

The Effects of Combining Drill Diameters Bypass, and Implant Bed under Preparation Protocols on Primary Stability of Dental Implant in Low-Density Bones (Experimental Study)

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الخلاصة

الأهداف: تهدف الدراسة الى مقارنة تأثير استخدام بروتوكولات الحفر المختلفة على ثبات الزرعة السنية الابتدائي الذي يتم غرسه في العظام منخفضة الكثافة. **المواد وطرائق العمل:** من بين اثنان وعشرون ضلع تم استخدام عشرة اضلاع ثيران في هذه الدراسة المختبرية، باستخدام الاشعة المقطعية ، تم تأكيد أن ثلاثة سنتيمترات (سم) للجزء الاقرب من عظم القص هو عظم منخفض الكثافة يمكن مقارنته بعظام الفك البشرية. أربعون غرسة سنية تم غرسها ، كل ضلع استقبل أربع غرسات سنية باستخدام أربع تقنيات مختلفة مرتبة في أربع مجموعات دراسية: المجموعة (الاولى): تتضمن عشرة غرسات سنية حيث يكون ثاقب الحفر والغرسات السنية بنفس الحجم . تقنية ملائمة الحجم (التقليدية) للغرس. المجموعة (الثانية): تتضمن عشرة غرسات سنية حيث يكون قطر ثاقب الحفر أقل من قطر الغرسة السنية . تقنية تصغير الحجم لموضع الغرس. المجموعة (الثالثة): تتضمن عشرة غرسات سنية حيث تم استخدام بروتوكول الحفر المبسط للغرس. المجموعة (الرابعة): تتضمن عشرة غرسات سنية حيث تم استخدام بروتوكولات الحفر المجتمعة (تقنية تصغير الحجم لموضع الغرس + بروتوكول الحفر المبسط للغرس). **النتائج:** أظهرت النتائج عن وجود فرق ذات دلالة إحصائية في معدلات قياس جهد الإدخال لمجموعة الزرعات السنية المغروسة باستخدام بروتوكولات الحفر المجتمعة للغرس (٦٥,٠٠٠ نيوتن لكل سنتيمتر) مقارنة بمجموعة الزرعات المغروسة باستخدام بروتوكول الحفر ملائمة الحجم (التقليدية) للغرس (٤٥,٠٠٠ نيوتن لكل سنتيمتر). فيما يخص جهاز البيروتيست م (الطريقة الإلكترونية لقياس ثبات الغرسة) ، وجد فرق ذات دلالة إحصائية بين مجموعة الزرعات السنية المغروسة باستخدام بروتوكولات الحفر المجتمعة للغرس (- ٦,٤٥٠٠) مقارنة بالزرعات المغروسة باستخدام بروتوكول الحفر ملائمة الحجم . تم العثور على علاقة ذات دلالة إحصائية قوية بين طريقة قياس جهد الإدخال وبالطريقة الإلكترونية لقياس ثبات الغرسة(جهاز البيروتيست م). **الاستنتاجات:** غرس الزرعات السنية في العظام منخفضة الكثافة باستخدام بروتوكول الحفر المبسط من المفضل ان يتم دمج مع تقنية تصغير الحجم لموضع الغرس للزرعة السنية لتعزيز الثبات الابتدائي للزرعة السنية وبمدة زمنية اقصر.

