Benefits of an Implant Platform Modification Technique to Reduce Crestal Bone Resorption

Xavier Vela-Nebot, MD, DDS,* Xavier Rodríguez-Ciurana, MD,† Carlos Rodado-Alonso, MD,† and Maribel Segalà-Torres, MD, DDS*

Purpose: The alveolar bone resorption that occurs around a 2-piece implant following abutment attachment is a well-documented observation. Several investigators propose that crestal bone loss is a response to the invasion of the biologic width by secondary bacterial colonization and micromovements at the implant-abutment interface. This study proposes the creation of a difference between the diameter of the implant platform and diameter of the abutment (implant platform modification), shifting the implant-abutment interface medially to minimize invasion of the biologic width.

Material and Methods: We present a series of 30 control cases and 30 study cases using the platform-modification technique. Interproximal bone resorption on the medial and distal of each implant was assessed using digital radiography at 1, 4, and 6 months after abutment attachment.

Results: The mean value of bone resorption observed in the mesial measurement for the control group was 2.53 mm, whereas for those patients included in the study group, it was 0.76 mm. The mean value of bone resorption observed in the distal measurement for patients in the control group was 2.56 mm, whereas for those included in the study group, it was 0.77 mm.

Conclusions: All patients in the study group had a significant reduction of bone loss in comparison to the control group ($P < 0.0005$). *(Implant Dent 2006;15:313–320)*

Key Words: dental implants, bone loss, platform modification, micro-gap, biologic width

Periodontal tissues around teeth consist of 4 anatomic structures: gingiva, gingival sulcus, junctional epithelium, and alveolar bone. The portion of the periodontium formed by the gingival sulcus, junctional epithelium, and supra-alveolar connective tissue constitutes the dentogingival junction. This area determines the biologic width, a functional unit described by Gargiulo *et al* in 1961.[1]

The dimensions (width and length) of the dentogingival junction, distance between the crest of the alveolar bone, and margin of the gingiva define the biologic width. This distance measures approximately 3.0 mm: 1.5–2.0 mm of gingival sulcus and junctional epithelium and a remaining 1.0–2.0 mm of connective tissue.[2] The biologic width is a biologically determined dimensional constant, the function of which is to protect and maintain the dentoalveolar junction, an area susceptible to aggressions from the oral medium.[3,4]

As with the natural dentition, biologic tissue responds to the insertion of an endosseous implant by generating periosteum, connective tissue, and epithelial lining on the exposed bone to create a band of soft tissue that maintains the integrity of the periodontium. The biologic width determines the minimum dimensions of peri-implant mucosa that ensure adequate junctional epithelium and supra-alveolar connective tissue to maintain an optimal seal around implants, and provide protection from mechanical and external biological agents.[2] When an external agent invades the biologic width, the epithelium responds by migrating beyond the damaging agent in an attempt to isolate it and create a defensive distance that ensures periodontal integrity. This results in bone resorption, which ensures the reestablishment of the biologic width dimensions. This process is also observed around natural teeth when the biologic width is invaded by formation of calculus or infra-gingival margins of crowns.

After a 2-piece implant is uncovered, bone loss of 1.5–2.0 mm in the vertical axis and 1.4 mm in the horizontal axis occurs with respect to the micro-gap (the implant-abutment interface).[5] This observation of bone loss has been made when submerged implants are uncovered in a 2-stage surgical procedure and the biologic width is reestablished. Whether or not the implant is placed into a fresh extraction site and whether it is loaded immediately or early does not appear to affect the phenomenon. However, the bone loss does appear to be related to exposure of the implant to the oral medium.[5,6]

Numerous studies have found a relationship between the presence and location of the micro-gap and peri-

*Private practice in Implantology, Barcelona, Spain.
†Private practice in Maxillofacial Surgery, Barcelona, Spain.

