THE USE OF ULTRA-SHORT DENTAL IMPLANTS IN ATROPHIC POSTERIOR RIDGES

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ABSTRACT

INTRODUCTION: Reduced alveolar bone in posterior arches is often a complication for regular dental implant placement, which leads to a longer, more complicated and unpredictable bone grafting procedures or nerve repositioning surgeries.
OBJECTIVES: : In this clinical case series, placing 4-mm long Global D implants supporting a fixed dental prosthesis in atrophic resorbed posterior, arches were evaluated for 6 months.
MATERIALS AND METHODS: In nineteen dental arches, 43 dental implants were placed and a screw retained Fixed dental prostheses were attached to two or three dental implants. All implants were placed in adequate amount of bone. No bone grafting procedures were implemented. A minimum torque of 25 Ncm was used to place the dental implants.
RESULTS Forty-three dental implants were inserted. Three dental implants failed before loading. 17 Fixed dental prostheses were delivered. One patient didn't show up for follow up and dropped out of the study. Forty-one implants were eligible for examination and follow up. At 6 month-post–insertion, the survival rate reached 92.7%. No patients suffered from any complications or side effects after implant surgeries. The mean change in the marginal bone loss around implant was found to be 0.22 mm with SD of 0.43 mm $p<0.01$.
CONCLUSIONS: This study shows that 4 mm trans-mucosal dental implants with roughed sand blasted large grit acid etched surfaces can be safely used to support fixed partial prosthesis in atrophic posterior ridges. Further and longer follow up is needed for these types of implants.
KEYWORDS: bone loss, crown-implant ratio, jaw bone atrophy, short implants.

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INTRODUCTION

Dental implants are a widely used therapy method in the restoration of lost dentition either in fully edentulous or partially edentulous patients. A very high success rate of implant therapy has been observed over the years (1). In some sites, it is very difficult to obtain the amount of bone height to place these implants. Many techniques have been used to augment the alveolar ridge, especially in the posterior mandibular region. These approaches are highly technically demanding, require a higher healing period, can result in further more complications, and higher cost (2, 3). The use of short implants in the past 10 years has been very appealing to numerous clinicians. Recent reviews indicated that short implants achieved the same survival rate as regular implants (4, 5).

Short implants were considered less than 10 mm in the last decade (6). Recently, it is more considered to be 8 mm or less (7). With the development of the implant manufacturing and clinical experience, it showed that the proper use of ultra-short implants that are less than 6 mm is also highly successful (8).

During the last 5 years, the use of extra -short implants and short implants has become a highly acceptable viable treatment available for clinicians (9). Extra -short implants of 6 mm in length or less have been introduced to the market during the past few years by major companies like Straumann, Global D, Bicon and others. These implants showed very high comparable success rates within the past few years. A retrospective study on short implants less than 8.5 mm on 1287 implants showed success rate of 99.3% to 98.8%. This study showed that short implants are a very predictable treatment option (10). In addition, another retrospective study of Bicon short implants (< 8 mm) was conducted by Demiralp et al (11) and showed that these short implants achieved comparable results as regular implants. Also, Srinivasan et al (8) showed in their literature review and meta-analysis that the survival rate of 6 mm implants is 93.0 %.

A retrospective study was conducted by Penarrocha-Oltra et al. (12) comparing the outcome of vertically regenerated posterior mandible with onlay graft and 5.5 mm implants. It showed that extra-short implants have a very high success rate as the grafting technique, but result in less complications.

Other studies were conducted to compare between the failure rates of implants in relation to the decrease in implants length. They found that there was no direct relation between the length of the implant and its failure (13, 14).

A five-year prospective multicentre study conducted by Slotte et al (15) showed that four millimetre implants can support fixed partial dentures in the posterior mandible. One piece 4mm implants were a valuable option in the posterior jaw region with the same outcome like longer implants with no bone augmentation procedures as shown in the case report done by Pistili et al (16).

In this study, the main objective was to assess the outcome of placement of ultra-short dental implants in atrophic posterior ridges and to assess the marginal bone loss around the implants after 6 months of placement.

MATERIALS AND METHODS

Informed consent

The appropriate ethical clearance was obtained from the institution at which the study was conducted. An informed

consent was signed by all patients participating in the study. All patients were informed about the aim of the study.

