

Evaluation of two different implant designs for immediate placement and loading in fresh extraction socketsAmr Zahran¹, Hisham Samy², Basma Mostafa³, Ramy Rafik⁴^{1.} Professor, Department of Periodontology, Cairo University, Cairo, Egypt^{2.} Assistant Professor, Department of Periodontology, Cairo University, Cairo, Egypt^{3.} Researcher, Department of Surgery and Oral Medicine, National Research Centre, Cairo, Egypt^{4.} Assistant Researcher, Department of Surgery and Oral Medicine, National Research Centre, Cairo, Egypt**Corresponding author:** Dr. Basma Mostafa Zaki, BDS, MDS, PhD

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Abstract: This study was conducted to compare between two self-tapping, self-drilling tapered one-piece implant designs used for immediate post-extraction placement with the immediate loading protocol. **Materials and Methods:** Ten patients (6 males and 4 females), with a mean age of 28.5 years (range 18-39 years) were included in this study. All selected patients had two or more maxillary unrestorable hopeless anterior or premolar teeth indicated for extraction. Each patient received two implants of different designs (The OsteoCare™ Midi and Maxi-Z implants) which were placed in fresh extraction sockets and immediately loaded. Clinical criteria were survival rate, papillary bleeding index, probing depth, gingival index, Periotest M values, crestal bone level and bone density. An overall survival rate of 100% was attained. **The results** showed no significant difference in both the bleeding index and gingival index scores and also in the probing depth values, bone density measurements and crestal bone level for both implant designs after 3 and 6 months. The mean and the standard deviation of the Periotest M values (PTMV) for the Midi and the Maxi-Z implants immediately post operative were (-1.83±0.8) and (-2.57±0.9) and after 6 months were (-3.06±0.7) and (-3.11±0.7) showing a significant difference immediately postoperative and no significant difference after 6 months. Surface area analysis revealed that there is a direct relation between the initial stability and the surface area. **Conclusion:** It can be concluded that the immediate implant placement and loading using both designs is a successful treatment modality and the prognosis depends on proper case selection and treatment planning.

[Amr Zahran, Hisham Samy, Basma Mostafa, Ramy Rafik. **Evaluation of two different implant designs for immediate placement and loading in fresh extraction sockets.** Journal of American Science 2010;6(12):1192-1199]. (ISSN: 1545-1003). <http://www.americanscience.org>.

Keywords: Dental implants, immediate implant, immediate loading, two implant designs

1-Introduction:

One of the most important significant scientific breakthroughs in clinical dentistry was undoubtedly the introduction of osseointegrated implants 40 years ago Fischer(2008). The original protocol was described by Branemark who described the two-stage surgical protocol which involves the surgical placement followed by the surgical uncovering of an implant. A healing period of 3-6 months after tooth extraction to allow for bone filling and contouring before implant placement was required. Branemark(1977); Adell et al.,(1981).

Investigations showed that significant bone volume changes of the alveolar process take place

following tooth extraction Denissen et al.,(1994) Araujo and Lindhe (2009) · It was reported that there is a 50 % reduction in bucco-lingual width of the extraction socket over a period of twelve months with two thirds of the reduction taking place during the first three months and a reduction of crestal bone level ranging from 0.7 to 1.5 mm after four to six months Schropp et al.,(2003).

Thus, immediate post extraction implant placement into fresh extraction sockets is considered a predictable and accepted procedure of preserving the alveolar dimensions, with its consequences of better crown-implant ratio, improved soft tissue esthetics and favourable inter-arch relationship

Schulte et al.,(1978);Rosenquist and Grenthe(1996); Sclar (2003); Oh et al., (2006); Lee et al.,(2009). Immediate implant placement has also been reported to have the advantage of reducing the treatment time required with the reduction of the number of surgeries Gapski et al.,(2003); Lorenzoni et al.,(2003); . Testori et al.,(2004); Tsirlis(2005)and Wang et al.,(2006).With the improvement of implant design regarding the surface treatments and thread designs which has the purpose of achieving better primary stability and osseointegration, immediate loading became more popular and many authors have reported a high success rate with this technique Kahnberg (2009)and Guirado et al.,(2010)

Recent researches reported that there are three options for implant loading: conventional staged loading protocol in which the implant is loaded after insertion by 3-8 months Esposito et al.,(2007) immediate loading protocol in which the implants are immediately loaded after insertion or within a week after placement, Glauser et al.,(2001); Degidi et al.,(2003); De Bruyn and Collaert(2002) while early loading protocol allows the implant to be loaded after insertion by 1 week to 2 months De Bruyn and Collaert(2002) ; Attard ang Zarb, (2005).

