.81%)	11 (17.46%)	26 (41.27%)

Table 2: Primary implant stability in relation to treatment protocol and site of placement.

Placement protocol	Jaw site		Primary stability (mean ISQ)
	Mandible	Maxilla	
Group A (100 fixtures)	Anterior	3 (3%)	30 (30%)	70.21
	Primary ISQ	75.5	65.5	
	Posterior	31 (31%)	36 (36%)	
	Primary ISQ	72.5	67.37	
	Mean ISQ	74	66.43	
Group B (50 fixtures)	**Mandible**	**Maxilla**	68.55
	Anterior	3 (6%) 67.33	32 (64%) 61.04	
	Posterior	2 (4%) 76.37	13 (26%) 69.46	
	Mean ISQ	71.85	65.25	

paired t-test showed significant difference in the ISQ value between the Group A (0.000) and Group B (0.003) (P<0.05), Pearson correlation showed direct proportional relationship between Group A & B (0.9 & 0.3) respectively, which indicates higher primary stability in Group A, table 3 explains statistical results (Table 3).

In Dentium system different implant dimensions utilized for this research. The highest stability regarding implant diameter registered with the widest diameter in group A (4.8 mm) in which the mean stability was 75.75 ISQ. While; the lowest figures noted with the narrowest diameter in this system (3.4 mm) which was 62.70, With the mean for all diameters 69.63.

For group B (4.8 mm) diameter was not applied, as the highest stability reported with (4.3 mm) 70.66 ISQ, while; the lowest was with (3.8 mm) 59.68 ISQ, with the mean for all diameters 64.19 ISQ. These are demonstrated in table 4 and mean stability regarding the diameters was also higher in delayed protocol, Fig 3.
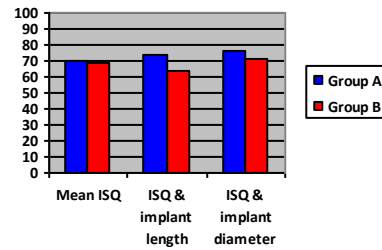

Fig 3: Variables distribution.

Table 3: Statistical results.

Sample size	Mean ISQ (placement protocol)	Mean ISQ (length)	Mean ISQ (diameter)	t-test	Sig	R	P-value
Group A (100)	70.21	73.78	75.75	0.000	0.05	0.9	0.8
Group B (50)	68.55	63.85	70.66	0.003	0.05	0.3	0.5

Table 4: The effect of implant diameter on mean stability for both delayed and immediate placement.

Protocol & ISQ	Implant diameter (No. & %)			
	3.4 mm	3.8 mm	4.3 mm	4.8 mm
Group A- (69.63) ISQ	3410 ► 10 (10%) 3412 ► 20 (20%) 3414 ► 3 (3%)	3808 ► 4 (4%) 3810 ► 11 (11%) 3812 ► 18 (18%) 3814 ► 4 (4%)	4308 ► 4 (4%) 4310 ► 16 (16%) 4312 ► 6 (6%)	4808 ► 2 (2%) 4810 ► 1 (1%) 4812 ► 1 (1%)
Mean stability	62.70	70.06	70.03	75.75
Group B- (64.19) ISQ	3412 ► 6 (12%) 3414 ► 7 (14%)	3812 ► 10 (20%) 3814 ► 24 (48%)	4310 ► 1 (2%) 4312 ► 2 (4%)	---------
Mean stability	62.23	59.68	70.66	

In a correlation to the implant length for group A: the highest stability recorded with the length (14 mm) 73.78 ISQ and the lowest with (8 mm) 67.70 ISQ. While; for group B, the highest figure 81 ISQ was with (10 mm, insignificant) since single fixture is inserted. The lowest reported with (14 mm), however, most fixtures fall under the category of this length (31 dental implants) with 63.85 ISQ as shown in table 5.

Fig 4: ISQ primary stability measurement for tooth site No. 12 with the aid of Osstell device.

Table 5: The effect of implant length on mean stability for both delayed and immediate placement.

Treatment protocol	Implant length (No. & %)							
	14 mm	%	12 mm	%	10 mm	%	8 mm	%
Group A- (69.95) ISQ	3414 ► 3 3814 ► 4	7%	3412 ► 20 3812 ► 18 4312 ► 6 4812 ► 1	45%	3410 ► 10 3810 ► 11 4310 ► 16 4810 ► 1	38%	3808 ► 4 4308 ► 4 4808 ► 2	10%
Mean stability	73.78		68.05		70.30		67.70	
Group B- (69.67) ISQ	3414 ►7 3814►24	31 (62%)	3412►6 3812►10 4312►2	18 (36%)	4310►1	1 (2%)	----------	
Mean stability	63.85		64.16		81 (insignificant)			

DISCUSSION

The primary stability is considered to be as the password for osseointegration. Gaining good primary stability is of paramount importance for successful osseointegration and subsequently achieving the main goal of dental implant placement from the functional and esthetic points of view which is the long term success. An objective precise measurement for primary stability is the RFA seems to be the most indicative. This study tried to analyze the influence of some important variables on the primary stability, those are treatment protocol (delayed vs immediate), site of fixture in the jaws and dental implant dimensions (diameter vs length).

