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Original Article

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Effect of platform switching on bone loss around implants: a retrospective study

Efeito da plataforma switching na perda óssea ao redor de implantes: um estudo retrospectivo

Lorena Gonçalves ALEXANDRINO[a], Leticia de Santana MASCARENHAS[b], Gabriela Moretto dos SANTOS[a], Flávia Noemy Gasparini Kiatake FONTÃO[a], Valdir Gouveia GARCIA[a], Luis Eduardo Marques PADOVAN[a], Guilherme José Pimentel Lopes de OLIVEIRA[b], Élcio MARCANTONIO JUNIOR[c*]

[a]ILAPEO – Instituto Latino-Americano de Pesquisa e Ensino Odontológico, Curitiba, PR, Brasil
[b]UFU – Universidade Federal de Uberlândia, Faculdade de Odontologia de Uberlândia, Departamento de Periodontia, Uberlândia, MG, Brasil
[c]UNESP – Universidade Estadual Paulista "Júlio de Mesquita Filho", Faculdade de Odontologia de Araraquara, Departamento de Diagnostico e Cirurgia, Araraquara, SP, Brasil

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Resumo

Introdução: O impacto do desnível da plataforma switching na estabilidade óssea ainda não é conhecido. **Objetivo:** O objetivo deste estudo foi avaliar o efeito de diferentes desníveis (mismatchings) da plataforma switching na estabilidade óssea ao redor de implante com uma conexão Morse de angulação interna modificada (16°) após 4 a 11 meses do carregamento protético. **Material e método:** Os implantes foram avaliados em dois períodos experimentais (momento da instalação e carregamento protético e no momento da visita de manutenção – após 4 a 11 meses do carregamento protético). As varáveis avaliadas foram o nível ósseo avaliado através de radiografia periapical e a taxa de sobrevivência destes implantes. O nível ósseo peri-implantar também foi avaliado de acordo com o diâmetro utilizado. **Resultado:** 119 implantes dentários instalados em 45 pacientes foram avaliados. Destes implantes, 33 apresentaram diâmetro de 3.5mm, 33 implantes apresentaram 3.75mm e 19 apresentaram 4.0mm de diâmetro. A variação na perda óssea destes implantes foi de 0.36 ± 0.34 mm. O índice de correlação entre os diâmetros do implante e a perda óssea peri-implantar foi r=0.01, com um valor de p=0.22. Esses achados indicam que a correlação entre a variação do nível ósseo peri-implantar e o diâmetro do implante não foi significativa. A taxa de sobrevivência total da amostra foi de 97,47%. **Conclusão:** Implantes com conexão Morse com angulação interna de 16° boas taxas de sobrevivência em curto prazo de acompanhamento, apresentando perda óssea limitada, a qual não foi influenciada pelos diferentes desníveis provocados pelo diâmetro do implante.

Descritores: Implantes dentários; perda óssea marginal; plataforma switching.

Abstract

Introduction: The impact of switching platform unevenness on bone stability is not yet known. **Objective:** The aim of this study was to evaluate the effect of different mismatching of platform switching on the bone stability around implants with a Morse taper with internal angulation of 16º after 4-11 months of prosthetic loading. **Material and method:** The implants were evaluated in two experimental periods (implant installation time and loading, and maintenance visit – after between 4 and 11 months of prosthetic loading). The variables evaluated were the bone level assessed by periapical radiography, and the survival rates of the dental implants. The peri-implant bone level was also evaluated according to the diameter of the implants used. **Result:** One hundred and nineteen dental implants placed in 45 patients were evaluated. Of these implants, 33 presented a 3.5mm diameter, 33 a 3.75mm diameter, 19 a 4.0 mm diameter, and 34 a 4.3 mm diameter. The variation in bone loss from these implants was 0.36 ± 0.34 mm. The correlation index between the implant diameters and peri implant bone loss was r = 0.01, with a p value = 0.22. This finding indicates that the correlation between the variation in peri-implant bone level and the implant diameter was not significant. The survival rate of the total sample was 97.47%. **Conclusion:** Implants with a Morse taper connection and 16º internal angulation presented good early survival rates with limited bone loss, that was not influenced by the degree of platform switching.