Patient selection

This clinical study was conducted on 19 dental arches and 43 dental implants for patients having resorption of posterior mandibular or maxillary ridges. All patients were selected from the Outpatient Clinic of Oral and Maxillofacial Surgery Department, Faculty of dentistry, Alexandria University.

Inclusion criteria

Patients of 18 years of age or older and good general health with loss of adjacent 2 teeth in the premolar and molar areas or more were included. Healed ridge sites after extraction or even augmentation with a minimum width of 6 mm for the bucco-lingual alveolar bone and a minimum available bone height of 6 mm had been chosen. Occluding teeth or implants or any other type of prosthesis in the opposite arch was mandatory. Confirmed motivation regarding implant treatment and consent to participate in the clinical trials with signed informed consent was obtained.

Exclusion criteria

Pregnant patients and patients suffered with any general contraindications for implant surgery or Psychological disease or suspected psychological disorder were excluded. Also, patients with severe periodontal disease, infection in site to be implant inserted or had been subjected to irradiation in the head and neck area weren't included. Patients suffering of Immunosuppression or immune-compromised, uncontrolled diabetes, substance abuse were also excluded. Furthermore, patients with acute inflammation or infection in the area of implants, poor oral hygiene, low motivation, or requiring bone grafting and cases with an insertion torque of less than 25 Ncm were excluded. Other problems that made implant surgery difficult, such as bruxism or insufficient space for a prosthesis also was ineligible for the clinical trial.

Implants

The implants used were Twinkon®4 4 x 4 mm implants (Tekka-Global D, France implants). The Twinkon®4 is an ultra-short 4mm long implant that can be used in single stage surgery. Twinkon®4 had an aggressive retentive apical thread profile, being made of commercially pure titanium with roughened surface by sandblasted and double-etched techniques. The trans-mucosal part is a combination between a 1.5 mm long 2.7 mm diameter collar, which allows formation of a thick protective mucosal-conjunction tissue joint, and a 2.4 or 3.4 external friction-fit taper-type prosthetic connection with 5 degrees taper. (Fig. 1)

Figure 1: Showing Twinkon 4-mm implant.

Pre-operative evaluation

Intraoral inspection and palpation of the residual ridge were carried out in order to know the condition of the soft tissues and alveolar bone, followed by a check for the presence of any intra oral lesions or signs of infections, such as fistula tract or boney defects. Cone beam and panoramic x ray were used for the identification of the inferior Alveolar canal and the height of residual alveolar bone.

Surgical procedure

Before surgery, an antiseptic mouthwash chlorhexidine solution (Hexitol, the Arab Drug Company, Cairo, A.R.E.) was applied as prophylaxis. A local anesthesia Articaine HCL with epinephrine 1:100,000 (Septocaine, Septodont, USA) as an infiltration was performed in the implant-drilling site (Fig. 2a). Full thickness flap was done. Crestal incision was made by blade number 15 with one releasing distal incision for full access for the implant site. The drilling of the implant site followed the principles and guidelines of the Twinkon®4 system (Fig. 2b). This drilling sequence was supposed to gain the optimal primary stability for the implants in different bone density. The drills were designed with 4.8 length stoppers for precise and safe drilling.

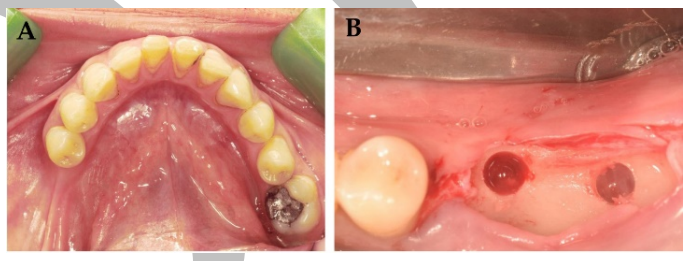

Figure 2: (a) Pre-operative picture (b) Incision with drilling sites.

According to the bone density, drilling protocol was at speed of 600-100 tr/min. For D3 and D4 density, drills sequence was 2, 2.5 and 3mm for 4 mm wide implant and 2, 2.5, 3 and 3.5 mm for 4.5 wide implant. For D1 and D2 density, drills sequence was 2, 2.5, 3 and 3.5 mm for 4 wide implant and 2, 2.5, 3.5 and 4 mm for 4.5 wide implant.

