Influence of Dental Implant Diameter on Implant Success

Amer A. J. Al-Khazraji

F.I.C.M.S. Head of Oral and Maxillofacial Surgery, Nu'mman General Hospital; Head of Dental Implant Unit at Al- Elwiya Specialist Dental Center; Coordinator and Supervisor of the Arabic Board of Medical Specializations.

ABSTRACT

Background: Missing teeth may result in a functional and cosmetic deficit and have traditionally been replaced with dentures or bridges. Dental implants offer an alternative; they are inserted into the jawbones and used to support dental prostheses.
Objective: To relate diameter of dental implants with implant success.

Patients and Methods: Implants with a root form, conical morphology and internal hex design, with SLA (sand blast large grid acid etch) surface treatment was used in this study. Two surgical procedures for submerged, bone level implants were used and 3 years follow up after prosthetic procedure was done. The diameter was classified as narrow, regular, or wide. The statistics were computed with Epi Info Version 6.

Results: In this study, 603 dental implants (312 maxillary and 291 mandibular) were placed in 285 patients (mean age, 45.23 years) involving 152 males and 133 females with 1.2: 1 male to female ratio. The 3 years survival rate for all 603 implants was 96.02%. The largest success rate was observed in wide diameter implants (99%), followed by regular diameter (97.6%) and then narrow diameter (94.11%). According to Epi Info Version 6 analysis the chi2= 7.6 and P- value= 0.03 associated with 3 years follow up.

Conclusion: According to this study there is a relationship of implant diameter with success rate.

Key words: Dental implant, implant diameter, implant success.

INTRODUCTION

The endosseus dental implant is a predictable technology to facilitate the prosthetic replacement of teeth. The focus of implant research is shifting from descriptions of clinical success to the identification of factors associated with failure[1]. New implant types varying in length, diameter, and shape have been continuously introduced[2].Choice of implant depends on the type of edentulism, the volume of residual bone, the amount of space available for the prosthetic reconstruction, the emergence profile, and the type of occlusion[3].

In general, the success of dental implants is related to the quality and quantity of local bones, implant design and surgical technique[4]. Implant diameter and length are accepted as key factors[5,6]. The posterior jaw, the main functional area of masticatory activity, is mainly composed of type III or IV bone, as classified by Lekholm *et al*.[7].The effects of implant diameter and length on stress distribution and implant stability in this region remain unclear. The optimal range of implant diameter and length is hard to define. It is necessary to understand the role of implant diameter and length in regions with poor quality bones[8].

Wide-diameter implants were introduced in 1993 with indications for their use associated with 1) poor bone quality, 2) inadequate bone height, and 3) immediate replacement of nonosseointegrated fixtures or fractured fixtures[9].

Stress and bone-implant contact influence the stability and survival of implants. A biological impediment to the use of wide-diameter implants can be a lower blood supply because of minimum existing cancellous bone[10]. Consequently, the total bone implant contact may be greater, compensating for the lack of height or bone density. However, wider implants are used when bone is scarce and the influence of diameter on bone-implant contact may not translate into a clinical advantage[11]. Decreasing the diameter of dental implant means increasing the risk for implant fracture because of reduced mechanical stability and increasing the risk for overload[12].

The aim of this study was to evaluate the effect dental implant diameter on success rate, for a period of 3 years, of patients treated by use of implants with different diameters.

PATIENTS AND METHODS

The study was based on a retrospective analysis of patients who received dental implants between May 2006 and May 2009 at Al-Elwiya Specialized Dental Center and Private Dental Implant Center. The study consisted of 603 dental implant placed in 285 patients .The inclusion criterion was dental implant placement in patients who had undergone two stage dental implant surgery. All implants analyzed in the study followed the protocol of 2 surgical procedures (submerged implants), and the implants were evaluated from the placement of the implants (first surgical phase) until 3 years after the procedure of reopening (second surgical phase) and prosthodontic stage.