Descriptors: Dental implants; marginal bone loss; platform switching.

INTRODUCTION

The prosthetic connections of dental implants have been significantly modified in recent decades[1]. These modifications are motivated by the observation that the success of dental implants does not only depend on osseointegration, but is also related to other factors, including maintenance of the top of the crestal bone, with prosthetic components presenting a fundamental role in this function[2,3]. Over time, a discrete process of bone remodeling is expected around the dental implants, especially implants with external hexagon connections[4]. Furthermore, the micro movement of the abutment during masticatory forces, especially in single cases, where there is greater occurrence of loosening of the screws that join the abutment to the implant, can favor bacterial colonization of this interface, generating tissue inflammation and local infection, and increasing the chances of developing peri-implantitis[2].

An alternative suggested to reduce this local bone loss was the platform switching (PS) concept, which involves the use of an abutment with a smaller diameter than the implant platform, allowing better accommodation of the peri-implant tissues and reducing marginal bone loss[5]. Furthermore, internal connections emerged as an attempt to reduce the occurrence of screw loosening due to their mechanical conformation, which has this concept integrated naturally[6]. Pre-clinical and clinical studies have shown a reduction in marginal bone loss around single implants when internal connections are used, especially Morse taper connections[7-10]. This connection, which has been used in dentistry since the 90s, allows for better distribution of forces, reduced bacterial contamination through better marginal sealing at the implant/abutment interface, and reduced occurrence of loosening of the retention screw[2,11].

The results described by different authors regarding bone preservation and soft tissue aesthetics are quite satisfactory in implants with platform switching[9,12,13]. This has favored an increase in the number of investigations in recent years, and even the emergence of dental implants with a switched platform integrated into their macrogeometry. Most publications agree on three aspects of platform switching that protect the crestal bone: the biomechanical behavior in the face of occlusal loads of the abutment-implant complex, maintenance of the bone height of the crestal margin, and restoration of the biological space[8,14,15]. These aspects are more widely addressed in implants with an external hexagon platform, where the reduction in the diameter of the abutment, with consequent horizontal mismatching in the platform level, promotes a reduction in marginal bone loss[12,16,17]. In relation to the Morse taper connection, the diameter of the abutments is naturally reduced, due to its design, which nullifies the comparative effect of the platform switching. In this case, it is not yet known whether biomechanical behavior, maintenance of bone height, and restoration of biological space are associated with different horizontal mismatching levels between the dental implant and abutment.

Despite the clinical success observed with the use of Morse taper connections with an internal angulation of 11.5º, advances in this connection design are necessary to improve prosthetic rehabilitation. The current study evaluated dental implants with a Morse taper with a 16º internal angulation. Given the scarcity of studies on the behavior of the crestal bone around this type of implant, the objective of the current study was to evaluate the effect of the implant diameter (which results in different levels of mismatching between the implant platform and abutment) with a modified Morse cone connection on the peri-implant bone level between 4 and 11 months after the implant placement and prosthetic loading.

MATERIAL AND METHOD

Ethical Considerations and Eligibility Criteria

This retrospective clinical study was conducted with patients treated from August 2017 to December 2019, at the dental clinic of the ILAPEO faculty (Latin American Institute of Dental Research and Education). The patients underwent the installation of implants with a hybrid body (cylindrical at the cervical portion and conical at the middle and apical portions), double thread profile (trapezoidal in the cervical region and triangular in the apical region), with a hydrophilic surface obtained by blasting with acid etching, and a modified Morse taper connection with internal angulation of 16º (Grand Morse® Helix®, Neodent, Curitiba-PR). The follow-up of these patients was 4 to 11 months after prosthetic loading. This study was approved by the Human Research Ethics Committee under number 2.571.201-2018. Additionally, the study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

The patients were selected according to the following inclusion criteria: 1) aged between 18 and 60 years; 2) previously submitted to the installation of Helix Grand Morse® type implants; and 3) available to attend a maintenance visit. The exclusion criteria were: 1) patients with systemic diseases, drug and alcohol dependence, chronic treatment with steroids and bisphosphonates; 2) a history of radiotherapy in the previous 5 years in the head and neck region; 3) patients with significant occlusal changes; 4) patients with widespread aggressive or chronic periodontal disease.