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Table 1. Fifteen Random Results as Examples of the Mesial and Distal Measurements for Both Groups of Patients

Case	Group	Platform Switch	Patient Sex	Tobacco Habits	Teeth	Implant Measures (mm)		Prosthesis	Surgical Technique	Bone Loss Measures (mm)	
						Diameter	Length			Mesial	Distal
1	Control	—	Male	Smoker	15	5.00	13.00	Crown	1 stage	2.90	2.70
2	Control	—	Female	Smoker	23	5.00	15.00	Bridge	2 stages	2.60	2.20
4	Control	—	Female	—	14	5.00	11.50	Bridge	2 stages	2.60	2.60
18	Control	—	Female	Smoker	11	5.00	15.00	Crown	1 stage	2.70	2.50
22	Control	—	Male	—	46	5.00	13.00	Crown	1 stage	2.30	2.40
24	Control	—	Female	—	26	5.00	11.50	Crown	2 stages	2.60	2.80
28	Control	—	Male	—	15	5.00	13.00	Bridge	1 stage	2.50	2.70
33	Study	Applied	Male	Smoker	35	5.00	13.00	Bridge	1 stage	0.70	0.80
36	Study	Applied	Female	—	46	5.00	13.00	Crown	1 stage	0.80	1.00
37	Study	Applied	Male	Smoker	47	5.00	13.00	Crown	1 stage	0.60	0.50
44	Study	Applied	Female	Smoker	25	5.00	10.00	Bridge	2 stages	0.70	0.50
46	Study	Applied	Female	—	47	5.00	13.00	Bridge	1 stage	0.50	0.30
49	Study	Applied	Male	—	24	5.00	11.50	Crown	1 stage	0.80	0.90
51	Study	Applied	Female	Smoker	14	5.00	13.00	Crown	1 stage	0.60	0.70
54	Study	Applied	Male	—	24	5.00	13.00	Bridge	2 stages	0.70	0.60

implant bone loss.[5,7-9] These studies conclude that the location of the micro-gap violates the biologic width and initiates a response causing significant peri-implant bone loss that correlates with the proximity of the micro-gap to the bone crest. With 1-piece implants, the location of the micro-gap is coronal to the biologic width, and less bone resorption occurs.[9,10] Locating the shoulder of the implant crestally or subcrestally avoids exposure of the metal, and is indicated for achieving adequate vertical dimension and an aesthetic emergence profile. However, the deleterious effect is higher bone resorption.

Crestal bone resorption primarily occurs during the first 4 weeks after uncovering, and although the cellular mechanism has not yet been identified, the micro-gap elicits an inflammatory response and subsequent bone loss.[9,11] The width of the interface, micromovements of the implant and/or abutment, and peri-implant vascular alterations might all contribute to the influence of microbial contamination on the biologic width.[12]

Based on these speculations regarding the micro-gap and our clinical observations, we propose a modification of the implant-abutment interface that shifts the external margin of the micro-gap toward the axis of the implant and away from the crestal bone. This effect can be achieved by using abutments of a lesser diameter (4.1 mm) than the implant platform (5.0 mm), which creates a 0.45-mm wide zone around the circumference of the implant that minimizes invasion of the biologic width. The following case series was initiated to show radiographically the effects of platform modification on crestal bone loss.

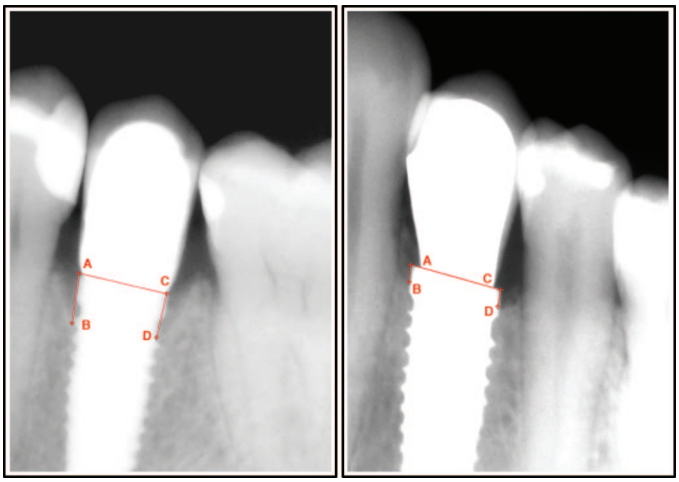


Fig. 1. A, An x-ray of 1 of the cases from the control group showing the reference points for the measurements: mesial vertex of the platform (A), mesial point of alveolar crestal bone-implant interface (B), distal vertex of the platform (C), and distal point of the crestal bone/implant interface (D). B, An x-ray of 1 of the cases from the study group indicating the reference points for the measurements: mesial vertex of the platform (A), medial point of the crestal bone-implant interface (B), distal vertex of the platform (C), and distal point of the crestal bone-implant interface (D).

