Revista de Ciencias Médicas de Pinar del Río

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2024; 28(S2): e6606

ORIGINAL ARTICLE

Marginal bone loss when using titanium healing abutments vs. zirconia custom healing abutments

Pérdida ósea marginal al utilizar pilares de cicatrización de titanio frente a pilares de cicatrización personalizados de zirconio

Delia María Villacrés-Yancha[1]✉ , Gabriela Ximena Marín-Vega[1] , Andrea Katherine Miranda-Anchundia[1]

[1]Universidad Regional Autónoma de los Andes. Quevedo – Ecuador.

Recibido: 12 de diciembre de 2024
Aceptado: 14 de diciembre de 2024
Publicado: 17 de diciembre de 2024

Citar como: Villacrés-Yancha DM, Marín-Vega GX, Miranda-Anchundia AK. Pérdida ósea marginal al utilizar pilares de cicatrización de titanio frente a pilares de cicatrización personalizados de zirconio. Rev Ciencias Médicas [Internet]. 2024 [citado: fecha de acceso]; 28(S2): e6606. Disponible en: http://revcmpinar.sld.cu/index.php/publicaciones/article/view/6606

ABSTRACT

Introduction: dental implants are a viable alternative for the recovery of lost teeth; the long-term success of implants depends largely on the stability of the crestal bone.
Objective: to determine marginal bone loss on digital periapical radiographs; occurring around implants with titanium versus zirconia healing abutment.
Methods: a total of 54 digital radiographs were collected at two times: surgical phase, time zero (T0), and prosthetic phase four months later, time 1 (T1); 28 radiographs were of cases of implants with immediate placement of a zirconium healing abutment and 26 were of cases of implants with immediate placement of a titanium healing abutment. Marginal bone loss measurements were made with Adobe Photoshop software, using four stable reference points on the radiological image, two on the implant platform, mesial side (A) and distal side (B); and two points at the first visible contact between the bone and the implant, mesial (C) and distal (D).
Results: there was no statistically significant difference in marginal bone loss at mesial level (p=0,859) and at distal level (p=0,338) between zirconia and titanium.
Conclusions: marginal bone loss in the present study was comparable in both zirconia and titanium abutments.

Keywords: Dental Implants; Bone Resorption; Wound; Titanium; Zirconium.

RESUMEN

Introducción: los implantes dentales son una alternativa viable para la recuperación de las piezas dentales pérdidas; el éxito a largo plazo de los implantes depende en gran medida de la estabilidad del hueso crestal.
Objetivo: determinar la pérdida ósea marginal en radiografías periapicales digitales; que ocurre alrededor de los implantes con pilar de cicatrización de titanio versus zirconio.
Métodos: se recolectaron un total de 54 radiografías digitales, en dos tiempos: fase quirúrgica, tiempo cero (T0), y fase protésica cuatro meses después, tiempo 1 (T1); 28 radiografías fueron de casos de implantes con colocación inmediata de un pilar cicatrizal de zirconio y 26 fueron de casos de implantes con colocación inmediata de un pilar cicatrizal de titanio. Se procedió a realizar las mediciones de la pérdida ósea marginal con el programa Adobe Photoshop, mediante cuatro puntos de referencia estables en la imagen radiológica, dos en la plataforma del implante, lado mesial (A) y lado distal (B); y dos puntos en el primer contacto visible entre el hueso e implante, en mesial (C) y distal (D).
Resultados: No hubo diferencia estadísticamente significativa de la pérdida ósea marginal a nivel mesial (p=0,859) y a nivel distal (p=0,338) entre el zirconio y titanio.
Conclusiones: la pérdida ósea marginal en el presente estudio fue comparable en ambos pilares de zirconio y titanio.

Palabras clave: Implante Dental; Pérdida Ósea; Cicatrización; Titanio; Zirconio.

