One stage immediate loading implants "experimental study on dogs"

Anwar A. Al Saeed, B.D.S., M.Sc.(1)
Mohammed J. Essa, B.V.M, S., M.Sc., Ph.D.(2)
Zaid G. Hamdoon, B.D.S, M.Sc.(3)

ABSTRACT

Background: One stage immediate loading to implants offers some clinical advantages. The purpose of this study was to evaluate the concept of one-stage immediate loading implant (screw type) in comparison to non-loading group.

Materials and Methods: One stage dental implant (Denti Dental Implant System), Hungary, 10mm in length, and of 4-4.5mm in diameter, was used. Five adult dogs of 15-22 Kg body weight were selected in the current study. Extraction of left fourth premolar and first molar was done, and the region was left to heal for about 2 months. Twenty implants were installed, ten implants of (4-4.5mm in diameter) were inserted in the left posterior region of the lower jaw which was loaded by Nickel Chrome crown which is considered as (study group), and ten implants of (4- 4.5mm in diameter), without crowns were inserted anteriorly to the loaded groups and considered as (control group).

Results: The current study shows that one of the immediate loaded implant of 4mm in diameter lacked primary stability, which exfoliated later on. There were significant differences at level of loading, diameter and their interaction. Analysis of variance revealed that the smaller diameter implants were significantly higher value of mobility than larger one. The study shows a high incidence of successful rate of the immediate loaded implants of 4.5mm, similar to the non-loaded group, while low incidence of successful rate of loaded implants with 4mm in diameter in compare to the non-loaded group.

Conclusions: The study reported that immediate loading of freestanding implants can achieved osseointegration by using screw shaped implant with large diameter (4.5mm) similar to the non-loaded type. The larger implant diameter associated with higher successful rate and less bone loses when compared with smaller diameter in both groups.

Key words: Immediate loading implant, One-stage, dogs. **(J Bagh Coll Dentistry 2005; 17(3): 76- 84)**

INTRODUCTION

Many root form implants have been introduced, some of these are traditional screw or plate form, and others are hallowing, vented with different surface preparation. All of these attempts have one goal that to promote osteoinduction and to increase bone implant interface. [1,2]

All experimental studies were evaluated one stage supramerge implant system in which coronal portion stays exposed through the gingival margin during implant healing, these studies demonstrated that such implant produce direct bone to implant contact similar to the two stage implant, where it remain cover by oral mucosa during healing periods. [3,4,5]

The advantage of one stage implant system is that the mucogingival management around the implant is easier, patient comfort, because of fewer surgeries are involved, and facilitate esthetic management. In addition to that one-stage dental implants produce no microgap at abutment implant interface, and this will avoid the possibilities microbial proliferation and bone loss. [6.7] while the main disadvantages of supra-merged implants are epithelium brake down and risk for undue early loading. [8,9]

(1) Assistant professor, Department of Oral and Maxillo-Facial Surgery, College of Dentistry, University of Baghdad.
(2) Assistant professor, Department of Veterinary Surgery, College of Veterinary, University of Mosul.
(3) Lecturer Assistant, Department of Oral and Maxillofacial Surgery, College of Dentistry, University of Mosul.

Factors affecting osseointegration:

Successful osseointegration required the use of biocompatable materials, an implant that precisely adapted to the prepared bone, atraumatic surgery to minimize tissue damage, immobile, and undisturbed healing phase. [10]

1. **Biocompatibility:** It is the capacity of a material to exist in harmony the surrounding biologic environment without having toxic or injurious effects on its biologic functions. [11] The biocompatibility of material being considered for endosteal implant is evaluated primary by the reaction of bone to the material, although the reaction with mucosa at the implant neck is also significant. [12]
2. **Implant osteotomy site and primary stability:** The size of gap between implant and bone is critical foe achieving osseointegration. The gap size can bed into which the implant is placed, the precise surgical bed is made by precision instrumentation to minimize the distance between the implant and host bone, but technical difficulty and consistencies between an implant and instrument diameter make it impossible to obtain perfect microscopic contact between bone and

implant. [13,14]) The lack of significant initial bone contact resulted in micromotions between implant and bone, and this situation might prevent osseointegration of implant. [15-17]

