THE IMPACT OF DENTAL IMPLANT DIAMETER AND LENGTH ON OVERALL FAILURE RATES REGARDING DELAYED LOADING PROTOCOL

Constantin Razvan Giuvara[1], Cosmin Bida[2], Ovidiu Nicolaiciuc[3], Bogdan Bulancea[3], Eduard Radu Cernei[4], Doriana Agop-Forna[5]*,Dan-Nicolae Bosanceanu[6]*

[1] "Gr. T. Popa" U.M.Ph. - Iași, Romania, Faculty of Dentistry, - Department of Oral and Maxillofacial Surgery
[2] "Gr. T. Popa" U.M.Ph. - Iași, Romania, Faculty of Dentistry, Department of Prosthodontics
[3] "Gr. T. Popa" U.M.Ph. - Iași, Romania, Faculty of Dentistry, Department of Prosthesis Technology
[4] "Gr. T. Popa" U.M.Ph. - Iași, Romania, Faculty of Dentistry, Department of Orthodontics and Dentofacial Orthopedics
[5] "Gr. T. Popa" U.M.Ph. - Iași, Romania, Faculty of Dentistry, Department of Oral Surgery
[6] "Gr. T. Popa" U.M.Ph. - Iași, Romania, Faculty of Dentistry, Department of Removable Denture

***Corresponding author:** Dan-Nicloae Bosanceanu e-mail: dbossu1@gmail.com
Doriana Agop-Forna e-mail: drdorianaforna@gmail.com

ABSTRACT: The study is aimed at evaluating the importance of physical characteristics of dental implants like diameter and length in relation to the overall failure rate. **MATERIAL AND METHOD:** The relevant data was obtained from analyzing the failure rates of dental implants used to rehabilitate the clinical condition of the study group's patients and which added up to a number of 124 implants. **RESULTS AND DISCUSSIONS:** The overall implant fail rate was established to be 8.06% meaning a total number of 10 implants that were considered to be a clinical failure. All of the implants that were considered to be clinical failure were associated with small diameters and/or lengths**.** **CONCLUSIONS:** The clinical length and diameter of the implant has been proved to enhance the success rate of the dental implant inside the low-density bone

Keywords: *dental implant diameter, dental implant length, delayed loading, implant failure*

INTRODUCTION

It is commonly accepted that the bone-implant interface surface which is designed to accept compressive forces is actually the most effective area for sharing occlusal forces to underlying bone structures [1,2]. The force transfer process has been found not to be symmetrical around crestal and trabecular bone [1,3]. This generates the need to have an implant design that efficiently distributes occlusal loads to the surrounding bone without generating overloads [1,3,4]. Although occlusal force dissipation starts at crestal bone level it continues below this level to the adjacent trabecular bone where dental implant design and geometry has been shown to be of greatest importance as it has a direct effect regarding the implant-bone contact area and occlusal force distribution. At his level, the trabecular bone is responsible for dissipating all the remaining amount of occlusal force. The implant geometry in this area needs to be well suited for supporting compression forces. Considering this, it is obvious that the implant's diameter and length contribute to expanding the surface area that may take over occlusal forces in a compressive manner so that the dental implant may act in the same physiological manner in resemblance to natural teeth. This aspect is even more important when considering low density bone that is to receive dental implants because, in this case, the bone area that will come into close contact with the implant's surface is reduced due to the poor bone quality. Taking this aspect into consideration it becomes clear that when the bone density is located around low values there is an unequivocally need to insert implants with larger surface areas in order to efficiently dissipate occlusal forces [1,5]. A dental implant placed in adjacent bone having a certain length will become more prone to success by increasing it's diameter as this will result in a wider contact surface area that will enable the implant do transmit a greater amount of force to the underlying bone with an adequate bone volume [1]. Increasing the implant diameter solely is not a substitute for other factors that need to be taken into consideration so therefore it cannot constitute a guarantee for clinical success. Other studies have shown that increasing the implant dimeter had no significant effect regarding the incidence of peri-implant marginal bone resorption [1,6]. Having more surface to act when it comes to dissipating mechanical energy, the implant-bone interface will display a reduced amount of stress, which is opposite to the case of narrower implants that display stress in a higher degree. Besides being protected from a high degree of mechanical stress, the wider diameter also enables the implant in becoming less susceptible to fracture under occlusal forces or the fracture of the abutment screw [1]. The length of the dental implant also represents an important factor as it offers additional surface area that will develop into bone-implant interface as well as provides enhanced primary stability. Studies regarding implants with lengths ranging from 7 mm to 16 mm have shown that the survival rates were 66.7% for the 7 mm and 96.4% for the 16 mm pleading this way for the insertion of longer implants to achieve greater success rates [1,7].