ORIGINAL ARTICLE

INTRODUCTION

Marginal bone loss around implants has been described since 1986 by author Albrektsson, who states that bone loss occurs at 1.5 mm the first year after implant loading and a loss of 0.02 mm annually.(1)

Maintaining bone stability around implants depends on several factors. Recent studies describe that soft tissues act as a protective barrier between the oral environment and the peri-implant bone.(1)

One of the main causes of marginal bone loss is the accumulation of bacterial plaque at the implant-abutment interface. Since there is a hermetic seal between the soft tissue and the implant abutment, this union will act as a barrier against bacterial invasion; the degree of union of the soft tissue to the implant abutment will depend on the union of the epithelial tissue to the abutment; for this reason, the selection of the abutment and consequently the type of material of this takes on a high degree of importance.(2)

Currently, some categories of abutment materials are described, such as: metal, zirconium, lithium disilicate, porcelain, peek and composites; which also influence the stability of the crestal bone.(1)

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Linkevicius T and Vaitelis J.,[1] mention zirconium as a biocompatible material for peri-implant tissues with lower adhesion to bacterial plaque compared to titanium; Hu J et al.,[2] found in their experimental study, when performing ultrasonic cleaning on zirconium and titanium implant abutments, that the zirconium abutment had a greater resistance to mechanical damage and better epithelial adhesion than the titanium abutment after ultrasonic cleaning. Wangy et al.,[3] in their findings observed fewer inflammatory cells around zirconium healing abutments than around titanium healing abutments when performing a histopathological analysis in dogs; therefore, the biocompatibility of the implant abutment with soft tissues is crucial to form a hermetic seal between them and therefore the preservation of the crestal bone level; it is important when selecting the abutment to take into account the material it is made of.

For this reason, the present investigation arose, in which marginal bone loss was determined when using titanium healing abutments versus personalized zirconium healing abutments placed on the same day of implant installation, using control digital periapical radiographs of patients who were treated at the FOUCE Oral Implantology Postgraduate Clinic at the end of the 2021-2022 academic period.

METHODS

The study was observational and cross-sectional, as there was no intervention by the researcher and the variables defined in the study were measured. The control digital periapical radiographs used to verify the proper position of the implants and the control radiographs used in the prosthetic phase were used. And the collection of information from the radiographs was carried out at the end of the 2021-2022 academic period.

The eligibility criteria were control digital periapical radiographs taken from patients treated at the FOUCE Oral Implantology Postgraduate Clinic at the end of the 2021-2022 academic period; clinical cases recorded in the medical records in which a titanium or zirconium healing abutment was placed on the same day of the implant placement surgery; clinical cases of single or multiple implants; X-rays taken in two stages: on the same day of the implant placement surgery and 4 months later in the pre-prosthetic phase; X-rays taken with a parallel technique; the three-dimensional location of the implant is optimal.

Also excluded were cases of analogous periapical radiographs; poorly angled radiographs with distortion (foreshortening or elongation); clinical cases in which it is not well recorded which healing abutment material was placed; clinical cases of total prostheses on implants.

VARIABLES

Dependent Variable. Marginal Bone Loss: is the bone remodeling produced at the level of the alveolar crest around the crestal region of the implant;[2,7] measured from the shoulder of the implant to the first contact of the bone with the implant in millimeters.

Independent Variable. Scar abutment: Prosthetic attachment that connects to the implant platform and comes into contact with the peri-implant tissues. This variable will be obtained from the clinical history record and will be recorded: 1 if the scar abutment placed was made of zirconium; and 2 if the scar abutment placed was made of titanium.

Non-probability sampling; the sample in this case was purposive since the population of clinical records is quite restricted and even more so when exclusion and inclusion criteria are considered. In any case, the sample size (27 cases) allowed statistical analysis without any restrictions.