ABSTRACT

Aims: The aim of the current study is to compare the impact of using different drilling protocols on the dental implants primary stability inserted in the low-density bones. **Materials and Methods:** Out of twenty-two, ten oxen ribs were used in this in-vitro study. Using computed tomography (CT) scan, the most proximal three centimeters (cm) of the rib was confirmed to be a low-density bone comparable to human edentulous jaw bones. Forty dental implants were inserted, each rib received four dental implants using four different techniques that are arranged into four study groups: Group (I): includes a number of ten dental implants where the drilling burs and implants have the same size. Fit-size technique (F.G). Group (II): includes a number of ten dental implants where the diameter of the drilling burs is less than the implant diameter. Under-sized technique (U.G) Group (III): includes a number of ten dental implants where the simplified drilling protocol (Drill bypass) (D.G) was used for insertion. Group (IV): includes a number of ten dental implants where combined drilling protocols (C.G) (Undersized U.G+ Drill bypass D.G) were used for insertion. **Results:** Results revealed a statistically significant difference in the mean of insertion torque values (IT) between combined group (C.G) (65.000 N.cm) and fit-sized group (F.G) (45.0000 N.cm). Concerning Periotest M, a statistically significant difference was found in the mean of (PTV) between combined group (C.G) (-6.4500) and fit-sized group. A statistically highly significant correlation was found between insertion torque values (ITs) and Periotest M values (PTVs). **Conclusions:** Dental implant insertion in low-density bones using simplified drilling protocol (Drill bypass) (D.G) is better to be combined with undersized implant bed preparation (U.G) to enhance

implant primary stability and with less time. Keywords: Kinesiology adhesive tape, Swelling, Pain, Dexamethasone, lower third molar teeth removal.

Keywords: Primary Stability of Dental Implant, Drill bypass, under preparation,

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INTRODUCTION

Human teeth loss is still a major problem in ageing populations worldwide, although advanced methods of oral-health preservation are delaying teeth loss later in life ⁽¹⁾, teeth loss has an impact on chewing, function, dental esthetics and quality of life ^(2,3). Endosseous dental implants are an increasingly widespread treatment option for achieving good functional and aesthetic outcomes ⁽⁴⁾. Misch classified cancellous (spongy) bone density into 5 grades: D1: > 1250 HU; D2: 850 to 1250 HU; D3: 350 to 850 HU; D4: 150 to 350 HU; and D5: < 150 HU ⁽⁵⁾. Implant stability plays a vital role for successful osseointegration, it may be defined as the capacity of the implant to withstand loading in the axial, lateral and rotational direction ⁽⁶⁾. Implant stability serves as an indirect indication for osseointegration, and the clinical perception of implant stability is often related to the rotational resistance during placement of the dental implant ⁽⁷⁾. Dental implant stability can be divided into "Primary" and "Secondary" components; primary stability refers to mechanical implant bracing in the

bone and lack of any minimal movement, while secondary stability refers to successful "Osseointegration" of dental implant with the adjacent bone ⁽⁸⁾. Accomplishing primary stability of dental implant is of essential importance at the time of implant insertion ^(9, 10). Primary stability of dental implant is influenced by a number of factors which include quality and quantity of local bone, implant-related factors like diameter, form, length, surface characterization and the drilling protocol followed meaning that size of the drill comparison to size of dental implant, pre-tapped or self-tapping implants ^(8, 11, 12).

Many adjustments of the surgical procedures and drilling protocols have been established in order to increase the implant's primary stability in the low-density bone.

Under-sized implant preparations have been proposed through the use of smaller final drill diameter than the implant's diameter ^(13, 14).

Some researchers suggest that the implant drilling protocols may be simplified ⁽¹⁵⁾, these attempts to simplify drilling protocols are expected to contribute the improvement of

implant-related treatments in future⁽¹⁶⁾. Various methods are developed to assess implant stability such as histologic analysis, radiographs, percussion test, reverse torque test, insertion torque (cutting torque resistance analysis), Periotest, and resonance frequency analysis (RFA) device⁽¹⁷⁾.

MATERIALS AND METHODS

The Dentium surgical kit was used in-vitro using oxen ribs. Bones were numbered from one to twenty-two before scanning by CT scan.

Out of twenty-two ribs, ten oxen ribs were selected according to previous research⁽¹⁸⁾ on bone which showed that the proximal three centimeters of ribs were classified as a low-density bone after CT scan's confirmation.