Radiographic Analysis

For radiographic evaluation, images were acquired using the Heliodent X-ray device (Sirona, Bensheim, Germany), operating at 7 mA and 85 kVp, using a CMOS sensor (Xios Supreme, Sirona). Periapical radiographs were performed using the parallelism technique, with the aid of an XCP-DS positioner (Dentsply Rinn, Elgin, USA), which allowed the obtention of radiographic views at a standardized distance. The marginal bone level in relation to a fixed reference point on the implants (top of the platform) was measured on each implant on both proximal surfaces using specific software for image analysis. The measurements were carried out using Sidexis 4 Software (Sirona, Bensheim, Germany) by two trained operators (LAG and GMS). Initially, the radiographic image was calibrated using specific software tools, taking the actual size of the implant length as a reference (Figure 1).

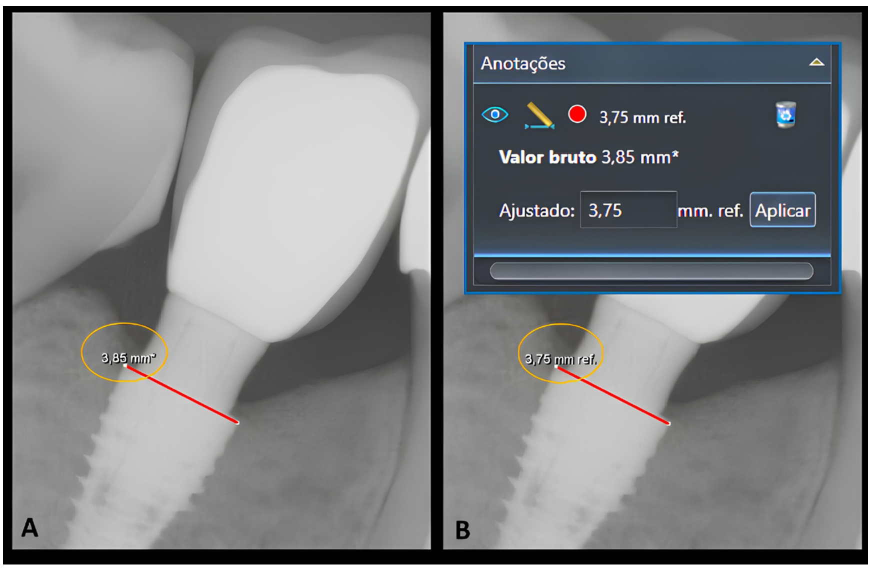

Figure 1. Calibration in the Sidexis 4 software: (A) measurement of the implant diameter in the original image obtained (3.85 mm), (B) calibration based on the real value of the implant diameter = 3.75 mm.

After image calibration, a reference line was drawn following the cervical portion of the implant. Next, linear measurements of peri-implant bone height were performed in the mesial and distal regions. In implants with a bone level above the line of the cervical portion of the implant, the measurement was performed from the highest point of the alveolar crest (bone/abutment interface) to the line of the cervical portion of the implant (Figure 2). To obtain the value of vertical bone loss, in implants with a bone level below the line of the cervical portion of the implant, the measurement was performed from the most apical point of the radiolucent image (at the bone/implant interface) to the reference line of the cervical portion of the implant, forming a 90-degree angle (Figure 3). The bone level variation was obtained by subtracting the values at T1 (Radiographic data at the time of the follow-up) from the values at T0 (Radiographic data obtained at the time of implant installation).