3. **Traumatic surgery:** Gentle surgery is required to allow minimal mechanical and thermal injury to occur which considered as a one of the major reasons for early implant failure. [18] Albrektson (1983); stated that all surgical preparation on hard tissue cause necrotic zone of bone at the implant bone interface owing to the cutting of blood vessels. Traumatic surgical manipulation of bone causes poor vascularization of the implant boarder zone with delay or absence of ossification from excessive trauma and heat generation. The crucial threshold temperature for impaired bone regeneration is 44C` to 47C` for a period of one minute, this could be due to the interference with local circulation, capillary leakage, and dehydration that occur with traumatic manipulation. [20] The temperature of denaturation of the alkaline phosphates is 56C`, but it is possible to obtain functional bone regeneration if a Temperature of 44C` or less is not exceed for one minute, where as bone damage occur when bone temperature reach 47C` or less for 1-5 minutes. [21]

Reingewirtz et al., (1997); studied the influence of various parameters on bone heating during drilling in a bovine cortical femur models, they concluded that type of drilling motor using standard, surgical or laboratory motor unite, did not affect temperature elevation. The use of refrigerating spray would reduce temperature elevation, and they found that low speed hand piece reduce heat generation during bone cutting. [22]

While Sharawy et al., (2002); found that the ideal speed of hand piece for implant is 2,500 rpm which may decrease the devitalized zone adjacent to implant, and they suggested that this is the ideal speed for immediate loaded implant. [23] Also no significant differences were found between external, and internal irrigating system. [24]

4. **Delay loading:** Branemark et al., (1977); reported that dental implant should be loaded after period of time, while others found that when implant was loaded immediately, a fibrous connective tissue encapsulation will occur at implant interface. [26]

Concept of immediate loading:

Dental implant has been widely used to retain and support cross-arch partial denture. The implant surgical sites should be undisturbed for at least 3-6 months to allow uneventful wound healing. [27]

Several animal experimental studies shows a conflicting result about the possibility of achieving osseointegration in case of loaded implant and observed direct bone to implant contact rather than fibrous tissue encapsulation. [28-30] Gatti et al., (2000); evaluated long-term result of immediate loaded implant retained over dentures. The over dentures were supported by four implants, and bar clips. Accumulative survival rate of 96% was reported in 25 months follow up. [31] Malo et al., (2000); investigated that immediately loaded Branemark implants shows that 96% have survival rate at periods of six months years follow up. [32] While, Chiapasco et al., (2001); compared the success rate of immediate loaded implant versus delay loaded implant, the result demonstrated a similar success rate 97% for both groups. [33]

MATERIALS AND METHODS

Materials:

1. Dental implant: One-stage dental implants (Denti Dental Implant System) were used in this study, Figure (1). The physical features, geometry, batch number and other feature of implants materials used in this study are shown in table (1).
2. Surgical instruments (Figure 2).
3. Prosthetic equipment (Figure 3)
4. Medications (Figure 4)
5. Experimental animals: In this study five adult local dogs weighting 15-22 Kg from both sexes were selected for the study, the animals were kept under the same condition of feeding and housing in standard separated cages in Veterinary Medicine College, University of Mosul. During the experiment, they were feed on a special diet, examination of animal were performed to check the general health condition of animals.

Methods:

Animal preparation: The dogs received antihelminthic drugs (Piprazin citrate) at a dose of 10 mg/Kg body weight orally and repeated after 21 days, also we gave Ivermectin subcutanously at a dose of 1ml/50 Kg body weight to control external and internal parasite. Periapical radiographs were taken to the left side of mandible to evaluate root length, morphology and the presence of pathological lesion. Each dog was starved for 12 hours; the mouth was irrigated by 2% chlorhexidine mouth wash, with coverage of prophylaxis antibiotics by combination of Procaine Penicillin and Streptomycin IM at a dose of 10.000 IU, 10 mg/Kg body weight, and analgesic as Metalgen, at a dose of 3ml once daily and continued for 4 days after operation. All surgical, measuring, and follow up procedures were done under general anesthesia using Atropine Sulfate at a dose of 0.04 mg/Kg body IM as premedication, followed 10 minutes later by a minute of Ketamine hydrochloride 5% and Xylazine 2% at a dose 15,5 mg respectively IM.