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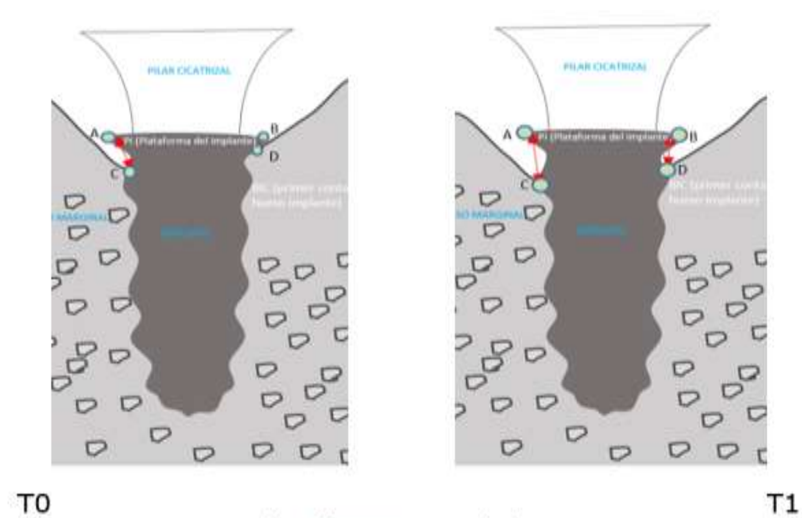
Fourteen samples were obtained in which a zirconium healing abutment was used and 13 samples with a titanium healing abutment.

The number of samples in the present study is in agreement with the number of samples used in the registered studies evaluating MBL (marginal bone loss) at 40 implants;(4,5,6) Khorsand A et al.,(7) and Gulje et al.,(8) to measure MBL use a sample of 41 implants, Canullo et al.,(9) Hadzik et al.(10) evaluate a sample of 30 implants.

Statistical methods: Marginal bone loss was measured using Adobe Photoshop software version (20.0.3 20190130.r.57 2019/01/30: 1204598 x64); as follows: The reference measurement was the diameter of the PI (implant platform), i.e.: 3,5; 4 or 4,5 mm. Four stable reference points were determined on the radiological image, two reference points on the implant platform, mesial side (A) and distal side (B); and two reference points on BIC (first visible contact between bone and implant) on mesial (C) and distal (D). This was done on the two control radiographs T0 (time 0, control radiograph taken on the day of implant placement); T1 (time 1, control radiograph taken in the pre-prosthetic phase). The perpendicular distance from the implant shoulder to the first visible contact between bone and implant was considered. Measurements were taken on the mesial and distal side of each implant.(11, 12, 13)



Fuente: Delia Villacrés. Autor de la investigación.

Fig. 1 Standardization for measuring marginal bone loss around implants on digital periapical radiographs using Adobe Photoshop software.

DATA COLLECTION MANAGEMENT AND METHODS

Approval was obtained from the Ethics Committee of the Faculty of Dentistry of the Central University of Ecuador. Authorization to carry out the research was obtained from the Graduate Department of the Faculty of Dentistry of the Central University of Ecuador.

A total of 54 digital radiographs were collected, of which 28 were cases of implants with immediate placement of a zirconium scar abutment from both the control, surgical phase (14 radiographs) and the prosthetic phase (14 radiographs); and 26 were cases of implants with immediate placement of a titanium scar abutment from both the control, surgical phase (13 radiographs) and the prosthetic phase (13 radiographs).