Patients were not admitted to the study if any of the following exclusion criteria was present:

- The patients had missing or incomplete files.
- The patients had implants with external hex.
- The patients had implants other than Kentron K-one.
- The patients with age below 18 years.
- The patients had miniimplants

The implants used in this study were divided according to platform diameter into three groups: narrow implants (3.8mm), regular (4.5mm), and wide (5.5mm).

In this study a 2-stage surgery, submerge, and crestal level protocol used with root form design implants, titanium alloy grade 4 with SLA (Sand blast Large grid Acid etch) surface treatment from Geass Italian Company (Kentron K-one system) and we depend on the following criteria of success:

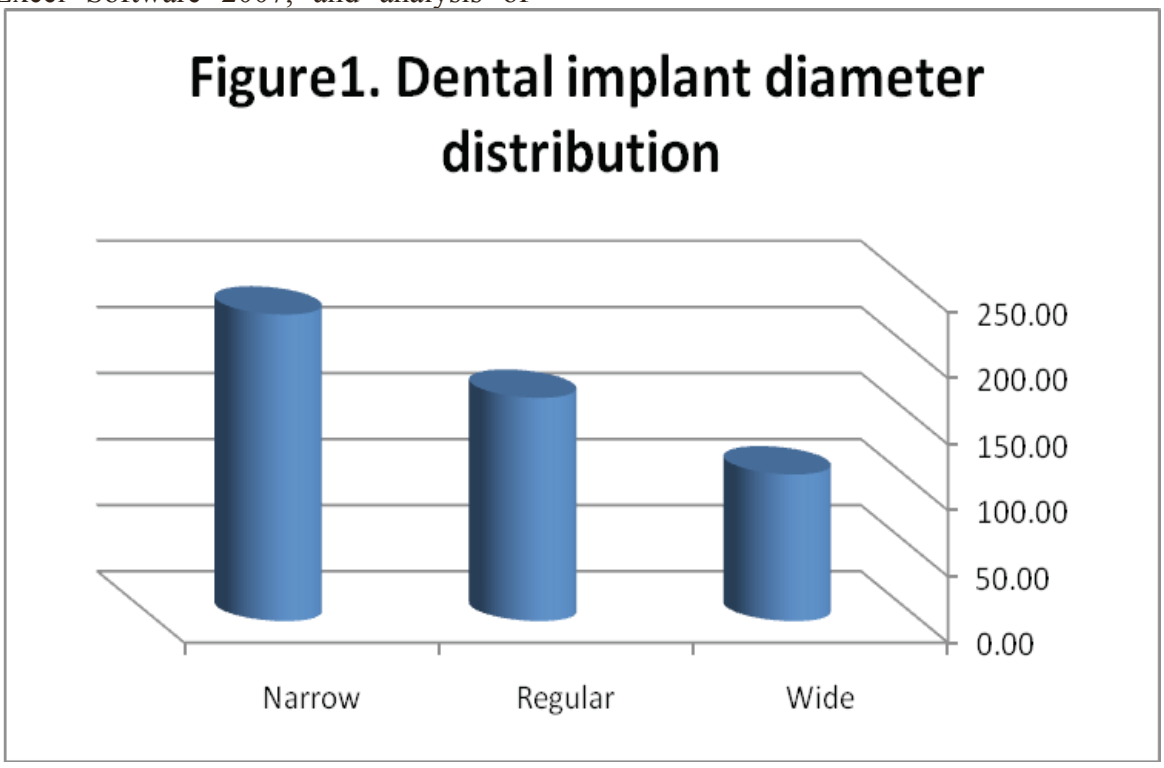
1. The implant is immobile when tested clinically.
2. No evidence of perimplant radiolucency is present, as assessed on an undistorted radiograph.
3. The mean vertical bone loss is less than 0.2 mm annually after the first year of service.
4. No persistent pain, discomfort, or infection is attributable to the implant.
5. The implant design does not preclude placement of a crown or prosthesis with an appearance that is satisfactory to the patient and the dentist.