A total (40) Dentium SLA Super line tapered dental implants were inserted in the most proximal three centimeters of each rib. Each rib out of ten selected ribs received four dental implants. A distance of one centimeter was left between each implant and another as follow:

Group (I) (Control Fit-sized Group) (F.G): Ten implants were installed by conventional drilling protocol with constant drilling speed (1500 rpm) under copious normal saline irrigation at 25° room **temperature**.

Group (II) (Undersized Group) (U.G): Ten implants were inserted in the bone using undersized implant bed preparation technique.

Group (III) (Drill bypass or Simplified drilling Group) (D.G): Ten implants were inserted with the bypass drilling protocol (simplified) (Pilot drill and final drill only).

Group (IV) (Combined Group (II + III) (C.G) Ten implants were inserted by combining drilling protocols (Undersized implant bed preparation, Drill bypass protocol of drilling respectively) starting with the pilot drill (Lindermann Guide) of 2.2 in diameter and then final drill 4.0 mm drill used only. The final implant bed diameter was less diameter of implant fixture diameter under copious normal saline irrigation.

Oxen ribs frozen until used, each oxen rib was maintained at room temperature ($21 \pm 1^\circ\text{C}$) for three hours and wrapped in sterile isotonic saline solution gauze for hydration^(19,20,21). A parallel vise was used for fixation of rib bones.

Drilling protocol for the first (10) implants group (F.G) was done as conventional incremental drilling protocol. The 2nd group (U.G) consisted of (10) dental implant inserted in the bone using undersized implant bed preparation technique. The 3rd group (D.G) consisted of (10) dental implant inserted by simplified drilling protocol, (Drill bypass), while the last (10) implants group (C.G) was inserted using combined drilling protocols (Undersized implant bed preparation, Drill bypass drilling protocol). Each implant was installed in its site by a special adapter which is placed on the implant and then rotated

by a torque wrench. The torque required for implant insertion was recorded by Dentium new wrench XNTW. These records ranged between 10 and 70 N.cm. Then the primary stability of each implant was measured by Periotest M device. These values ranged between (-8 to + 50).

RESULTS

Results revealed a statistically significant difference in the mean of insertion torque values (ITs) between undersized implant bed group (U.G) (58.0000 N.cm), drill bypass

drilling protocol group (D.G) (57.0000N.cm) and combined drilling protocols group (C.G) (65.000 N.cm) compared to fit-sized group (F.G) (45.0000 N.cm). Concerning Periotest M, the results showed no significant difference in the mean of Periotest M values (PTVs) between undersized group (-5.8000) (U.G) and drill bypass group (D.G) (-5.2300) compared to fit-sized group (F.G) (-5.0900). While a statistically significant difference was found in the mean of (PTVs) between combined group (C.G) (-6.4500) and fit-sized group, the significance was at $p \leq 0.01$, Tables (1, 2, 3, and 4).

Table (1): One-way ANOVA test of insertion torque values.

ANOVA					
Insertion Torque					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2067.500	3	689.167	7.952**	0.000
Within Groups	3120.000	36	86.667		
Total	5187.500	39			

** Highly Significant at $P \leq 0.01$

Table (2): Duncan Multiple Analysis Range Test of insertion torque

Insertion Torque			
Duncan			
S.Group	N.	Subset for alpha = 0.01	
		1	2
F.G	10	45.0000	
D.G	10		57.0000
U.G	10		58.0000
C.G	10		65.0000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 10.000.

Table (3): One-way ANOVA for Periotest M values

ANOVA					
Periotest M Values					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11.523	3	3.841	**4.287	0.011
Within Groups	32.255	36	0.896		
Total	43.778	39			

** Highly Significant at $P \leq 0.01$

Table (4): Duncan Multiple Analysis Range Test of Periotest M values

Periotest M Values			
Duncan			
S.Group	N.	Subset for alpha = 0.01	
		1	2
C.G	10	-6.4500	
U.G	10	-5.8000	-5.8000
D.G	10		-5.2300
F.G	10		-5.0900

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

A highly statistically significant correlation was found between insertion torque values (ITs) and Periotest M values (PTVs), Table (5).