Materials and Methods

A series of 60 submerged and nonsubmerged implants were divided into 2 groups. In the study group with 30 patients, including 15 males and 15 females, 4.1-mm diameter abutments were connected to the 5.0-mm diameter implant platforms. In the control group with 30 patients, including 15 males and 15 females, the standard procedure was performed, using abutments of the same diameter as the implant platform (5.0 mm). Of the 2 techniques, 1 was used to place the implants in both groups. In the 1-stage

Table 2. Descriptive Statistics

	N	Minimum (mm)	Maximum (mm)	Mean (mm)	SD Error	SD
Modified platform mesial	30	0.40	1.20	0.76	0.03488	0.19106
Modified platform distal	30	0.30	1.30	0.77	0.03482	0.19070
Nonmodified platform mesial	30	2.10	3.10	2.53	0.04307	0.23589
Nonmodified platform distal	30	2.20	2.90	2.56	0.04307	0.33026
Valid N (listwise)	0					

SD indicates standard deviation.

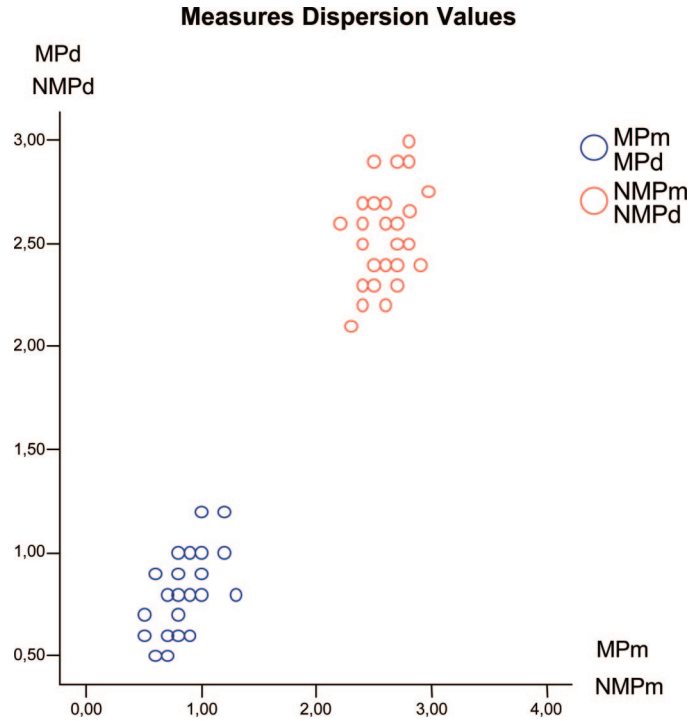


Fig. 2. Dispersion graph showing the values (in mm) between the point of the crestal bone-implant interface and the mesial and distal vertices of the platform. The distal measurements have been plotted along the x-axis, while the mesial measurements are plotted along the y-axis. Values of the nonmodified platform (NMP) group are plotted in red, while the values of the modified-platform (MP) group are plotted in blue. Less than 30 points have been plotted for each group because data for some of the implants were identical. MPd indicates modified-platform distal values; MPm, modified-platform mesial values; NMPd, nonmodified platform distal values; NMPm, nonmodified platform mesial values.

technique, the abutment was connected at implant placement. In the 2-stage technique, the abutment was connected only after the implants had osseointegrated (*i.e.,* 2 months after placement in the maxilla and 4 months after placement in the mandible). There were 20 implants in the study group and 16 in the control group placed using the 1-stage technique. Regardless of whether a 1 or 2-stage technique was used, all the implants in both the control and study groups were placed so that the surface of the implant platform was at the level of the alveolar crest. Each implant was then torqued to 30 Ncm.