MATERIAL AND METHOD

The study was conducted upon implants that were inserted by various clinicians in different private practices which provided initial data, treatment data and also follow-up data for the study. Initial data consisted of patient situation before treatment with indicators like gender, age, edentation class and preexistent medical condition. The implant data represents all the technical parameters that were used pending the implant insertions procedure like implant size with length and diameter, irrigation, drilling speed, insertion torque, bone density and also the use of countersink type drills for lower bone densities. The follow-up data consisted of radiographic imaging evaluation and also clinical evaluation of inserted dental implants. The digital imaging evaluation was aimed at evaluating implant failure signs represented by various degrees of radiolucency around implant contour meaning a lack of proper bone integration or at the level of crestal bone where it signals a high degree of bone resorption leaving more than half of the implant's length without bone contact. Clinical evaluation is aimed at evaluating failure signs as implant mobility or signs of peri-implant inflammation.

Initial data was synthetised using a group consisting of 48 patients that underwent implant placement procedures. The gender distribution of the patients was 26 male patients and 22 female patients. The age of the patients ranged between 41 and 74 years old. The median age of the whole patient group was 54.7 years.

The implant data was obtained from dental implants used to rehabilitate the clinical condition of these patients and which added up to a number of 124 implants, with a median number of 2 implants per patient. The implants were of different brands, diameters and lengths. The lengths of the used implants vary from 6 mm to 16 mm with the median value of 10 mm. The longest implants (16 mm) were inserted in oblique positions, at a 45-degree angle, during "all on six" protocol. From the entire group 4 of the patients underwent rehabilitation procedures using "all on six" protocol in which they received prosthesis connected through locator or ball type abutments to the underlying implants. The diameter of the implants used varies from 3.30 mm to 6 mm. The 3.30 mm implants were used in cases that displayed advanced horizontal bone resorption that was not adjusted trough bone grafting due to various reasons. All of the above implants were two-piece tapered implants with abutments being separately added. The osteotomies for the implants were drilled using an average of 600-700 rpm with moderate irrigation. In the case of all the implants at the end of the osteotomy sequence a countersink was used as the surgical protocol requires when dealing with less denser bone. The insertion of the implants was performed using the electric motor and the handpiece so that the torque could be accurately measured. Only the last few threads of the cortical area were inserted using a manual wrench to ensure the perfect positioning of the implant at the crestal level. The implants were placed at bone level adjacent to the margin of the crestal bone ridge considering the fact that all of the implants had an internal hex connection.

The torque which was been recorded at insertion moment varied between 15 N/cm and 30 N/cm with a median value of 21 N/cm. All the patients have been selected so that the maxillary bone which is to receive the dental implants was low in density and was categorized as type 3 or type 4 bone. Considering the low torque that was necessary to attain primary stability and the low density of the maxillary bone in all of the cases the delayed loading protocol was used in order to obtain a higher degree of osteointegration and biological stability. All of the implants were loaded with abutments and prosthesis after more than 6 months of healing period. The actual time intervals vary from 6 months to 9 months. All of the dental implants were placed in the posterior area of the maxillary bone.

The follow-up data consists of evaluating the cases for signs of implant failure. Clinical evaluation was aimed at revealing aspects like : inflammation, implant mobility, soft tissue dehiscence an the presence of purulent secretions adjacent to the implantation site. The radiographic evaluation was aimed at revealing aspects like radiolucency around implants which may suggest a lack of osteointegration or crestal bone resorption that may extend to more than half of the implant length categorizing the implant as a clinical failure.