The combination of immediate post-extraction placement with immediate loading of dental implants has the advantage of shortening the treatment time and increasing case acceptance and reported to be safe in terms of survival rates and esthetics Cooper et al., (2002); Crespi et al., (2007) and Oh et al., (2007). An overall survival rate of 97.5 % to 98 % was reported for implant immediately loaded after placement Calandriello et al., (2003); Lorenzoni et al., (2003); Drago and Lazzara(2004); Degidi et al.,(2005); Zahran(2008).

Both the Midi and the Maxi-Z implants are machined from a piece of titanium alloy that incorporates both the implant body and an integral post or ball fixed abutment in a single component. These implants are designed with a "Buttress" thread design that has the advantage of allowing for the compression and expansion of the implant site to achieve high stability in even poor quality bone. They have grit-blasted and acid-etched (GBA) surface treatment. The conical macro-design of the Mini implants allows their placement in limited tooth-to-tooth spacing and atrophic ridges Zahran(2008). Maxi-Z implants have a tapered body geometry which has the ability to distribute forces into the surrounding bone, thereby creating a uniform compaction in adjacent osteotomy walls when compared with parallel-walled implants. The unique design of both implants allows their placement with minimally invasive flapless procedures. Both designs

the Midi and the Maxi-Z implants are tailored for immediate loading and allow for the provision of same day restorations following the concept of "a tooth in a day" Zahran and Gauld(2007)

2. Material and Methods

2.1. Materials:

2.1.1.Subjects:

Ten patients (6 males and 4 females), with a mean age of 28.5 years (range 18-39 years) were consecutively included in this study.

All selected patients had two or more maxillary unrestorable hopeless anterior or premolar teeth indicated for extraction due to root fracture, endodontic failure or unrestorable crown fracture. The patients were required to be in good health, and had no condition that might affect the outcome of the treatment.

All patients participated in the study were thoroughly informed of the immediate loading protocol and all the risks associated with this type of procedure and signed an informed consent form.

2.1.2. Implants

-Ten Midi implants (strictly, conical in shape) and ten Midi implants (tapered in shape) OsteoCare™ Implant System, London, United Kingdom)

2.2.Methods:

2.2.1.Pre-surgery evaluation:

-Pre-surgical radiographic evaluation with panoramic and periapical radiographs (using standardized parallel techniques) was carried out.

-All patients received oral hygiene instructions and periodontal treatment if needed.

- Midi implants (strictly, conical in shape) and ten Midi implants (tapered in shape) were used and placed in ten patients so that each patient received both designs.

2.2.2. Surgical Protocol and implant placement

After administration of local anaesthesia, periodontal ligament was excised using periostome, followed by careful a traumatic tooth extraction using the forceps to deliver the tooth out. After extraction, the integrity of the buccal plate of bone was checked using an osteotomy probe through the fresh extraction socket as intact buccal plate of bone was considered crucial. The extracted roots were measured in bucco-palatal and mesio-distal dimensions at the middle third using a digital calliper and the readings were averaged, to determine the correct implant diameter. The length of the implant was obtained from the panoramic radiographs using radiographic stents.

Under copious saline irrigation to prevent heat generation and damage of bone, the 1.3 mm profile pilot drill was used to give needle point accuracy for position, angle and depth.

The osteotomy preparation extended three to five millimetres beyond the base of the extraction socket to achieve good primary stability for the implant. While for the Maxi-Z implant, when harder bone density was met, sequential drilling was performed using the 2.2 mm and the 2.75 mm drills to facilitate easier insertion of the implant without exerting undue pressure on the bone.

The type of implant was selected according to the size of the extraction socket:

-The Maxi-Z implants were always selected for the larger socket.