Surgical extraction of teeth: The fourth mandibular left premolars, and first molars were extracted surgically by the help of full thickness two-sided mucoperiosteal flap, Figure (5;A). The region is left to heal for about 2 months.

Surgical preparation for implant placement: Dental implants were sterilized by the used of autoclave at 2.1 bar and 134 C` for 4 minutes. Each dog received four implants of two different diameters (4 and 4.5 mm), with standard length of 10mm. The anterior two implants were the control group, while the posterior two implants were considered the experimental group. A mid crestal incision was done along the healed extraction site, then mucoperiosteal flap were reflected both buccally, and lingually. Implant osteotomy sites were prepared with a distance of 3mm between two individual implants by the aid of surgical template with standard instrument of Denti Implants System, Figure (6). The insertion of dental implant were placed in its site until the end of the screw surface reached the crestal bone of the mandible, and the tap collar smooth surface extended 4mm above the crestal bone. The flap was repositioned and sutured by 3/0 black silk suture, Figure (5; B, C, D, E).

Impression technique and crown insertion: Heavy body rubber base impression materials were used for the construction of study model from primary impressions. Second impressions were taken immediately after implant instillation. Nickel chrome crown were constructed two days after implant insertion, the crowns were checked over the implants and occlusal premature contacts by the help of articulating paper, then the crown was fixed on the abutment by the means of self cure composite resin, Figure (5; F, G, H, I).

Figure 1: DenTi Dental implant screw Shaped, Pure Titanium ISO 5832-2

Figure 2: Surgical Instruments

Figure 3: Prosthetic Equipment

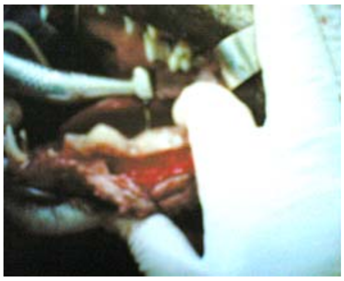

Figure 4: Medications

Figure 5: A- Teeth extraction

Figure 5: B-Preparation of implant site

Figure 5: C- Paralleling Indicators

Figure 5: D- Implants placement with surgical template

Figure 5: E- Implants with abutments

Figure 5:F-Primary impression

Figure 5:G- Secondary impression

Figure 50:H- Laboratory analogues

Figure 5:I- Nickel chrome crowns

Figure 6:Template forming machine

RESULTS

The results of this study shows that one of the immediate loaded implant of 4mm in diameter lack to primary stability at the time of placement due to spongeous type of bone, and the invasion of the implant inside the mandibular canal, which exfoliated later on. The second implant of the same group showed signs of soft tissue infections, which were related to the gingival dehiscence occurring during the third day after surgery.

1. **Primary implant stability:** The mean value of primary implant mobility for each tested group were calculated, and represented by analysis of variance, which shows that there was no significant difference in implant mobility at the time of placement, Table (2).
2. **Implant mobility at the period of (0-1) month:** The mean value of implant mobility of the immediate loaded and non-loaded of 4mm and 4.5mm in diameter shows that, there were significant differences at the level time and

diameter with their interaction as shown in Table (3).

a. ***Effect of loading:*** The study shows that there were no significant differences in the mobility of the loaded and non-loaded implants regardless the time and implant diameters, Table (3).

b. *Effect of diameter:* Table (4); shows that there was significant difference in the mobility among the different implant diameter.

c. *Effect of time:* Analysis of variance shows that there was a significant difference in the mobility of the implants as revealed in Table (5).

d. *Effect of time and loaded interaction:* Table (3); shows that the interactions of time and loading have non-significant effect on mobility of the implants.

e. *Effect of time and diameter:* Figure (6); indicates that the interaction between time and diameter significantly affected mobility of implant.