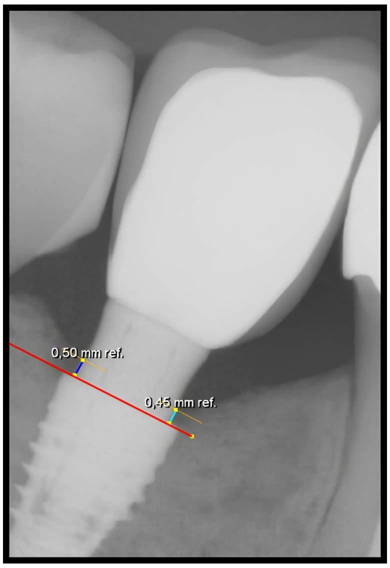

Figure 2. Example of measuring bone height (mesial and distal), in an intraoral x-ray image of a lower implant.

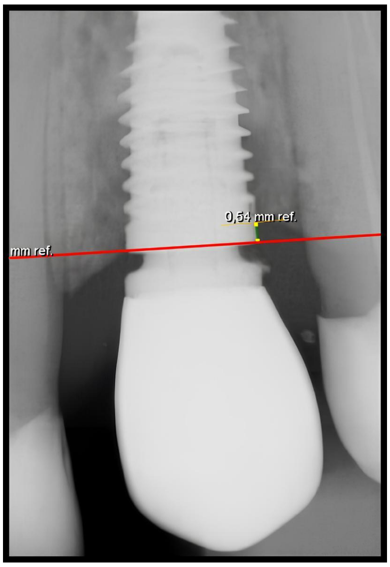

Figure 3. Example of measuring bone loss (distal), in an intraoral x-ray image of a superior implant.

Statistical Analysis

The current study evaluated the effect on bone loss associated with different diameters of dental implants with a Morse taper internal angulation of 16º, providing different levels of mismatching between the dental implant platform and the abutments. The diameter of the implants was correlated with the variation in bone level at T1 (periapical radiography performed during the maintenance visit) in relation to T0 (periapical radiography performed immediately after surgery). The Spearman correlation test was applied to evaluate the correlation of these two parameters. GraphPad Prism 8 software (San Diego, CA, USA) was utilized for statistical analysis. One-way ANOVA was used to compare peri-implant bone loss in relation to each implant diameter evaluated. All analysis adopted a 95% confidence level, with a value of $p<0.05$ being considered a statistically significant difference.

RESULT

One hundred nineteen implants placed in 45 patients (51.59 ± 11.01 years old) were evaluated. Of these implants, 33 presented a diameter of 3.5 mm, 33 a diameter of 3.75 mm, 19 a diameter of 4.0 mm, and 34 a diameter of 4.3 mm. The variation in bone loss observed in these implants was 0.36 ± 0.34 mm. The correlation index was $r = 0.01$, with a p value = 0.22. This indicates that the correlation between the variation in peri-implant bone level and the implant diameter was not significant. No statistically significant differences in peri-implant bone loss were observed when comparing different implant diameters.

In total, 3 implants were lost from 2 patients. One implant presented a 3.5mm diameter, and the other 2 a 3.75mm diameter. Thus, the survival rate of the total sample was 97.47%. Implants with a diameter of 3.5mm had a survival rate of 96.96%, implants with a diameter of 3.75mm presented a survival rate of 93.93%, and implants with diameters of 4.0mm and 4.3mm presented a survival rate of 100%. The data on mean and standard deviation of peri-implant bone level and frequency of implant survival in relation to each diameter group evaluated are shown in Table 1.

Table 1. Data on mean and standard deviation of peri-implant bone level and frequency of implant survival of each diameter group evaluated

Diameter	Bone level (mm)	Rate of survival (%)
3.50	0.37 ± 0.35	96.96
3.75	0.46 ± 0.31	93.93
4.00	0.22 ± 0.44	100.00
4.30	0.32 ± 0.27	100.00

DISCUSSION

Maintenance of peri-implant bone levels is of extreme relevance for the health of peri-implant tissues and the long-term success of implant-supported rehabilitation[2,11,18]. Biomechanical factors, such as short abutments, dissipation of occlusal forces around the implants, micromovements between the abutment/implant interface, and bacterial colonization in the peri-implant interface are factors related to peri-implant bone loss[9,15]. Platform switching is based on the concept that the horizontal mismatching of the implant/abutment interface from the top of the crestal bone promotes its protection, which occurs naturally in Morse taper connections due to their macrogeometry[5,6,19]. The current study demonstrated similar behavior with regard to peri-implant bone loss in implants with platform switching with different levels of mismatching, using dental implants with a Morse taper connection with internal angulation of 16º, in a period between 4-11 months after prosthetic loading, accepting the null hypothesis.