Table 1 provides additional information about the smoking status of each patient, length of the implants used, types of prostheses used, and locations where the implants were placed. To evaluate the amount of bone loss that occurred around each implant, radiographs were taken at the following intervals:

1. On the day the implant was exposed to the oral medium (*i.e.,* on the day of placement in those cases in which a 1-stage technique was used and on the day of abutment connection in those cases in which a 2-stage technique was used).
2. One month later.
3. Three months later (*i.e.,* 4 months after exposure to the oral medium).
4. Two months later (6 months after exposure to the oral medium).

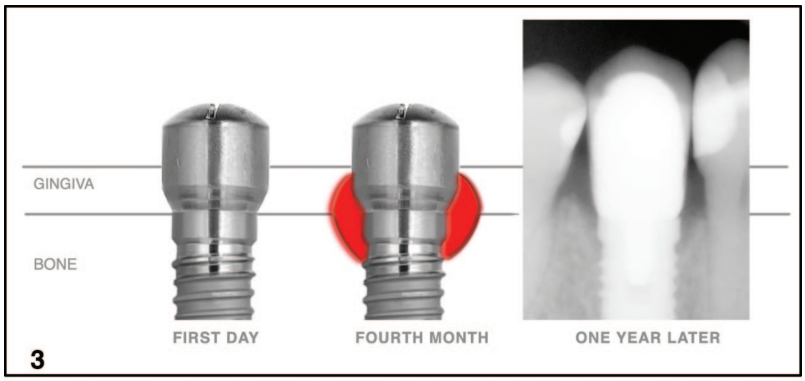
All radiographs were taken using the Kodak RVG 6000 Digital Radiography System (Eastman Kodak Co., Rochester, NY) in high-resolution mode. A mouthpiece was used to ensure a parallel technique. Bone loss was measured using the previously calibrated Kodak Trophy software. The following measurements were taken for each of the radiographs in the study (Fig. 1):

- Mesial bone loss: The distance between the mesial edge of the implant platform (point A) and the mesial point where the implant meets the alveolar crest (point B), in millimeters.
- Distal bone loss: The distance between the distal edge of the implant platform (point C) and the distal point where the implant meets the alveolar crest (point D), in millimeters.

Because all the implants were placed so that the surface of the implant platform was at the level of the alveolar crest, the distance between points A and B, and the distance between points C and D were considered 0.0 mm at the first radiograph.

Results

Table 1 shows 15 random results as examples of the mesial and distal measurements for both groups of patients as well as the distribution per gender. Table 2 indicates the results yielded by the descriptive statistical analysis as calculated by the SPSS 12.0 program (SPSS, Inc., Chicago, IL). The minimum value of bone resorption observed in the mesial measurement for the patients in the control group was 2.10 mm. For those patients included in the study group, the same value was 0.40 mm. The maximum value of bone resorption observed in the mesial measurement for the patients in the control group was 3.10 mm, whereas for those included in the study group, it was 1.20 mm.



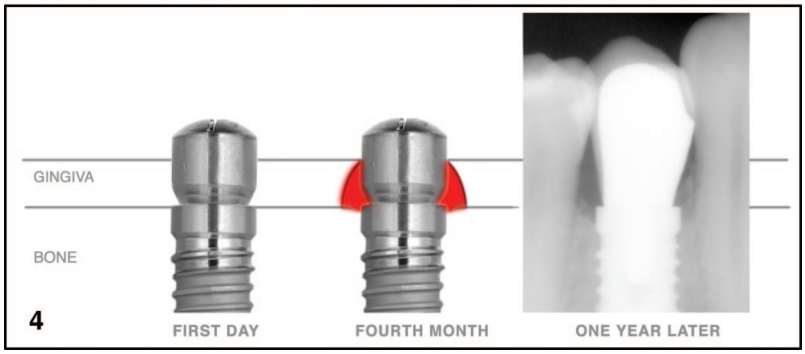


Fig. 3. Schematic and radiologic representations of bone resorption 4 months after placement of the abutments without modification of the platform. A, Representation of the implant/abutment micro-gap. B, Reaction of the biologic width to irritating agents. C, Radiograph of bone resorption secondary to invasion of the biologic width.