3. Implant mobility during the period of (6) months: The study shows that there were significant differences at the level of loading, diameter, and their interaction as explain in Table (7).

a. Effect of loading: A significant differences in the mobility between loaded and non-loaded implants, Table (8).

b. Effect of diameter: Analysis of variance as shown in Table (9); revealed a significant difference in the mobility between different implant diameters. The smaller diameter implants were significantly higher value than the larger one.

c. Effect of time: There were no significant differences in implant mobility regardless to loading and diameter, Table (7).

d. Effect of loading and diameter: Analysis of variance indicates that the interaction of loading and implant diameter was significantly affecting the mobility of the implants, Table (7).

4. Implant success and failure at end of the study: The study shows high incidence of successful rate of the immediate loaded implant with large diameter similar to the non-loaded group, while low incidence of successful rate of loaded implant with small diameter in compare to the non-loaded group, Table (10).

5.

Table 1: Characters of Implant Material used in the study

Characters	Description
Type of implants	One stage endosseous implant
Implant macrodesighn	Screw type
Implant microdesighn	Titanium plasma spray
Type of metal	Grade 2 pure non-alloyed titanium according to ISO 5832-2
Implant length	10 mm
Implant diameter	4,4.5 mm
Implant condition	Non-sterile
Manufacture	Hungary
Batch No.	1998-09-20

Table 2: Analysis of Variance (ANOVA) representing implant mobility at the time of lacement.

Source	DF	SS	MS	F-Value	P-Value
Load	1	0.05	0.05	1.07	0.316
Diameter	1	0.05	0.05	1.16	0.298
Load *Diameter	1	0.04	0.04	0.99	0.335
Error	16	0.76	0.04		
Total	19	0.9			

DF = Degree of Freedom, MS= Mean of Square, P= Probability Value, SS= Sum of Squares, F-Value = F Calculated.

Table 3: Analysis of variance (ANOVA) representing the effect of load, diameter, and implant mobility at the period of 0-1 month.

Source	DF	SS	MS	F-Value	P-Value
Load	1	0.080	0.080	2.37	0.135
Diameter	1	0.271	0.271	7.98	0.008*
Time	1	0.290	0.290	8.56	0.006*

Loade*Diameter	1	0.078	0.078	2.32	0.139
Load * Time	1	0.076	0.076	2.24	0.145
Diameter * Time	1	0.251	0.0251	7.40	0.011*
Load * Diameter *Time	1	0.080	0.080	2.38	0.132
Error	28	0.950	0.950		
Total	35	1.816			

Table 4: Duncan Multiple Range Test for the effect of implants diameter on mobility.

Diameter	N	Mean (mm)	Duncan Grouping
4 mm	16	0.176*	A
4.5 mm	20	0.022	B

N= Number, mm = Millimeter , * = Significant.

Table 5: Duncan Multiple Test for the effect of time on the mobility of implants.

Time	N	Mean (mm)	Duncan Grouping
First month	18	0.162*	A
Base line	18	0.018	B

N= Number, mm = Millimeter , * = Significant.

Table 6; Duncan Multiple Range Test for the effect of time and diameter interaction.

Diameter	Time	N	Mean (mm)	Duncan Grouping
4 mm	**First month**	8	0.330*	A
4 mm	**Base line**	8	0.020	B
4.5 mm	**First month**	10	0.016	B
4.5 mm	**Base line**	10	0.029	B

D = Diameter, N = Number, mm = Millimeter, * = Significant.

Table 7: Analysis of variance (ANOVA) representing the effect of load, diameter, and time on the implant mobility at the period of 6 months.