In the current study, a variation in bone loss of 0.36 ± 0.34 mm was observed during the follow-up, which is within the expected limits for this type of prosthetic connection[9]. The clinical study by Messias et al.[8] compared an internal connection (Morse taper) with and without the concept of platform switching. The implants in the PS group had different mismatching sizes: 0.3mm for the 3.8mm implants and 0.35mm for the 4.3 and 5.0mm diameter implants. The conventional platform group was treated with abutments of the same diameter as the implant. In total, 31 patients, who received 65 implants, were analyzed in the PS group, and 29 patients, who received 56 implants with an abutment of the same diameter as the implants. From the moment of prosthetic loading until the end of the evaluation (60 months), the PS group demonstrated gains in bone height of 0.19 ± 0.53 while the conventional platform group demonstrated bone loss of 0.04 ± 0.58 mm (p=0.02). All implants tested in this study had a switched platform, which may be the reason for the absence of statistically significant differences, not corroborating the findings of the aforementioned study. Therefore, the protection of the crestal bone provided by implants with a Morse taper connection seems to occur mainly due to the platform switching concept, which is inherent to the design of the mostly Morse taper connection, and which, in itself, already promotes adequate tissue accommodation at supracrestal bone and soft tissues.

The main reason for the effect of the diameter of the dental implants on maintenance of the crestal bone is the difference in mismatching when an abutment of the same diameter is used in implants with different diameters. The literature shows that the greater the mismatching, the greater the reduction in the stress on the cervical bone tissue in implants with external and internal hexagon platforms[17,20]. However, the effect shown in the abovementioned studies did not occur in the present study since this study evaluated the effects of the mismatching in Morse taper implants. A finite element model analysis (FEA) carried out by Aslam et al.[21] (2019), used two digital models, with and without a switched platform, on implants with an external hexagon platform, to compare the dissipation of forces and cervical stress between the models. The authors compared implants of the same diameter (4.5mm) with a 4.5mm abutment in the conventional platform model and a 3.5mm abutment in the switching platform model, establishing a difference of 1.0mm. The authors concluded, after the stress test on the peri-implant bone, that the values were significantly higher in the group with a conventional platform, with both axial forces (p=0.002) and non-axial forces (p<0.001)[21].

Understanding the biomechanics and concentration of forces related to marginal bone loss when using abutments narrower than the diameter of the implant is well known for implants with an external hexagon platform[17,21,22]. However, when implants with a Morse taper connection are considered, possibly because their macrogeometry naturally produces a horizontal mismatching from the abutment/implant interface, little attention has been provided about the effects of platform switching on peri-implant bone loss. As a result, there is still no consensus on whether different mismatching levels cause less bone loss over time with a Morse taper[23,24].

Comparing the radiographic bone levels of 60 Morse taper dental implants with diameters of 3.5mm and 4.0mm, showing mismatching of 1.0mm and 1.5mm, 90 days after their installation, the values of marginal bone loss were significantly lower (p<0.001) in 3.5mm implants (0.73 ± 0.8mm) compared to 4.0mm implants (1.05 ± 1.1mm)[25]. On the other hand, in the present study, this difference was not found when comparing different implant diameters (p>0.05). It is worth noting that the follow-up period may interfere with the evaluation of the results. The current study followed the bone loss around the implants for 4-11 months after prosthetic loading, whereas the study by Gehrke et al.[25] carried out the comparison for 90 days[25]. This period can be considered short for measuring this type of parameter. Furthermore, the authors themselves recognize the limitations of the research, which, through randomization, was unable to adapt the widths and heights of the bone crests of the recipient beds, which may have interfered with the radiographic evaluation, possibly favoring narrower implants with a wider bone crest in the buccolingual direction.