The implant was then placed in the bone using a hand-piece carrier with maximum torque of 30 Ncm, the carrier was mounted to the pre-mounted implant holder (Fig. 3a). Any extra torque needed to insert the implant into the bone was delivered using a hand ratchet. After screwing in the implant, the implant holder was detached using the key against torque. Healing abutment (Fig. 3b) "single stage surgery" was placed, the incision was closed by Vicryl 4-0 sutures (Coated VICRYL, Ethicon, USA)

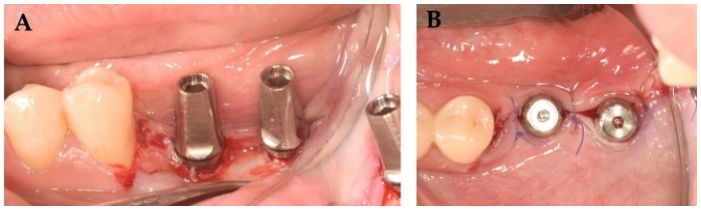

Figure 3: (a) Implants placed with implant driver (b) Implants placed with healing caps.

Postoperative instructions

Patients were advised Cold fomentation for the first 24 hours and warm mouth wash on the next day. Oral hygiene

instructions had been given. Patients were instructed to follow a soft diet for 2 weeks.

Postoperative medication

Patients were prescribed antibiotic: oral tablet of amoxicillin trihydrate equivalent to 875 mg amoxicillin and potassium clavulanate equivalent to 125 mg of clavulanic acid (Augmentin 1gm, GlaxoSmithKline, UK) twice daily for 7 days. Also, NSAID: Diclofenac potassium50 mg tablets (Cataflam, Novartis, Egypt), 1 table 2 times daily for 5 days and warm mouthwash: chlorhexidine HCL 0.12% (Hexitol, the Arab Drug Company, Cairo, A.R.E.) were prescribed.

Follow up and prosthesis

Patients were followed up after 2 weeks for clinical examination for wound closure and suture removal. Also any pain or any signs or symptoms as pain or edema. Patients were checked up after 6 weeks for any peri-implant infection, soft tissue closure and patient discomfort. After 12 weeks of implant insertion patients were called in for check-up of the implant mobility, oral hygiene and peri-implant infection. Also, impressions were taken for screw-retained temporary restoration with non-occlusal loading, then a final screw-retained splinted fixed partial prosthesis was fixed after another 6 weeks. (Fig. 4). Bleeding index was also documented according to Mombelli A et al. (23) after 6 months post-operatively.

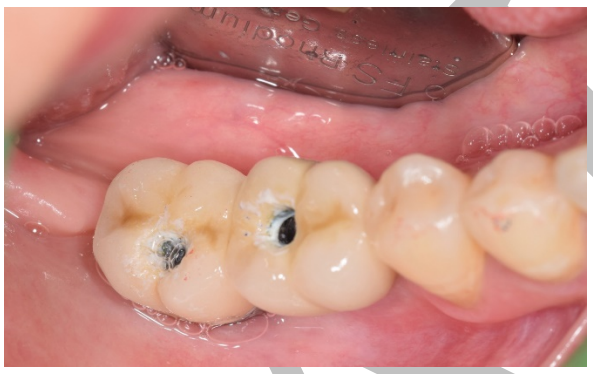

Figure 4: Final restoration screw retained.

Implant positions and crestal bone level are recorded at the time of surgery for future assessment. In the later follow–up, the crestal bone level was recorded before the time of loading with the help of panoramic x-rays. Marginal bone changes were determined with the help of panoramic x-rays after implant placement (Fig. 5a) and 6 months post-operatively (Fig. 5b) and were compared. Comparison was made with the help of panoramic x-rays, all taken with the same scanning machine, following the same standards and guidelines. Then, the Dicom-data of the digital panoramic x-rays was imported to Ondemand3d application and measurement. The same radiology technician did all the measurements.

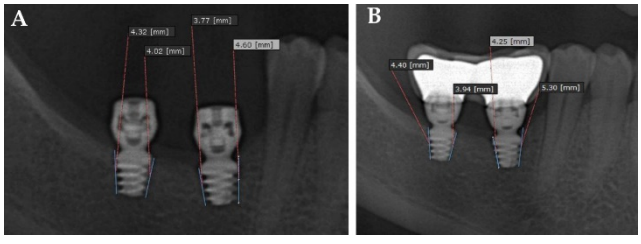

Figure 5: (a) Post opreative x ray. (b) Radiograph of implants with final prosthesis.