Table (5): Pearson correlation between insertion torque values and Periotest M values

Pearson Correlation(r)			
		IT	PTV
Insertion Torque	Pearson Correlation	1	-0.682**
	Sig. (2-tailed)		0.000
	N.	40	40
Periotest M	Pearson Correlation	-0.682**	1
	Sig. (2-tailed)	0.000	
	N.	40	40

** . Correlation is highly significant at the ($P \leq 0.01$) level (2-tailed).

DISCUSSION

Ideal dental implant primary stability is crucial in low-density bone^(22, 23). Tapered self-tapping endosseous dental implants have been chosen in the current study since the success rate of self-tapping implants was observed to be greater than that of conventional implants which means that self-tapping implants result in better stability of the implants⁽²⁴⁾. The density of the proximal region of the rib bones that were used in this research has been assessed by CT scan, as the results of the CT scan were both accurate and reliable^(25,26).

Several methods are available to measure the primary stability of dental implants such as Resonance Frequency Analysis (RFA), Periotest M device, insertion torque measurement etc.,. Insertion torque measurement by Dentium new wrench XNTW and Periotest M device have been selected for our current study as they were available and precise. Periotest M has been used in our current study which is the latest generation which is more sensitive and reliable than traditional Periotest⁽²⁷⁾.

1. Effect of Combined Protocols (U.G+D.G) on Primary Stability of Implant:

The main results of the present study when combining two drilling protocols (C.G): Undersized implant bed preparation group (U.G) and the Simplified drilling protocol group (Drill bypass) (D.G) showed the achievement of a better primary stability

comparable to other single drilling protocols (F.G, U.G, and D.G). This may be attributed to a "Synergetic" effect of combining the two drilling protocols, tables (6), (7).

Also, a less surgical time was consumed compared to conventional drilling protocols as we used two drills instead of a conventional number of six drills.

The outcome of the present study was in agreement with other previous studies, Abboud *et al*,⁽²⁸⁾ concluded that simplifying drilling protocol (Drill bypass) increase stability of dental implant two-fold compared with a conventional incremental drilling protocol with under preparation (undersize) of implant bed, with reduction of drilling time and had comparable bone trauma with regards to temperature effects.

A possible explanation for the better primary stability was obtained by combining two drilling protocols (C.G) might be due to the "**Press fit phenomenon**" in cancellous bone. A smaller diameter hole than the diameter of an implant is needed. In addition to the drill geometry, the implant geometry ensured additional press fit regions in the apical third, thereby forming "three" fixation regions could be hypothesized: first one at the crest level created by the implant neck the second at the middle third provided by the implant tapered walls, and third one the apical third which may increase fixation at the apical region^(28, 29).

2. Comparison among the Four Surgical Techniques:

Comparison among the four study Groups (F.G, U.G, D.G and C.G) revealed that the highest insertion torques (ITs) and Periotest M values (PTVs) were recorded while using combined drilling protocols group (C.G) compared with the other drilling techniques, tables (8) and (9). Both methods (insertion torque and Periotest M) showed similar results and influence on the dental implant primary stability in low-density bones.

A statistically significant correlation was noticed between insertion torques (ITs) and Periotest M values (PTVs). The Periotest M values (PTVs) decreased as the implant stability increases, while insertion torque values (ITs) increases as the implant stability increases, Table (5).

CONCLUSION

In low-density bones (type III, IV), dental implant insertion using simplified (Drill bypass) drilling protocol may be combined with undersized implant bed preparation to increase implant primary stability with less time consuming compared to the other three drilling protocols: (Conventional fit-sized F.G), (Undersized U.G), and (Drill bypass D.G) techniques.

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