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Measurements of each digital radiograph were taken using the Adobe Photoshop program using the following steps:

1. The jpg file of the control X-ray of the surgical stage corresponding to Sample T0 was opened in the Adobe Photoshop program.
2. A guide line (in green) was drawn from the vertical ruler on the left side for alignment of the radiograph based on the inserted guide line.
3. With the CRTL + T function the image was rotated from the upper or lower vertices so as not to distort the image.
4. Using the Ctrl+K function, the units and rulers option was selected to calibrate the grid measurement to the diameter measurement of the implant placed, in this case reference 35 mm, and click Enter.
5. To view the grid, the VIEW option SHOW option GRID option was selected.
6. The grid measurement was scaled to the implant diameter, using the CRTL + T function to enlarge or reduce the image from the vertices.
7. The jpg file of the control radiograph of the pre-prosthetic stage corresponding to Sample T1 was opened in the Adobe Photoshop program; and the calibrations of Sample T0 were repeated.
8. The transparency of one of the layers was increased for the superposition of the two radiographic images, both the radiograph taken at the surgical stage and the radiograph of the pre-prosthetic stage, to measure the marginal bone loss that has occurred.
9. The grid was hidden to begin the measurements. The image was zoomed in to better visualize the marginal bone level. Reference points were placed on the implant platform on the mesial and distal side; using the sphere option; point where the measurement began. The pencil tool was selected to draw the measurement line from the reference point marked with the sphere to the first contact with the alveolar bone.
10. Using the Ctrl + T function, the line drawn from the vertex was rotated for its correct location. Finally, the measurement was placed in text on each side of the lines drawn both mesially and distally; with blue color distinction. The same procedure was performed on the image of the T1 sample; it was measured from the reference points drawn previously to the first contact with the bone and the mesial and distal measurements were obtained; with green color distinction. Finally, once the measurements of the T0 and T1 samples were obtained, all the measurements were displayed to obtain the total marginal bone loss in the mesial and distal areas.

A subtraction of the measurement of the T0 sample minus the T1 sample was performed in cases where the marginal bone level was lower in the T1 sample compared to the T0 sample without exceeding the reference point drawn on the implant platform; in cases where the marginal bone level decreased below the reference point drawn at the platform level, an addition was performed to obtain the total measurement of marginal bone loss; and in cases where the measurement of the T1 sample exceeded the measurement of the T0 sample, a subtraction was performed but resulting in a bone gain.

The data obtained were organized in a spreadsheet in Microsoft Excel 2016, after review and coding they were exported as a database to the program (SPSS 26 IBM ®), in order to subject them to the necessary statistical analysis.

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RESULTS

A characterization of the obtained samples was carried out such as: the conformation of groups, age range, implant position, type of bone, estimating the absolute and percentage frequency, 14 Zirconium implants (51,9 %) and 13 Titanium implants (48,1 %) were evaluated, the positions in which the implants were located corresponded mainly to piece 24 (14,8 %), piece 35 (14,8 %) and piece 46 (14,8 %), also determining that 15 of the 27 samples belonged to the maxilla (55,6 %) and 12 to the mandibular (44,4 %) that belonged to patients between 20 and 65 years old with an average of 52.8 years and a standard deviation of 11,5. The type of bone was also assessed, and it was found that the majority corresponded to type D2 (48,1 %), followed by D3 (37 %) and D4 (14,8 %). (Table 1)

Tabla 1. Caracterización de la muestra.

Variable	Option	Frequency	Percentage
Material	Zirconio	14	51,9
	Titanio	13	48,1
Part	p11	1	3,7
	p12	1	3,7
	p14	2	7,4
	p16	1	3,7
	p24	4	14,8
	p25	3	11,1
	p26	3	11,1
	p35	4	14,8
	p36	3	11,1
	p45	1	3,7
	p46	4	14,8
Age	20-40 years	6	22,2
	40-60 years	9	33,3
	over de 60 years	12	44,4
Arcade	Maxillary	15	55,6
	Mandibular	12	44,4
	Total	27	100,0
Type of bone	d2	10	37,0
	d3	13	48,1
	d4	4	14,8
	Total	27	100,0

Fuente: Ing. Juan Carlos Túquerres

Slight differences were observed in the quantitative variables associated with the implants; such as the length and diameter of each implant, since they depended on the anatomy of the alveolar ridge in each case; on average, the diameter for the Zirconium implants was 3,82 mm and its average length was 10,11 mm, while for the Titanium, the diameter was slightly lower at 3,54 mm and the length, on the other hand, slightly higher with a value of 10,69 mm.