Fig. 4. Schematic and radiologic representations of bone resorption 4 months after the placement of abutments that are smaller in diameter than the implant platform. A, Representation of the modified implant/abutment micro-gap. B, Reaction of the biologic width to irritating agents. C, Radiograph of bone resorption secondary to minimum invasion of the biologic width.

The minimum value of bone resorption observed in the distal measurement for the patients in the control group was 2.20 mm, whereas for those included in the study group, it was 0.30 mm. The maximum value of bone resorption observed in the distal measurement for the patients in the control group was 2.90 mm, whereas for those included in the study group, it was 1.30 mm. The mean value of bone resorption observed in the mesial measurement for the patients in the control group was 2.53 mm, whereas for those included in the study group, it was 0.76 mm. The mean value of bone resorption observed in the distal measurement for the patients in the control group was 2.56 mm, whereas for those included in the study group, it was 0.77 mm. These differences were statistically significant ($P < 0.0005$).

In 2 cases not included in the study series, the insertion of the implants was performed using a 1-stage implant-placement technique. In each of those cases, the implant was left exposed to the oral cavity by using healing abutments of a lesser diameter than the implant platform. When the cases were prosthetically rehabilitated, abutments with the same diameter as the implant platform were used. The series of radiographs taken after insertion of the prosthesis showed the development of a marked peri-implant bone loss that was fundamentally established during the first month after prosthetic insertion.

Discussion

Two-piece implants have proven their versatility over the years in resolving aesthetic and functional problems.[5] The location of the micro-gap at the level of the crestal bone generates well-documented peri-implant bone resorption.[5,7-9] Most investigators[13] point to bacterial colonization of the interface as the main chronic factor irritating the biologic width. This irritation causes an apical movement of the biologic width at the expense of the crestal bone.

Callan *et al*[13] have shown that a migration of bacteria exists in the oral cavity toward the implant-abutment interface. Colonization of these surfaces occurs within the first 25 days after placement of the abutment and is limited to the contact surface of the 2 components. The main organisms that have been isolated are: *Actinobacillus actinomycetemcomitans*, *Tannerella forsythensis*, *Campylobacter rectus*, *Eikenella corrodens*, *Fusobacterium nucleatum*, *Porphyromonas gingivalis*, *Prevotella intermedia*, and *Treponema denticola*.[13] Herman *et al*[14] have reported that the bone loss at the alveolar crest is significantly influenced by micro-movements of the implant components, but not by the size of the micro-gap. They conclude that significant crestal bone loss occurs in 2-piece implant configurations, even with the smallest-sized micro-gaps (<10 μm) in combination with possible movements between implant components.

Conclusion

The results of our study indicate that a statistically significant reduction in bone loss occurred in all those cases in which the platform geometry was modified, as compared with the control group for which matching-diameter implant platforms and abutments were used (Fig. 2). The radiologic protocol used indicated that the main bone loss occurred between the time when the first and second radiographs were taken (*i.e.,* within the first month after the oral exposure). Measuring the digital radiographs obtained from the patients included in the series assessed confirmation of bone loss.

If the micro-gap is moved away from the peri-implant crest (as occurs with 1-piece implants), less bone loss occurs, but superior aesthetics cannot dependably be achieved because of the increased risk of metal exposure. To all the restorative possibilities offered

by 2-piece implants, platform modification has been proposed to reduce the biologic and mechanical aggressions on the biologic width (Figs. 3 and 4). The resulting peri-implant bone preservation leads to better aesthetics results. Further microbiologic, pathologic, and clinical studies are necessary to confirm these results, and the working hypothesis.

Disclosure

The authors claim to have no financial interest in any company or any of the products mentioned in this article.

