FACULDADE ILAPEO

Lucas Fernandes Vilela

Marginal Bone Loss of Two Different Implant-Abutment Connections: a Split-Mouth Randomized Clinical Trial

CURITIBA
2025

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Dissertação apresentada a Faculdade ILAPEO como parte dos requisitos para obtenção de título de Mestre em Odontologia com área de concentração em Implantodontia.

Orientador(a): Profa. Dra. Elisa Mattias Sartori.

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Dedicatória

Dedico este trabalho à minha família, por todo o amor, apoio e compreensão durante essa jornada acadêmica. Às minhas raízes, que me ensinaram o valor da educação e da persistência, e a todos que acreditaram no meu potencial mesmo nos momentos de maior dificuldade. Essa conquista é tão minha quanto de vocês.

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Sumário

1. Artigo científico 1

Artigo de acordo com as normas da Faculdade ILAPEO

MARGINAL BONE LOSS OF TWO DIFFERENT IMPLANT-ABUTMENT CONNECTIONS: A SPLIT-MOUTH RANDOMIZED CLINICAL TRIAL.

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RESUMO

Apesar da previsibilidade do tratamento com implantes dentários, a perda óssea marginal ainda ocorre, o que pode levar à perda do implante em última instância. Já se sabe que diferentes conexões implante-intermediário protético podem levar a vários graus de perda óssea. Assim, este estudo foi projetado para comparar a influência das conexões cônicas e hexagonais internas sobre a perda óssea peri-implantar 6 meses após a carga protética. Setenta e seis implantes foram instalados em 18 pacientes. Os implantes foram randomizados de acordo com a conexão implante-intermediário em um design de boca dividida: Grupo de implante CF e Grupo de implante IF. O protocolo de carga foi selecionado de acordo com as necessidades de cada paciente e as instruções do fabricante. Todos os pacientes receberam próteses temporárias e, após seis meses, receberam as próteses total definitivas sobre os intermediários protéticos. Os pacientes foram reavaliados 6 meses após o carregamento do implante. O nível ósseo peri-implantar e as alterações ósseas de cada paciente foram calculados na visita de acompanhamento. Além disso, as taxas de sobrevivência e sucesso do implante foram calculadas. As variáveis quantitativas foram descritas por média e desvio padrão. Frequências absolutas e relativas foram fornecidas para variáveis qualitativas. A normalidade da distribuição dos dados foi verificada pelo teste de Kolmogorov–Smirnov. Análises intragrupo foram conduzidas usando testes de Wilcoxon, e análises intergrupo foram realizadas usando testes de Mann-Whitney. Um nível ósseo marginal mais alto foi observado na visita de carregamento do implante em comparação com a visita de acompanhamento. Na visita de 6 meses, uma perda óssea média de -0,49 ± 0,56 mm foi observada no Grupo CF e -0,61 ± 0,73 mm no Grupo IF, considerando os níveis ósseos no carregamento do implante. Nenhuma diferença estatística foi observada entre os dois grupos (p = 0,765). Nenhum implante foi perdido, levando a uma taxa de sobrevivência e sucesso do implante de 100%. Pode-se concluir que não há diferença significativa na perda óssea marginal entre implantes com tipos de conexão protética cônica e hexágono interno. Portanto, ambos os tipos de implantes são opções de tratamento confiáveis para reabilitar pacientes completamente desdentados na mandíbula.

Palavras-chave: Perda óssea marginal; Conexão implante dentário; Implante dentário; Tecido peri-implantar.

ABSTRACT

Despite the predictability of dental implant treatment, marginal bone loss still occurs, which can lead to implant loss in the last instance. It is already known that different implant-abutment connections can lead to varying degrees of bone loss. Thus, this study was designed to compare the influence of conical and internal hex connections upon peri-implant bone loss 6 months after prosthetic loading. Seventy-six implants were placed in 18 patients. The implants were randomized according to the implant-abutment connection in a split-mouth design: CF Implant Group and IF Implant Group. The loading protocol was selected according to each patient's needs and the manufacturer's instructions. All patients received temporary prostheses, and after six months, they received the definitive full-arch prostheses over the abutments. Patients were re-evaluated 6 months after implant loading. Each patient's peri-implant bone level and bone changes were calculated at the follow-up visit. Additionally, implant survival and success rates were calculated. Quantitative variables were described by mean and standard deviation. Absolute and relative frequencies were provided for qualitative variables. The normality of the data distribution was verified by Kolmogorov–Smirnov tests. Intragroup analyses were conducted using Wilcoxon tests, and intergroup analyses were performed using Mann-Whitney tests. A higher marginal bone level was observed in the implant loading visit compared to the follow-up visit. At 6 months visit, a mean bone loss of -0.49 ± 0.56 mm was observed in CF Group and -0.61 ± 0.73 mm in IF Group, considering bone levels at implant loading. No statistical difference was observed between the two groups ($p = 0.765$). No implants were lost, leading to an implant survival and success rate of 100%. It can be concluded that there is no significant difference in the marginal bone loss between implants with conical and internal abutment-connection types. Therefore, both types of implants are reliable treatment options for rehabilitating patients completely edentulous in the mandible.