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Normality test The values of the mesial and distal magnitudes at the two evaluation moments were subjected to the Shapiro Wilks test in order to determine if they met the normal distribution criterion. This allows us to decide statistically on the need to use the Student's t-test or another test according to the present study (Table 2).

Tabla 2. Prueba de Normalidad Test de Shapiro Wilks.

		mbl mesial T0	mbl mesial T1	mbl distal T0	mbl distal T1	mbl mesial total	mbl distal total
N		27	27	27	27	27	27
Normal parameters	Average	1,8822	1,1196	1,4904	1,0326	1,2167	1,4904
	Std. Deviation	0,67774	0,58384	0,59405	0,46642	1,12195	0,59405
Test statistic		0,129	0,170	0,166	0,166	0,150	0,166
Significance (p)		0,2	0,054	0,053	0,054	0,124	0,053

Fuente: Ing. Juan Carlos Túquerres

It was observed that the four variables of interest and the difference between the corresponding pairs met the normality criterion (p>0,05), which determined the need to use the Student t-test for both paired and independent samples to compare the mean magnitudes at the two assessment moments between the two groups and between groups.

Comparación de grupos

Tabla 3. Magnitud media nivel mesial.

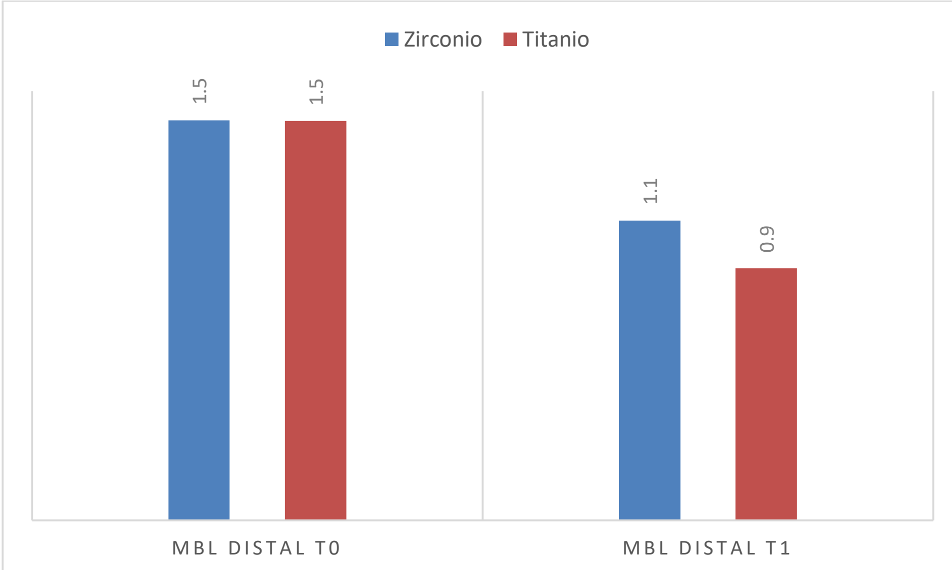
Cluster	mesial mbl T0	mesial mbl T1	Significance (p*)
Zirconium	2 (0,7)	1,3 (0,7)	0,0001
Titanium	1,8 (0,7)	0,9 (0,2)	0,0001
Total	1,9 (0,7)	1,1 (0,6)	0,0001
Significance (p**)	0,353	0,117	

Fuente: Ing. Juan Carlos Túquerres

Marginal bone loss was observed in both groups, a decrease that was statistically significant (p<0,05), according to the Student T test for paired samples. While there were no statistically significant differences for the mesial magnitude at the beginning between the two groups (p=0,353) or at the end (p=0,117), according to the Student T test for independent samples.(table 3)

Magnitud media nivel distal

At the distal level, marginal bone loss was also observed in both groups, a decrease that was statistically significant (p<0,05), according to the Student T test for paired samples, but of a smaller magnitude than at the mesial level. There were no statistically significant differences for the distal magnitude at the beginning between the two groups (p=0,993) or at the end (p=0,330), according to the Student T test for independent samples.