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Reprint requests and correspondence to:
Xavier Vela-Nebot, MD, DDS
Sant Martí N° 43
08470 Sant Celoni
BCN Spain
Phone: (34) 938-675822
Fax: (34) 938-674419
E-mail: headquarters@borgroup.net

ID Abstract Translations

GERMAN / DEUTSCH

AUTOR(EN): Xavier Vela - Nebot, MD, DDS*, Xavier Rodríguez - Ciurana, MD**, Carlos Rodado - Alonso, MD***, Maribel Segalà - Torres, MD, DDS#. **Privat praktizierender Facharzt für Implantologie, Barcelona, SPANIEN. **Privat praktizierender Facharzt für Gesichts- und Kieferchirurgie, Barcelona, SPANIEN. ***Privat praktizierender Facharzt für Gesicht—und Kieferchirurgie, Barcelona, SPANIEN. #Privat praktizierender Facharzt für Implantologie, Barcelona, SPANIEN. Schriftverkehr: Xavier Vela-Nebot, MD, DDS, Sant Martí N° 43, 08470 Sant Celoni, BCN Spanien. Telefon: (+34)938675822, Fax: (+34)938674419. eMail: headquarters@borgroup.net*

Welche Vorteile bringt eine Implantatplattformveränderung hinsichtlich einer Verringerung der Resorption des Kammknochengewebes?

ZUSAMMENFASSUNG: Zielsetzung: Vielfach konnte beobachtet und dokumentiert werden, dass eine Resorption des alveolären Knochengewebes im Umfeld eines zweiteiligen Implantats nach Stützzahnanbringung auftritt. Verschiedene Autoren stellen hierbei die These auf, dass es sich bei dem Verlust des Kammknochens um eine Reaktion der biologischen Breite auf das Eindringen sekundärer Bakterien und Mikrobewegungen an der Implantat-Stützzahn-Schnittstelle handelt. Die aktuelle Studie unterbreitet den Vorschlag, den Durchmesser der Implantatplattform und den Durchmesser des Stützzahnes unterschiedlich zu gestalten (Veränderungsmethodik der Implantatplattform) und dadurch eine mediale Verschiebung der Implantat-Stützzahn-Schnittstelle zu erreichen, die die Beeinflussung der biologischen Weite möglichst gering hält. ***Materialien und Methoden:*** Die Studie umfasst eine Reihe von insgesamt 30 Kontrollfällen und 30 aktiven Studienfällen, bei denen die Behandlungstechnik der Implantatplattformveränderung Anwendung fand. Über digitale Röntgenographie wurde die interproximale Knochengewebsresorption zur Mitte sowie zum Rand eines jeden Implantats hin nach einem Monat, vier Monaten und sechs Monaten nach Stützzahnanbringung gemessen. ***Ergebnisse:*** Für die Kontrollgruppe betrug der Durchschnittswert der Knochenresorption bei me-

sialer Messung 2,53 mm, während sich dieser Wert für die Versuchsgruppe auf 0,76 mm belief. Die distale Messung ergab für die Patienten der Kontrollgruppe einen Durchschnittswert für die Knochenresorption von 2,56 mm; die gleiche Messung ergab 0,77 mm als Durchschnittswert für die Versuchsgruppe. ***Schlussfolgerungen:*** Alle in der Versuchsgruppe aufgenommenen Fälle wiesen eine erhebliche Verringerung des Knochenverlustes gegenüber der Kontrollgruppe auf ($P < 0.0005$).

SCHLÜSSELWÖRTER: Zahnimplantate, Knochengewebsverlust, Plattformveränderung, Mikrospalte, biologische Breite

SPANISH / ESPAÑOL

AUTOR(ES): Xavier Vela - Nebot, MD, DDS*, Xavier Rodríguez - Ciurana, MD**, Carlos Rodado - Alonso, MD***, Maribel Segalà - Torres MD, DDS#. **Práctica privada en Implantología, Barcelona, ESPAÑA. **Práctica privada en Cirugía maxilofacial, Barcelona, ESPAÑA. ***Práctica privada en Cirugía maxilofacial, Barcelona, ESPAÑA. #Práctica privada en Implantología, Barcelona, ESPAÑA. Correspondencia a: Xavier Vela-Nebot, MD, DDS, Sant Martí N° 43, 08470 Sant Celoni, BCN Spain. Teléfono: (+34)938675822, Fax: (+34)938674419. Correo electrónico: headquarters@borgroup.net*