The 5th decade of life (40-49 years) was the prominent one in this study (21 patients, 33.33%), this is logic in the country since the general impression on patient compliance is poor for patients with teeth loss, not seeking for treatment at early time, also most of patients who ask for immediate implant placement presented with symptomless retained roots.

Females occupied the first place 37 (58.73%) with female: male ratio 37:26 (1.4:1). Since most of fixtures for both groups introduced in the anterior region of maxilla and mandible (esthetic zone) about 33.3% for the group A and 70% for the group B (immediate placement), this is may be due to the willing desire in women for perfect esthetic more than males confirmed by (*Al Garni et al*. **2012**) [6]. In general the primary stability in group A (70.21 ISQ) was better than group B (68.55ISQ) and this may be related to the available amount of bone surrounding dental implant which is better with the delayed protocol than immediate postextraction implantation that is usually associated with alveolar defects and profound gaps between implant body and alveolar socket walls. This study revealed that the mean primary stability in the mandible was good for both groups A and B 74 ISQ and 71.85 ISQ respectively, this greatly related to the density of mandible which is better in all sites than the maxilla, here the maxilla showed medium stability for both functional zones 66.43 ISQ, 65.25 ISQ respectively. *Fyhrie*, **2004** stated that bone density of the mandible found to be 4% higher than maxilla and decreases progressively as to go posteriorly [7].

Best stability observed with the bigger dental implant diameter that is the best was with (Ø4.8 mm) implants 75.75 ISQ, followed by (Ø4.3 mm and Ø3.8 mm) 70.03 and 70.06 ISQ respectively. The least stability reported with the delayed protocol was with the narrowest conventional diameters Ø3.4 mm (62.70 ISQ), as this is supported by many researchers as (**Barikani**, **2013**) [8]. On the other hand with immediate placement the figures was unreliable with Ø3.8 mm recorded the least stability 59.68 ISQ, higher stability registered with Ø4.3 mm (few number 3) and Ø3.4 mm. With immediate treatment many factors affecting the measurement as the socket wall gaps created after extraction or bone defects as dehiscence or fenestration.

The length of dental implant has an influence on stability in group A. The stability was higher with 14 mm length dental implants (73.78 ISQ) and the least was with 8 mm. However this is not the case in immediate placement in which the dominant length was 14 mm (62%) but the lowest stability recorded 63.85 ISQ, however, clinically all implants had reasonable stability obtained by over-drilling procedure 2-3 mm beyond the depth of the socket walls.

CONCLUSION

The primary stability is of eminent influence on osseointegration and subsequent long term success. It was higher in association with

delayed implant placement, mandible, and increased implant diameters.

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الخلاصة

المقدمة: استنادا الى مبدأ برينمارك, فان وقت الانتظار بين قلع السن ووضع الزرعة هو 6-8 اشهر: وهذا هو الوضع المتأخر للزرعة. الحصول وتحقيق ثبات الزرعة هي اهم الاهداف المطلوبة لنجاح الزرعة.جهاز ال RFA هي طريقة جيدة لقياس ثبات الزرعة.الغاية من هذه الدراسة هو فحص تأثير مبدأ وضع الزرعة وابعادها على ثبات الزرعة الاولي بواسطة ال RFA .

المواد وطرق العمل: تتضمن الدراسة 63 مريض عراقي (37 ذكور, 26 اناث, بين 22-66 سنة). حسب توقيت العلاج, قسمت العينة الى مجموعتين: مجموعة أ (المتأخر) و مجموعة ب (الآني). ادخلت الزرعات وقيست الثباتية الاولية للزرعة بواسطة جهاز الاوستيل.

النتائج: بالنسبة لكلتا المجموعتين التي ادخلت زرعاتها في الفك السفلي اظهرت ثبات اعلى للزرعات (74 و 71,85) بالتعاقب وكانت اقل في الفك العلوي. كان معدل الثبات الاولي بالنسبة للمجموعة أ 70,21 (بين 51-83) , بينما كانت في المجموعة ب 68,55 (46,5-81).

الاستنتاجات: أثبتت نتيجة البحث الحالي تأثير ثبات الزرعة الاولي على التحامها بالعظم والنجاح طويل الامد. حيث كانت اعلى مع الوضع المتأخر للزرعة والفك السفلي ومع ازدياد ابعاد الزرعة.