RESULTS AND DISCUSSIONS

The overall implant fail rate was established to be 8.06% (Fig.1) meaning a total number of 10 implants that were considered to be a clinical failure Although this percentage can

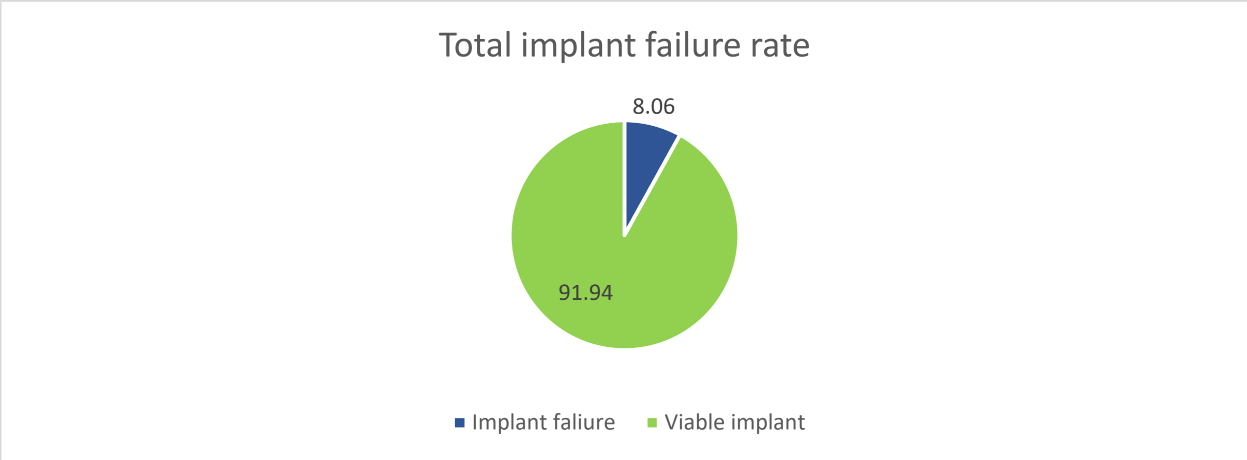

Figure 1. Total implant failure rate

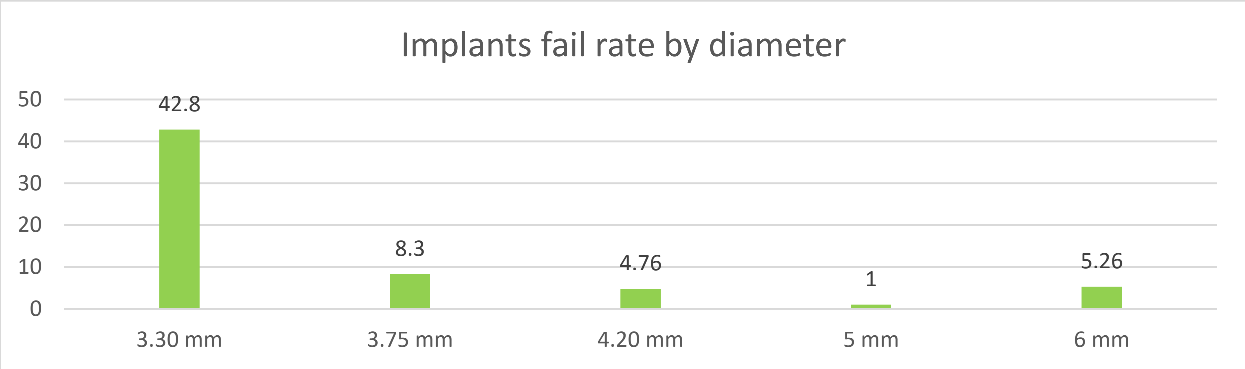

Figure 2. Implant fail rates by diameter

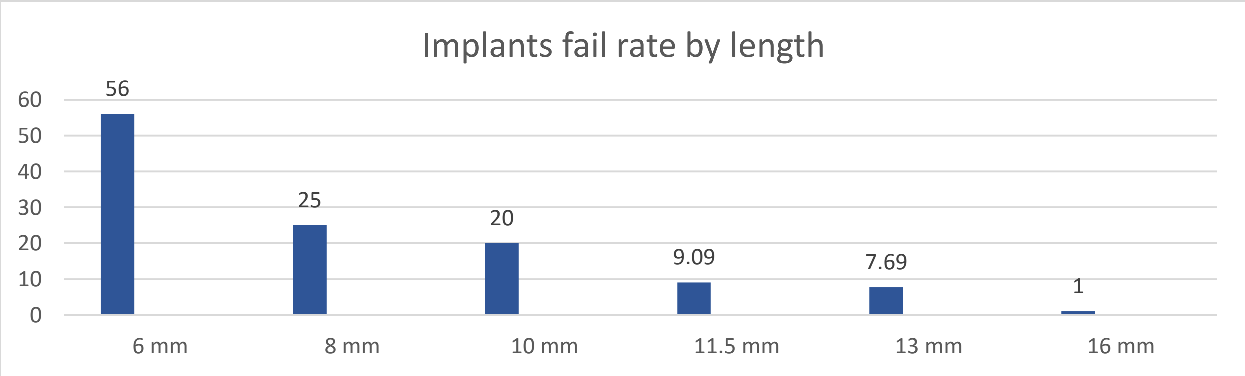

Figure 3. Implants failure rate by length

be considered as small, the distribution of implant failure among different diameters and lengths will reveal their importance regarding the evolution of the dental implant after it's insertion. When taking into consideration the diameters of the implants that were studied, we found the following failure percentages: 3.30 mm – 42.8%, 3.75 mm – 8.3%, 4.20 mm – 4.76%, 5 mm - -0% and 6 mm – 5.26% (Fig.2). The results are significant when trying to establish a connection between implant diameter and