Fuente: Ing. Juan Carlos Túquerres

Fig. 2 Magnitud media nivel distal.

In view of the objective, it was of interest to evaluate the magnitude of the variation between the initial and final moment, as in some cases the value was below the reference line, the value is obviously much greater, since the magnitude of change is of interest, which is of an absolute nature (the sign is not important).

Tabla 4. Variación total mesial y distal por grupo.

Cluster	mbl distal T0	distal mbl T1	Significance (p*)
Cluster	1,2 (1,3)	1,3 (1,3)	0,07
Zirconium	1,3 (0,9)	0,9 (0,9)	0,02
Titanium	1,2 (1,1)	1,1 (1,1)	0,07
Total	0,859	0,338	

Fuente: Ing. Juan Carlos Túquerres

In this case, it is observed that there was no statistically significant difference in the mean magnitude at the mesial level (p=0,859) and at the distal level (p=0,338) in the zirconium abutments, but there is a statistically significant difference in the variations when comparing the mesial variation (wider) to the distal variation in the Titanium abutments (p=0,02). (table 4)

DISCUSSION

It has been described in the literature that zirconium is a material that presents a better adhesion to soft tissues, which produces a hermetic seal between the abutment and the soft tissues, preventing the invasion of oral bacteria and consequently the preservation of the crestal bone.[1] Wang M,[3] investigated the early soft tissue response to zirconia and titanium healing abutments in vivo; in which no differences were observed in the soft tissue inflammatory infiltrate around zirconia and titanium abutments, but there was a lower finding of inflammatory cells around zirconia abutments.

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Because crestal bone level has always been used to assess implant success, the purpose of the present study was to compare marginal bone loss occurring in zirconium and titanium healing abutment implants using digital periapical radiographs.

The findings indicated that marginal bone loss averaged 1,2 mm mesially and 1,3 mm distally for implants with zirconia abutments; 1,3 mm mesially and 0,9 mm distally for titanium abutments.

A similar conclusion is presented by the meta-analysis of Linkevicius T.,[1] which showed no statistically significant differences in zirconium and titanium abutments in the effect on bone levels.

In disagreement with Hu J,[14] in his meta-analysis study, when comparing different abutment materials, he highlighted that zirconium had a better effect in maintaining crestal bone compared to gold and titanium.

This is because the degree of adhesion of the soft tissue to the implant abutment depends on the degree of adhesion of the epithelial cells to the abutment material; when placing the scar abutment, a basal lamina is first formed and the epithelial cells attach to the substrate by means of hemidesmosomes. In addition, the epithelial cells secrete laminin, which increases the degree of adhesion between the epithelial cells and the molecules of the basal lamina; thus, the biological width is formed in a period of eight weeks.

The smoother the surface of the abutment, the less adhesion to bacterial plaque and the better sealing of the soft tissue with the substrate by means of the hemidesmosomes. [14]

CONCLUSIONS

Marginal bone loss on zirconia abutments was 1,2 mm mesial and 1,3 mm distal on average. Marginal bone loss on titanium abutments was 1,3 mm mesial and 0,9 mm distal on average. There was no statistically significant difference in marginal bone loss mesial (p=,859) and distal (p=0,338) between zirconia and titanium. Marginal bone loss in the present study was comparable for both zirconia and titanium abutments.

Conflict of Interest
The authors declare that there is no conflict of interest regarding this study.

Authors' Contribution
DMVY, GXMV, AKMA: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing-original draft, Writing-review and editing.

Financing
The authors did not receive funding for this research.

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2024; 28(S2): e6606

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