Statistical analysis of the data (17)

Data was fed into the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) (18) Qualitative data was described using numbers and percentage. The Kolmogorov-Smirnov test was used to verify the normality of distribution. Quantitative data was described using range (minimum and maximum), mean, standard deviation and median. Significance of the obtained results was judged at the 5% level. The used tests were Wilcoxon signed ranks test for abnormally distributed quantitative variables, to compare between two periods

RESULTS

Clinical results

A total of 43 Ultra short 4 millimeter dental implants were placed in 19 dental arches of 13 patients. Six of these patients were males and 7 were females. 6 implants were placed in posterior maxilla (3 arches) and 37 implants were placed in 15 mandibular arches. All patients were screened according to the inclusion and exclusion criteria.

All patients were followed up except for one patient who dropped out not for study-related reasons. The results were registered as regards both clinical and radiographic evaluations.

After surgery, five patients experienced slight-to-mild pain at the surgical site. Two experienced slight pain and showed mild edema, which subsided totally by the 3rd post-operative day. All patients continued the follow-up period without signs of infection, gingivitis, or peri-implantitis.

All over the evaluation period, three implants showed mobility and failed after 1 month of placement. 38 implants were fully loaded after 3 months and remained in function for the whole follow-up period. Three implants did not survive in 2 patients. This gave a survival rate of 92.7%. (Table 1)

Table 1: Showing Distribution of the success cases (n= 41)

Implants	No.	%
Failure	**3**	**7.3**
Success	38	92.7

No sulcus bleeding was found in 95.2% of implant surfaces after 6 months post-operative (Table 2), which shows a healthy periodontal attachment around implants.

Table (2): Distribution of the studied cases according to bleeding upon probing (n= 38).

Bleeding upon probing	No.	%
Non bleeding	30	78.9
Bleeding	8	21.1
No. of sites	**(n= 228)**	
Non bleeding sites	217	95.2
Bleeding sites	11	4.8

Radiographic results

Based on all sites, marginal bone loss was calculated 6 months post-operative that is the mesial and distal (see table 3-4-5 and Fig.23-25). The average bone loss around the

implants was found to be -0.22 mm with SD of ± 0.41 mm, significant ($p < 0.001$). (Table 3)

Table (3): Showing Distribution of the studied cases according to total bone loss (n= 38)

Total Bone Loss (mm.)	On day of surgery	After 6 months
Min. – Max.	4.0 – 5.50	3.40 – 5.60
Mean ± SD.	5.07 ± 0.29	4.83 ± 0.49
Median	5.12	4.98
Change	-0.22 ± 0.41	
P	<0.001*	

DISCUSSION

The implant survival rate was slightly lower than that of a similar study conducted with 4 mm Straumann by Slotte et al. (19) who reported a survival rate of 92.3 %. Also, similar survival rates could be found for the same type of implants done by Esposito et al (20). Compared to longer implants (7 mm implants), a slightly lower survival rate was found in this prospective study compared to Renouard et al (21) who reported a survival rate of 94.6% after 2 years of loading.

These authors discussed that the good results yielded by short implants might be related to the high primary stability and the effective use of the residual bone volume with high primary bone-to-implant contact in dens bone structures. Further results were reported by Misch (22) who placed 745 7–9-mm-long implants in 273 patients. After 1 to 5 years, they reported a survival rate of 98.9%, which is slightly higher than the results of this study, even though the patients were observed for a longer period of time, which shows that using longer implants might be more successful. Even though Renouard et al (21) discussed that the failure rate of short dental implants was associated with the operator's learning curves, routine surgical preparation (independent of bone density). It was indicated that an adapted surgical preparation and the use of textured-surfaced implants resulted in comparable survival rates between short implants and longer ones. But a longer follow-up period should be done to have more comparable results to longer implants.

The mean change in crestal bone level was 0.22 mm with standard deviation of 0.41 mm in the first six months after implant placement. These results were in line with and even less than the earlier study conducted by Slotte et al. (19) who reported a 0.43 mm marginal bone loss over follow-up of 1 year after placement. Also the results of the marginal bone loss are similar to or even better than those yielded in Renourd et al (21) study. Same results were found by Esposito et al. in their randomized clinical trial using the same 4-mm implants (20). The greater marginal bone loss during the first year might be explained by the considerable trauma and inflammation of the tissue, even with careful surgery. Initial necrosis of the bone adjacent to the implant had been shown experimentally and further bone loss took place around the loaded implant as an adaptive remodeling response to shear forces until a steady state is established (23).