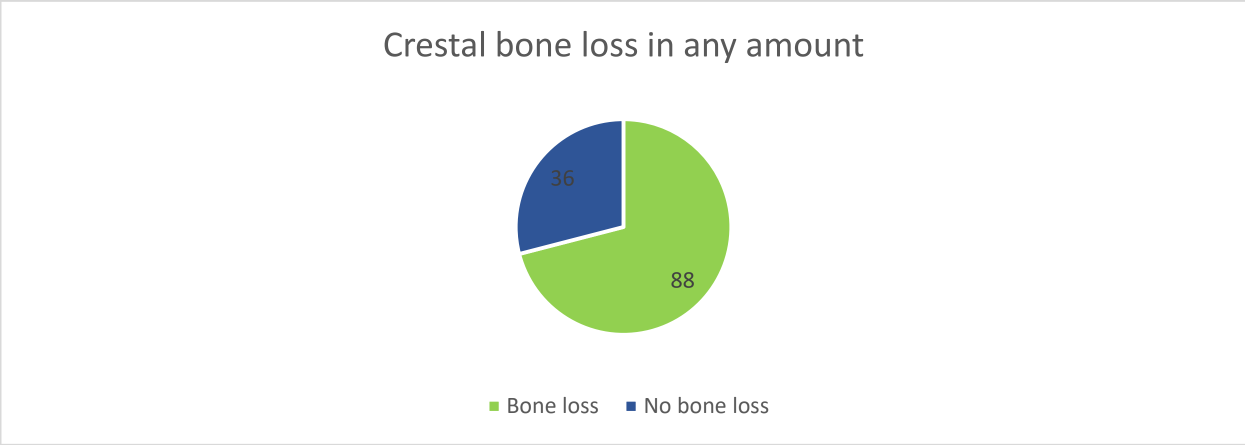

Figure 4. Crestal bone loss

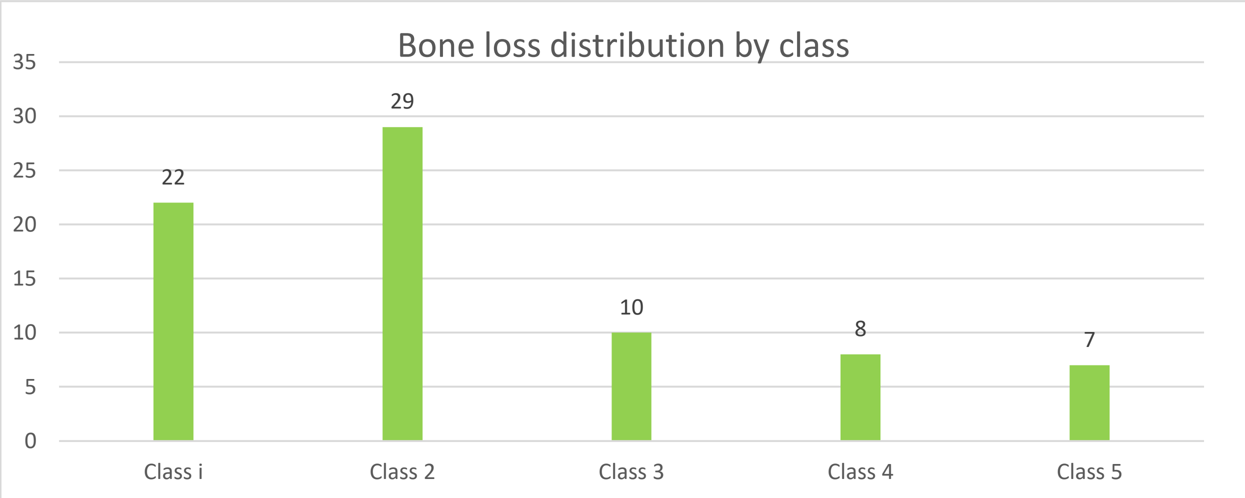

Figure 5. Peri-implant bone loss by class

overall success/failure rates. As far as dental implant length is concerned the following failure percentages resulted: 6 mm – 57%, 8 mm – 25%, 10 mm – 20%, 11.5 – 9.09%, 13 mm – 7.69% and 16 mm – 0% (Fig.3). In the case of the dental length criteria the length doesn't seem to have a high relevance when dealing with extreme lengths like 13 mm and 16 mm but, nevertheless, the failure rates grow dramatically as we get closer to the smallest lengths like 6 mm and 8 mm.

The radiographic examination found a number of 88 implants that displayed crestal bone resorption which means a total of 70.9% (Fig.4). Considering abnormal crestal bone resorption we created five classes in order to classify our results : class I – 0 to 1 mm of bone loss, class II – lack of bone contact with crestal threads, class III – lack of bone contact with 1/3 of dental implant, class IV – lack of bone contact with ½ of the dental implant and lass V – more than half of he dental implant lacks bone contact. From the overall number of 88 implants that were found to present crestal bone loss a total of 22 implants were represented by class I resorption. Another 29 implants were class II and 10 as class III. A number of 8 implants have been evaluated as a class IV and 7 as class V which were also considered to be a clinical failure (Fig.5). Considering the fail of osteointegration criteria we found a number of 3 implants that did not displayed an important crestal bone resorption but instead a lack of bone contact on all the surface of the implant was noticed. This lack of osteointegration was correspondent to a thin line of radiolucency around the implant contour. These implants were also considered to be a clinical failure.