Beneficios de una técnica de modificación a la plataforma de un implante para reducir la reabsorción del hueso crestal

ABSTRACTO: Propósito: La reabosrción del hueso alveolar que ocurre alrededor de un implante de dos piezas luego de la colocación del pilar es una observación bien documentada. Varios autores proponen que la pérdida del hueso crestal es una respuesta a la invasión del ancho biológico por la colonización secundaria de bacteria y los micromovimientos en el interfaz entre el implante y el pilar. Este estudio propone la creación de una diferencia entre el diámetro de la plataforma del implante y el diámetro del pilar (modificación de la plataforma del implante), moviendo el interfaz del pilar e implante medialmente para reducir la invasión del ancho biológico. ***Materiales y métodos:*** Presentamos una serie de 30 casos de control y 30 casos de estudio usando la técnica de modificación de la plataforma. La reabsorción del hueso interproximal en el medial y distal de cada implante se evaluó usando una radiografía digital en un mes, cuatro meses y seis meses luego de la colocación del pilar. ***Resultados:*** El valor mediano de la reabsorción del hueso observado en la medición mesial para los pacientes del grupo de control fue 2,53 mm, mientras que los del grupo de estudio fue de 0,76 mm. El valor mediano de la reabsorción del hueso observado en la medición distal de los pacientes del grupo de control fue de 2,56 mm, mientras que los del grupo de estudio fue de 0,77 mm. ***Conclusiones:*** Todos los casos en el grupo de estudio demostraron una reducción significativa de la pérdida del hueso en comparación al grupo de estudio ($P < 0.0005$).

PALABRAS CLAVES: implantes dentales, pérdida de hueso, modificación de la plataforma, microespacio, ancho biológico

PORTUGUESE / PORTUGUÊS

AUTOR(ES): Xavier Vela - Nebot, Médico, Cirurgião-Dentista*, Xavier Rodríguez - Ciurana, Médico**, Carlos Rodado - Alonso, Médico***, Maribel Segalà - Torres Médico, Cirurgião-Dentista#. **Clínica particular em Implantologia, Barcelona, ESPANHA. **Clínica particular em Cirurgia Maxilo-facial, Barcelona, ESPANHA. ***Clínica particular em Cirurgia Maxilo-facial, Barcelona, ESPANHA. #Clínica particular em Implantologia, Barcelona, ESPANHA. Correspondência para: Xavier Vela-Nebot, MD, DDS, Sant Martí N° 43, 08470 Sant Celoni, BCN Spain. Telefone: (+34) 938675822, Fax: (+34)938674419. e-Mail: headquarters@borgroup.net*

Benefícios de uma Técnica de Modificação de Plataforma de Implante para Reduzir a Reabsorção da Crista Óssea

RESUMO: Propósito: A reabsorção do osso alveolar que ocorre em torno de um implante de duas peças após o encaixa do suporte é uma observação bem documentada. Vários autores propõem que a perda de crista óssea é uma resposta à invasão da largura biológica por colonização bacteriana secundária e micromovimentos na interface implante-suporte. Este estudo propõe a criação de uma diferença entre o diâmetro da plataforma do implante e o diâmetro do suporte (modificação da plataforma do implante), deslocando a interface implante-suporte medialmente para minimizar a invasão da largura biológica. ***Material e Métodos:*** Apresentamos uma série de 30 casos de controle e 30 casos de estudo usando-se a técnica de modificação de plataforma. A reabsorção óssea interproximal no medial e distal de cada implante foi avaliada usando-se radiografia digital a um mês, quatro meses e seis meses após os encaixes de suporte. ***Resultados:*** O valor médio de absorção óssea na medição mesial para os pacientes do grupo de controle foi de 2.53 mm, ao passo que para aqueles incluídos no grupo de estudo, foi de 0.76 mm. O valor médio de reabsorção óssea observada na medição distal para os pacientes do grupo de controle foi de 2.56 mm, ao passo que para aqueles incluídos no grupo de estudo, foi de 0.77 mm. ***Conclusões:*** Todos os casos no grupo de estudo mostraram uma redução de perda óssea em comparação com o grupo de estudo ($P < 0.0005$).