The implant shape and design parameters affect the load transfer to the surrounding bone. The implant diameter, length and thread shape affect the stress distribution on the bone. The finite element models had found that the cortical bone (as in the posterior mandible) seems to be more affected by the implant diameter and the stress peaks rather than implant length, while the opposite was found for the maxillary trabecular bone (24). As shown by Baggi et al. (24), the use of short implants in the posterior mandible might, therefore, be supported because it is mainly dependent on the cortical part of the bone. It was experienced in this study. Primary stability was optimal enough because of the cortical thickness.

Short implants had been compared to regular implants in other aspects, such as crown implant ratio and marginal bone loss after loading. A Retrospective study was conducted by Anitua et al. (25) on short and extra-short implants to see the influence of the crown on implant ratio. It showed that there was no significant difference in the marginal bone loss and the crown implant ratio. However, it showed that using a cantilever on short implants may show negative results. In this regard, Monje et al. (26) had made a systemic review of the marginal bone loss around short implants. The results showed that they have similar marginal bone loss as standard implants. It was concluded by Draenert et al. in their retrospective analysis (27).

The unfavorable ration of implant length and crown height were not found responsible for more bone loss in the recent systematic reviews and reports. In accordance with recent reports and systematic reviews, the unfavorable ratio of implant length to height of the suprastructure in this study, bone loss was found similar to longer implants (28-30). The marginal bone loss around implants was the same with different crown root ratio. Although it was not measured during this study, no impact of the crown ratio on the marginal bone loss could be observed in the x-rays. Higher peak strains (due to, e.g., increased crown–implant ratio) had been shown experimentally to promote periosteal/endosteal bone formation and, at the same time, not affecting bone remodeling within the skeletal envelope (31). However, it should be noted that the protocol in this study prescribed that all occlusal units should be supported by one implant. Moreover, the suprastructures were designed with freedom in-centric and avoided steep cuspal inclinations and extreme lateral contacts. These measures of precaution were most likely beneficial to the study outcome (22).

The investigator's experience with the tested implants suggested that handling them during surgery was the same as handling regular longer implants. But the loss of initial primary stability was a factor in the placement of ultra-short implants. This was due to the over preparation of the surgical site, which can occur easily. So avoiding over drilling and over torqueing of the implants must be taken care of. It was observed in a further study with 4-mm long Straumann implants (19).

Achieving implant parallelism was an important factor to allow using multi-unit screw-retained prosthesis. High care during surgery was necessary to allow loading of the implants without a problem. Further with ultra-short implants, the learning curve of handling and placing them was a great factor in success. It was mentioned by Slotte et al. (19) in their discussion about the learning curve of the operator. They had the same experience of the tested 4 mm dental implants as longer ones with precaution and great

care to avoid over drilling. Also, threading the implant bed made its placement easier. They also advised that these implants were more suited for well-experienced clinicians. The use of Ibrahim's parallelism kit was of great help in placing these implants.

It is a treatment option available for patients with reduced ridges due to the clinicians growing experience and techniques. People with cancer, implant failure or periodontal disease profit from the 4-mm implants without having to go through bone grafting. It has been shown in this study that the predictability of these implants, even in demanding situations, is good. It is of great advantage over the unpredictable outcome of some bone grafting situations. These implants are a good option compared to time-consuming and painful procedures. However, it is advised that these implants should be used by well-experienced clinicians due to the steep learning curve of short implants.

CONCLUSION

Ultra-short 4 mm implants can be successfully used to support multiple splinted fixed prosthesis in the posterior atrophic jaws, even with increased crown to implant ratios. The use of these implants allows for the treatment of patients who have medical, anatomical or financial constraints that don't allow them to undergo complex surgeries. The use of short implants reduces the need for complex surgeries. Therefore, they reduce the morbidity and treatment time. However, longer follow-up studies are needed. Also, more studies should be conducted to show the impact of crown to implant ratio on implant survival. The use of short implants also decreases the stress of the surgery on the patient and the surgeon.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest. All implants were supplied by Global D France company for dental implants.

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