-In cases of equally sized sockets the implants were selected randomly. The implant was removed from its sterile protective pouch and held using the attached plastic carrier and placed into the prepared socket and screwed manually until a resistance was met. The plastic carrier was removed and the ratchet wrench and the hex driver were used for complete seating of the implant into its final position. Both the collar of the Midi implant and the first thread of the Maxi-Z were placed 3 mm below the crestal bone level confirmed by the periapical radiographs.

Establishment of primary stability of over 30N/cm was considered crucial with all the placed implants in the extraction sockets to allow for the immediate loading protocol. Primary stability of the implants was evaluated by the torque wrench.

2.2.3. Abutment Preparation and Provisional Restoration:

Immediately after implant placement, the abutment was prepared using either carbide or diamond burs with copious water irrigation to avoid overheating. Then, a temporary crown was fabricated and cemented to be completely out of functional occlusion in centric and eccentric position. The patients were instructed to avoid direct biting on the provisional restoration.

2.2.4. Post-operative care:

Oral hygiene instructions were given to the patients. Analgesics were subscribed to prevent post-surgical pain when necessary. Finally, a periapical radiograph was taken to check the final implant position and to estimate the initial bone level around the implant.

Final restorations:

The provisional acrylic resin restorations were removed after a healing period of 6 months. Final porcelain-fused-to-metal restorations were

constructed and permanently cemented and checked for shade matching, marginal fitness and occlusion.

2.2.5 Post operative follow-ups and evaluation

2.2.5.1. Clinical records

Clinical records were obtained at 3 and 6 months post-operatively.

- Bleeding on probing was evaluated using papillary bleeding index (PBI) described by **Muhlemann (1977)** using a periodontal probe.

- Infection, swelling and gingival inflammation were assessed using the gingival index (GI) **according to Loe and Silness (1963)**.

- Probing Depth was measured according to a standard procedure described by **Glavind and Loe (1967)** using periodontal probe with Williams' calibrations.

- Mobility was tested using the Periotest M (Medizintechnik Gulden, Bensheim, Germany). Loose implants show high Periotest M values, while osseointegrated implants have low Periotest M values. Periotest M values (PTMV) of (-8 to 0) were considered the ideal values that denote successful osseointegration.

2.2.5.2. Radiographic evaluations:

Standardized periapical x-rays films were taken immediately after implant insertion, 3 and 6 months post operatively to detect any change in crestal bone level and bone density around the implant using the linear measurement system of Digora software (Orion Corporation, Sordex, Finland).

2.2.5.3. Implant surface area measurements:

The surface area of the Midi and the Maxi-Z implants were measured using a 3D scanner to perform a 3D image which is then analyzed and the surface area was calculated using another program (AutoCAD (2004), to compare between the two different geometric features of the two implant designs and evaluate its effect on the primary stability.

2.2.6. Statistical Analysis

Data were presented as mean and standard deviation (SD) values. Data were explored for normality using D' Agostino and Pearson normality test. Paired t-test was used to compare between the two implant designs. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with GRAPHPAD PRISM 5 for Windows.

3. Results

3.1. Complete soft tissue healing had occurred in all patients without any postoperative inconveniences during the study period.

3.2. The provisional acrylic resin restoration became loose in one patient in the fourth month after implant placement and was re-cemented in the same day.

3.3. All the 20 implants were successfully osseointegrated as revealed by clinical and radiographic examinations.

3.4. Implant survival rate of 100% was attested.

3.5. Clinically:

Results showed that the mean and the standard deviation of the papillary bleeding index after 3 months was (1.65 ±0.2) for the two implant designs and then after 6 months it was (1.4 ±0.2). There was no significant difference found, P_3months=1.0000 and P_6months=1.0000.

The mean and the standard deviation of the probing depth for the Midi and the Maxi-Z implants after 3 months were (3.6 ± 0.4) and (3.65 ± 0.4) respectively then at 6 months were (3.5±0.5) and (3.3 ± 0.4).

There was no significant difference found, P_3months=0.8144 and P_6months=0.9074). The mean and the standard deviation of the Gingival index scores for the Midi and the Maxi-Z implants after 3 months were (1 ± 0.3) and (1.1 ± 0.3) respectively, then after 6 months were (0.82 ± 0.3) and (0.87 ± 0.3). There was no significant difference found, (P_3months= 0.6193 and P_6months=0.6193). This means that the difference in implant design does not affect the bleeding index scores, the gingival index scores and the pocket depth values after 3 months and also after 6 months.