PALAVRAS-CHAVE: implantes dentários, perda óssea, modificação da plataforma, microespaço, largura biológica

JAPANESE / 日本語

インプラント・プラットフォーム・モディフィケーションによるCrestal Bone吸収軽減の利点

著者： ザビエル・ベラ-ネボト、MD、DDS*、ザビエル・ロドリゲス-シウラナ、MD**、カルロス・ロダド-アロンソ、MD***、マリベル・セガラ-トレス、MD、DDS#

概要：

目的： アバットメント装着後にtwo-pieceインプラント周辺に起こる歯槽骨吸収については、多くの研究論文が発表されている。そのうちいくつかは、crestal boneの損失は2次的な細菌群落形成とインプラント-アバットメント・インターフェースの微細動によるbiologic widthの侵襲に対する反応であるとの立場を取っている。本論文は、インプラント・プラットフォーム直径とアバットメント直径を異なるものとし（インプラント・プラットフォーム・モディフィケーション）、インプラント-アバットメント・インターフェースを中心方向に移動させてbiologic　widthの侵襲を最小化する方法を提唱する。

素材と方法： プラットフォーム・モディフィケーションが施された検体症例と対照実験症例が各々30件用意された。アバットメントの装着1ヶ月、4ヶ月、6ヶ月後に、各インプラントの中心と遠心におけるinterproximal　bone resorptionがデジタルX線で評価された。

結果： 骨吸収の平均値は、近心部計測で対照実験群が2.53 mm、 検体群が0.76 mmであった。骨吸収の平均値は、遠心部計測で対照実験群が2.56 mm、 検体群が0.77 mmであった。

結論： 本研究では、検体群のすべての症例が対照実験群と比べて有意に低い骨吸収値（P‹0.0005）を示した。

キーワード： デンタルインプラント、骨損失、プラットフォーム・モディフィケーション、マイクロギャップ、biologic width

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 # バルセロナ（スペイン）でインプラント科開業

問い合わせ先：Xavier Vela-Nebot, MD, DDS, Sant Martí N°43, 08470 Sant Celoni, BCN Spain
電話：(+34)938675822　ファックス：(+34)938674419　Eメール：headquarters@borgroup.net

CHINESE / 中国語

植體平台修形技巧對降低齒槽骨質流失的效益

作者：Xavier Vela - Nebot，MD，DDS* 、Xavier Rodríguez - Ciurana，MD**、Carlos Rodado - Alonso，MD***、Maribel Segalà - Torres MD，DDS#

摘要：

目的：針對支柱牙安裝後兩片植體周圍發生齒槽骨質流失，有大量的文件證明與觀察。多位作者提出，齒槽骨質流失是對在植體支柱牙介面次要細菌叢與微運動的生物寬度入侵的反應。本研究提議，製造植體平台直徑與支柱牙直徑間的差異（植體平台修形），將植體支柱牙介面居中移動，讓生物寬度的入侵降到最低。

資料與方法：我們提供使用平台修形技巧的30個控制案例與30個研究案例。在支柱牙安裝後1個月、4個月、6個月時，利用數位X光攝影，評估每個植體近中與遠中的鄰間骨流失。

結果：控制組病人在近中測量觀察到的骨流失平均值為2.53mm，研究組的平均值則是0.76mm。控制組病人在遠中測量觀察到的骨流失平均值為2.56mm，研究組的平均值則是0.77mm。

結論：和研究組比較，研究組所有案例皆顯示其骨質流失明顯減少(P<0.0005)。

關鍵字：牙科植體、骨質流失、平台修形、微縫隙、生物寬度

** 西班牙巴塞隆納，口腔移植私人開業醫生*
***西班牙巴塞隆納，頜面外科私人開業醫生*
****西班牙巴塞隆納，頜面外科私人開業醫生*
 # 西班牙巴塞隆納，口腔移植私人開業醫生

轉載申請與通訊方式：*Xavier Vela-Nebot, MD, DDS, Sant Martí No 43, 08470 Sant Celoni, BCN Spain*
電話：(+34)938675822　傳真：(+34)938674419　電郵信箱：headquarters@borgroup.net