Source	DF	SS	MS	F-Value	p-Value
Load	1	0.825	0.853	14.05	0.0005*
Diameter	1	1.601	1.601	26.37	0.0001*
Time	2	0.007	0.003	0.07	0.9367
Load * Diameter	1	0.870	0.780	14.34	0.0005*
Load * Time	2	0.034	0.017	0.29	0.7513
Diameter * Time	2	0.006	0.003	0.05	0.9509
Load * Diameter * Time	2	0.036	0.018	0.30	0.7449
Error	42	2.550	0.060		

DF = Degree of Freedom, SS = Sum of Square, F-Value = Calculated, MS = Mean of Square, P = Probability, * = Significant (P< 0.05).

Table 8: Duncan Multiple Range Test for the effect of loading on implants mobility.

Loading conditions	N	Mean (mm)	Duncan Grouping
Loaded	24	0.252*	A
Non-loaded	30	0.070	B

N = number, mm = Millimeter, * = Significant.

Table 9: Duncan Multiple Range Test for the effect of diameter on implant mobility.

Diameter	N	Mean (mm)	Duncan Grouping
4 mm	24	0.310*	A
4.5 mm	30	0.022	B

N = number, mm = Millimeter, * = Significant.

Table 10: The success and failure six months after implant placements.

Condition	N	Peri-implant radiolucency, and fibrous tissue formation	Percentage of success
Loaded 4 mm	3	2 implant only shows these features	33.33%
Loaded 4.4 mm	5	Absent	100%
Non-Loaded 4 mm	5	Absent	100%
Non-Loaded 4.5mm	5	Absent	!00%

DISCUSSION

The aim of contemporary dental implant is to reduce the treatment time and surgeries by the application of the immediate loading on the implants.

1. Primary implant stability: The result of this study shows that loosening, and exfoliation of one implant after 5 days of implant loading and this attributed to a high mobility at the time of placement, that exceed 500Nm due to the spongious type of bone in the molar region and the violation of implant inside the mandibular canal. The role of bone quality and quantity in the success of immediate loading implants are explain as a denser bone with adequate vertical dimension provides good stability, which is the key element for the success of immediate loading, and this in agreement with Schinitman et al., (1988) [(34)]; Jaffin and Berman (1991) [(35)]; and Friderg et al., (1999) [(36)]. The mobility of 150 Nm or less has no adverse effect on the integration, while mobility of more than 150Nm result in a soft connective tissue apposition to the implant, this result is in agreement with Szmukler-Moncler et al. (2000) [(37)].

2. Effect of time on the implant mobility: The implants shows that increase in mobility in the first month, while during the periods of (2-6) months does not show any significant effect on the implant mobility, and this may be due to bone necrosis and resorption which depends on the degree of surgical trauma, heat generation, and pressure resorption due to implants instillation, these changes are occur immediately after implants placement, which in agreement with Schenk and Buser (1998) [(38)]. The study recorded that the time after the first month does not shows a significant difference between implant groups, except one of the non-loaded implant shows 0.4 mm mobility at the end of first month then followed by gradual decrease in the subsequent time. On the other hand, the loaded implant of the same diameter shows 0.6 mm mobility and progressive increase in the mobility in the subsequent month which attributed to mechanical load which acts as a co factor for increasing the mobility of implants.

3. Effect of loading and diameter on implants mobility: The current study reported that increase in implant diameter reduce the mobility and this due to the reduction in bone strain which increase the liability to achieve earlier bone integration, and these findings are in agreement with Graves et al., (1994) [(39)], but disagreement with block (1990) [(40)]. The larger implants are less mobility during all phases of the study when compared with non-loaded of smaller diameter and this is due to the fact that larger implants has a greater surface area that contact the bone with better force distribution to the surrounding bone and less bone resorption followed implant instillation, which in agreement with findings of Balshi and Wolfinger (1997) [(41)]. Regarding the diameter the immediate loaded implant of 4.5 mm diameter shows 100% survival rate, and this in agreement with Branemark et al., (1999) [(25)], Who recommended that the long implant with a 5 mm diameter shows 98% of successfulness.

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