The mean and the standard deviation of the Periotest M values (PTMV) for the Midi and the Maxi-Z implants immediately post-operative were (-1.83 + 0.8) and (-2.57 + 0.9) and after 6 months were (-3.06 + 0.7) and (-3.11 + 0.7). There was a significant difference found in the Periotest M values immediately post-operative which means that the difference in implant design does affect the PTMV immediately post-operative (P_immediate post-operative = 0.0122). There was no significant difference found after 6 months which means that the difference in implant design does not affect the PTMV in the second stage, P_6months=0.8553).

Table (1): Correlation coefficients for the two implant designs.

Correlation coefficients	Initial stability	After 6 months
Surface area of Midi implant	0.8920912	0.7340346
Surface area of Maxi-Z implant	0.7824797	0.6114319

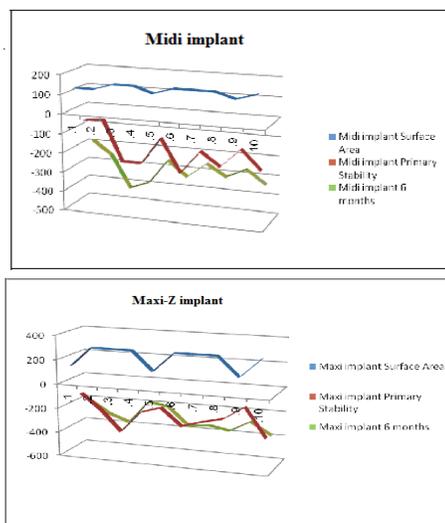


Diagram (1): showing the Midi and Maxi-Z implant surface areas, initial stability and stability after 6 months.

3.6. Radiographic evaluations:

Results revealed that the mean and the standard deviation of the crestal bone resorption for the Midi implants versus the Maxi-Z implants were (0.5 ± 0.3) and (0.6 ± 0.3) after 3 months, and was (0.67±0.3) after 6 months for the two implant designs. There was no significant difference found which means that the change in the bone level around the two implant designs was nearly the same after 3 months and after 6 months. (P_3months=0.1217 and P_6months=0.2848).



Fig 1: Checking of the integrity of the socket using the osteotomy probe



Fig 2: Clinical photograph showing implant immediately after placement



Fig 3: Checking of the integrity of the second socket using the osteotomy probe



Fig 4: Clinical photograph showing both implants immediately after placement

The mean and the standard deviation of the bone density values for the Midi and the Maxi-Z implants were (89.7 ± 2.1) and (88.1 ± 1.3) immediately post-operative, and after 3 months were (75.1 ± 0.84) and (76.4 ± 1.6) , and finally were (76.4 ± 0.7) and (76.9 ± 1.3) respectively after 6 months. There was no significant difference found which means that the difference in implant design does not affect the bone density immediately post-operative, after 3 months and after 6 months (P-immediate post-operative= **0.1075**, P_3months= **0.0801**, P_6months= **0.3691**).



Fig 5: Final ceramo-metal restoration



Fig 6: Immediate postoperative panoramic radiograph



Fig 7: 3 months post operative panoramic radiograph



Fig 8: 6 months post operative panoramic radiograph with final crowns

Surface area analysis showed that the calculated correlation coefficient range for the two implant designs was between 0-1 which indicated that the two variables tended to increase or decrease together. This means that there was a direct relation between the initial stability and the surface area.

4. Discussion

Success of osseointegrated implants has been validated for over 30 years as a viable alternative to fixed or removable prosthetic restorations Albrektsson et al.,(1988); Buser et al., (1997); Szmukler-Moncler et al., (2000). It has been advocated that after implant placement, surgical site should be undisturbed for at least 3-6 months depending on bone quality to allow for osseointegration. This waiting period may cause functional and psychological problems to the patients Chiapasco et al., (1997); Andersen et al., (2002). Several studies documented the success of the protocol of immediate implant placement in fresh extraction sockets in conjunction with immediate loading⁽⁴²⁻⁴³⁾. Research during the last 20 years has increasingly focused on immediate loading of dental implants Fischer(2008).