Regarding force dissipation, one of the main advantages of the Morse taper connection is the lower cervical tension when compared to the external hexagon platform[9]. The difference in the elastic modulus between bone and metal (titanium) inherently causes tension, however, the external hexagon platform demonstrates a greater concentration of force in the cervical region due to the proximity of the abutment/implant interface in relation to the marginal bone, as demonstrated in finite element tests[9,20,21]. One of the theories that the dissipation of forces can interfere with bone loss from the crest is based on the assumption that the concentration in the cervical region can contribute to cervical microfractures of the bone. This theory may support a possible difference in the marginal bone crest in Morse taper connection implants when there is different mismatching, although this was not observed in the current study.

Similarly to implants rehabilitated using the conventional platform, the survival rate observed in the present study was high, representing 97.47% of the sample. The study of Messias et al.[8], evaluated a total of 68 patients divided into 2 groups: Patients undergoing rehabilitation through intermediaries with a PS concept versus a conventional platform. After 5 years of follow-up, the overall survival rate was 94.2%, with no difference between groups (Messias et al.[8]). Similarly, Aimetti et al.[26] evaluated changes in bone level in implants installed 1mm infrabone using the PS concept in prosthetic rehabilitation. A total of 40 patients who underwent the installation of 58 implants (Certain Tapered Prevail – Biomet 3i – internal connection) were evaluated and the implant survival rate after 2 years was 100%.

The current study demonstrated no statistical differences in marginal bone loss around implants of different diameters, however, clinical variables are also important, because they reflect the importance of other factors that can influence the success of implants, such as marginal soft tissue positions, the presence/absence of peri-implant diseases, the patients' oral hygiene condition, possible bacterial contamination at the implant/abutment interface, and the loosening rates of prosthetic screws. Further studies are needed regarding these parameters in implants with an internal angulation of 16º.

The findings of this article cannot be extrapolated to other populations. Potential confounding factors such as parafunction, use of antiresorptive, and peri-implant disease were minimized with the exclusion criteria. Furthermore, the measurements in the software were calibrated based on the implant diameter value and were carried out by a single operator. However, other factors such as the type of prosthesis (multiple or single; cemented or screwed) may have represented a risk of bias in the results of the study.

The study does not have a sample size calculation. It was carried out with all available medical records of patients rehabilitated with the studied implant at the level of initial description of short-term biomechanical behavior. Another limitation of this study was that to evaluate the different mismatching within the PS concept in Morse taper implants, it is also necessary to increase the diameter of the implants, since companies maintain the same diameter of the prosthetic connection within the different diameters, facilitating rehabilitation and making it cheaper. Therefore, when evaluating the impact of mismatching on bone loss around implants with a Morse taper connection, the diameter becomes a major confounding factor, since the increase in diameter increases the contact area with the bone, resulting in reduced peri-implant stress[27].

CONCLUSION

The current study demonstrated no statistically significant differences in the peri-implant bone level between the different switching platform dimensions in implants with a Morse taper connection with 16º internal conicity throughout the follow-up period, between 4 and 11 months after the occlusal loading.

AUTHORS' CONTRIBUTIONS

- Conception and design of the study: LEMP, LGA, GMS, FNGKF, EMJ
- Literature review: LSM, LGA, GMS

- Data acquisition: LGA, GMS
- Data analysis and interpretation: GJOLP, LEMP
- Preparation of manuscripts: LSM, LGA, GMS, GJOLP
- Intellectual review of the manuscript: LSM, GJOLP, FNGKF, EMJ
- Final approval of the version submitted to the magazine: FNGKF, EMJ

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CONFLICTS OF INTEREST

Dr. Elcio Marcantonio Jr and Dra Flavia are speakers of the Neodent® Company.

*CORRESPONDING AUTHOR

Élcio Marcantonio Junior, UNESP – Universidade Estadual Paulista “Júlio de Mesquita Filho”, Faculdade de Odontologia de Araraquara, Departamento de Diagnostico e Cirurgia, R. Humaitá, 1680, 14801-903 Araraquara - SP, Brasil, e-mail: junior.elcio@gmail.com

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