The clinical examination of the patients during follow-up found a number of 10 implants which displayed abnormal mobility. From these 10 implants 3 implants had soft tissue inflammation, 2 implant displayed signs of infection like purulent secretions and another 3 implants showed soft tissue dehiscence.

CONCLUSIONS

The results of the study have shown that there is a clinical connection between physical characteristics of dental implants, like diameter and length that influence the overall survival rate and evolution on an implant under prosthetic loading. Even more, when it comes to treating patients that have a low-density bone in the posterior area of the maxillary bone, placing larger diameter implants is beneficial. In this case, the surface of the dental implant needs to be enhanced so that there is more active surface that will dissipate the occlusal forces into the surrounding bone. Low density bone will provide less primary stability and inherently lower biological stability therefore the need for an increased implant surface becomes obvious. Although placing larger diameter implants in order to enhance the clinical success rates that is not always possible due to the limited horizontal amount of bone. This study has show that when it is the case, a bone grafting procedure should be taken into consideration in order to magnify the bone offer rather than choosing the solution of placing a small diameter implant especially when the diameter reaches inferior measures like 3.30 mm or 3.75mm. In this case the chances of implant failure will be higher than the case of placing a wider implant. The clinical length of the implant has also been proved to enhance the success rate of the dental implant inside the low-density bone but at a lower extent in comparison to the implant’s diameter. An overall conclusion of this study reflects the importance of implants length and diameter when placed into the posterior maxilla consisting of low-density bone.

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