The immediate loading procedure has become a routine in the treatment of totally or partially edentulous patients and permits delivery of provisional fixed restorations the same day of implant placement Barzilay(1993); Hahn(2000);Gapski et al.(2003); Lorenzoni et al.(2003); Misch et al.(2004 a). A number of factors may influence the results of immediate implant loading. These factors could be related to the surgical procedures, patient, implant design or occlusion-related factors Gapski et al.(2003); Misch et al.(2004 a,b) Zahran, (2008) .

This technique is increasingly gaining popularity as an attractive advantage for both patients and clinicians alike. Today, quick delivery of implant-supported restorations immediately after extraction can be considered the standard of care in case of a missing tooth or teeth.

The present study was conducted to compare between two different implant designs for immediate placement and loading in fresh extraction sockets. All the implants were successfully osseointegrated over the six months follow-up period with a success rate of 100% with insignificant change in the crestal bone level.

The current results showed nearly similar results as that reported by **Kaj et al., (2007)** in which three implants were lost resulting in a cumulative survival rate of 97.9% after up to two years. The higher success rate which was noticed in the current study was probably attributed to the smaller sample size or the strict case selection. The results were also in agreement with those presented by **Lorenzoni et al 2003**), who evaluated the clinical outcomes of immediately loaded implants after one year of placement in the maxillary incisor region, resulting in a 100% survival rate. The results are also in agreement with **Zahran et al., (2010)** which evaluated the flapless immediate implant placement in fresh extraction sockets using the one piece.

Maxi-Z implant.

In the present study, the mobility of all implants was measured using the Periotest M immediately after placement (base line) and at 6 months post-operatively in the two implant designs. There was a significant difference between the mean Periotest values for the two implant designs at the base line but the difference was insignificant after the 6 months follow up period. This is in agreement with **Orenstein et al., (2007)** who performed a study evaluating the stability of the immediately placed and immediately loaded implants using the Periotest. It was concluded that the stability of the implant through the period of the study followed the sequence of socket healing and bone remodeling.

It was observed in the present study that the initial stability attained by the Maxi-Z implant was higher than that of the Midi which was measured by the Periotest M. This could be due to the surface area of the Maxi-Z implant which is higher than that of the Midi implant. This difference in the surface area could be attributed to the modification in the body geometry of the Maxi-Z or its wider range of diameters. This coincides with the study of **Langer et al., (1993)** who proposed the use of wide diameter (5.0 mm) self tapping implants to gain initial stability in the jaw bone region where low-density bone is common. The authors hypothesized that the increased contact obtained with a wider implant improved the engagement of bone and reduced the initial mobility. Increasing the diameter in a 3 mm implant by 1mm increases the surface area by 35% over the same length in overall surface. More contact area provides increased initial stability and resistance to stresses as reported by **Misch (1999)**.

In the present study the Maxi-Z implants attained higher initial stability in wide extraction sockets than the Midi implants which in agreement with the results reported also by **Jae et al., (2005)**.

In the present study the bone density changes around the implants was measured. It was found that there was no significant difference in the bone densities around the two implant designs. This may be attributed to the compression of the bone trabeculae around the implants which is nearly the same for the Midi versus the Maxi-Z implants which is in similarity with a comparative study performed to evaluate implants placed in healed bony sites versus extraction sites **Diago et al., (2008)**.

The first thread of the implants used in this study was placed 3 mm below the crestal bone level of the extraction sockets and this could be the reason for the minimal crestal bone resorption that occurred during the 6 months follow-up period of this study. Other studies recommended placement of the implants with their platforms below the level of the socket by 1-2mm **Lazzara (1989)**; **Becker (2006)** **Orenstein et al., (2007)**.

Conclusion

Both the Midi implant and the Maxi-Z implant can be placed immediately after extraction and immediately loaded showing a 100% clinical success. The Maxi-Z implant is more suitable for bigger extraction sockets due to its wide range of diameter and its body geometry that nearly fills all the jumping gaps with better primary stability. There is a direct correlation between the surface area and the initial stability.

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10/28/2010