Data were tabulated and analyzed by use of Microsoft Excel Software 2007, and analysis of Anthropometric data using Epi Info Version 6.

RESULTS

In this study, 603 dental implants (312 maxillary and 291 mandibular) were placed in 285 patients ranging in age from 18 to 77 years (mean, 45.23 years). The nymber if male patients was 152 (53.3%) and the female was 133(46.7%) , and male to female ratio was 1.2:1. A total of 603 implants were installed, with a median of 2.1per patient. The platform and implant connection were conventional internal hexagons and the implant was submerged and not submitted to dental load (delay loading).

We placed 111 wide-diameter implants (Ø5.5mm), 169 regular-diameter implants (Ø4.5mm), and 323 narrow-diameter implants (Ø3.8mm) see figure 1.



The 3 years survival rate for all 603 implants was 96.02%. The largest success rate was observed in wide diameter implants (99%), followed by regular diameter (97.6%) and then narrow diameter (94.11%). See table 1.

Table 1. Relationship of implant diameter to success rate.

Implant diameter	*Quantity*	*success*	*Success percentage*
Wide	111	110	99%
Regular	169	165	97.6%
Narrow	323	304	94.11%

Demographic variables such as gender and age did not show significant statistical differences. Epi Info Version 6 analyses showed significant relationships between diameter of implant and success rate (P-value = 0.03 and chi2= 7.6). Success rate of implant did not show a significant statistical difference with maxillary or mandibular installation (P- value = 0.80 and chi2= 0.06).

DISCUSSION:

The success of dental implants depends on endogenous and exogenous factors. Bone quality and quantity are endogenous factors, and implant diameter

and length are exogenous factors. All these factors appear to influence implant success rates significantly[13]. Bone quality varies in different areas of the jaw bone. Mandibles are usually more densely corticated than maxillae; and both jaws tend to decrease in their cortical thickness but increase in their trabecular porosity as they move posteriorly[14].

For many years, implant configuration has been considered an essential requirement for implant success. Among the related implant parameters, diameter and length play key roles in implant success, since they directly influence the primary stability, placement and removal torque values,[15].

As with this study result, Chiapasco *et al*.16 proposed that it would be better to use implants ≥4 mm in diameter. Few studies have been designed to reveal the effects of implant diameter and length on the implant stability in the posterior maxilla, where bone density is low. In the present study, we found that with the increase of diameter bone stress decreased and implant stability increased, which is consistent with previous studies [17,18].

Load-bearing implants in osteopenic bones with thin cortices and reduced spongiosa need larger dimensions to provide larger load-bearing bone-implant interfaces. The larger the interface, the smaller the unit load on the supporting bone. The unit load should be kept below the operational threshold of the bone's strain range, which is usually near 60 MPa[19,20] in stress terms.

Several meaningful points could be drawn from the perspective of biomechanics. First, stress in type IV bone is influenced by implant diameter and length, Second, biomechanically speaking, implant diameter exceeding 4.0 mm and length exceeding 9.0 mm are the optimal selection for a screwed implant in type IV bone[20], which is consistent with the result of this study.

Type of bone (maxilla or mandible) did not show significant statistical differences in this study, either the type of bone did not influence the success rate , or on the other hand, a second hypothesis might be that osseous class influence long term stress loading (> 5 years), Degidi *et al*.[3]did not find a significant difference associated with bone quality (maxilla or mandible) when evaluating survival of narrow- or wide-diameter implants. They did, however, find a different success rate according to length and diameter, with a better outcome with regard to reduced crestal bone loss over time for shorter than (13 mm) or narrower than (5.0 and 5.5 mm) implants[21].

According to the result of this study the diameter of implant should be considered as a reference for selecting implants. Prospective clinical studies are required to confirm the results.

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