Keywords: Marginal bone loss; Dental implant-Abutment design; Dental implants; Peri-implant tissue.

INTRODUCTION

Since the emergence of dental implants, these devices have been modified to achieve better results. With these improvements, dental implants have become a reliable treatment for partial or total edentulism. Survival rates varying from 91.5% to 99.4% in up to 10 years of follow-up were reported(1). It is already known that this survival depends on the patient’s, implant’s, or clinician’s characteristics. However, marginal bone loss can occur despite dental implant treatment predictability and, depending on its magnitude, lead to complications.

Nowadays, marginal bone loss is considered one criterion for implant success. In the presence of marginal bone loss, the patient can suffer from peri-implant inflammation, soft tissue recession, aesthetic problems, plaque accumulation, and implant failure in a more severe instance(2). The literature suggests that many factors, including the implant-abutment connection, influence peri-implant bone loss.

The implant-abutment connection can interfere with stress distribution, micro-movements, and bacterial infiltration(3–5). Therefore, manufacturers are constantly improving the implant-abutment connection. The first implant-abutment connection developed was the external connection, which gradually was replaced by the internal connection, which can be conical, octagonal, hexagonal, trilobed, or spline(6).

Many studies have compared bone loss around external and internal connections; however, few studies have compared an internal conical connection with an internal hex connection. Thus, this study was designed to compare the influence of conical and internal hex connections upon peri-implant bone loss 6 months after prosthetic loading.

MATERIALS AND METHODS

The study protocol was submitted to and approved by the Ethics Committee of the Bauru School of Dentistry (Bauru, Brazil; protocol number 4.925.367). The investigation was conducted in accordance with the revised principles of the Declaration of Helsinki and ISO 14155. Written informed consent was obtained from each enrolled patient. This study was registered in the Clinical Trials database under number NCT05082038.

Study population

This observational study involved 18 patients in whom 72 implants were placed. The sample was prospectively selected and comprised patients aged 18 years or older, completely edentulous, who qualified for mandibular rehabilitation by means of full-arch prostheses supported by two Nuvo Tapered CF implants and two Tapered IF implants.

Contraindications to the device, according to the instructions for users, were applied as exclusion criteria. Patients who show signs of allergy or hypersensitivity to the chemical components of the implant material were not included. In addition, implant placement in the

presence of acute infectious or inflammatory process, inadequate bone volume or quality, serious medical problems such as bone metabolism disorders, blood coagulation disorders, inadequate healing, inadequate oral hygiene, incomplete jaw growth, uncooperative and unmotivated patient, drug or alcohol abuse, psychoses, prolonged functional disorders that resist any drug treatment, xerostomia, weakened immune system, diseases that require the regular use of steroids, uncontrolled endocrine diseases, and pregnancy were considered factors for patient exclusion.

Surgical procedures (Figure 1)

Two Tapered Nuvo IF implants (Neodent, Curitiba, Brazil) were placed on one side of the mandible under local anesthesia (4% Articaine with 1:100,000 epinephrine) and with adequate bone bed preparation, as recommended by the manufacturer. Two Tapered Nuvo CF implants (Neodent, Curitiba, Brazil) were placed on the other side, according to the results established by the randomization, and the same procedures were followed. The implants were placed at bone level, preferably in an axial position for the medial implants and distally angled for the distal ones, depending on bone availability. All patients received the same brand and implant model with variation only in the implant length according to the patient's need. The patients were also given post-operatory and oral hygiene orientations.

After implant placement, the suture was performed, and an X-ray was taken (baseline - TP). Patients were instructed to return between 7 and 14 days after surgery to remove the sutures. The loading protocol (delayed or immediate) was selected according to each patient's needs and the manufacturer's instructions. At the surgeon's discretion, immediate loading was applied when primary stability reached at least 32 N.cm and the patient presented physiological occlusion.

All patients received a temporary prosthesis. Six months after implant placement, all final crowns were screwed over the Nuvo Multi-Unit Screw Retained Abutment (Neodent, Curitiba, Brazil). After the prosthesis installation, a radiographic examination was performed to confirm the adaptation of the prosthetic work.

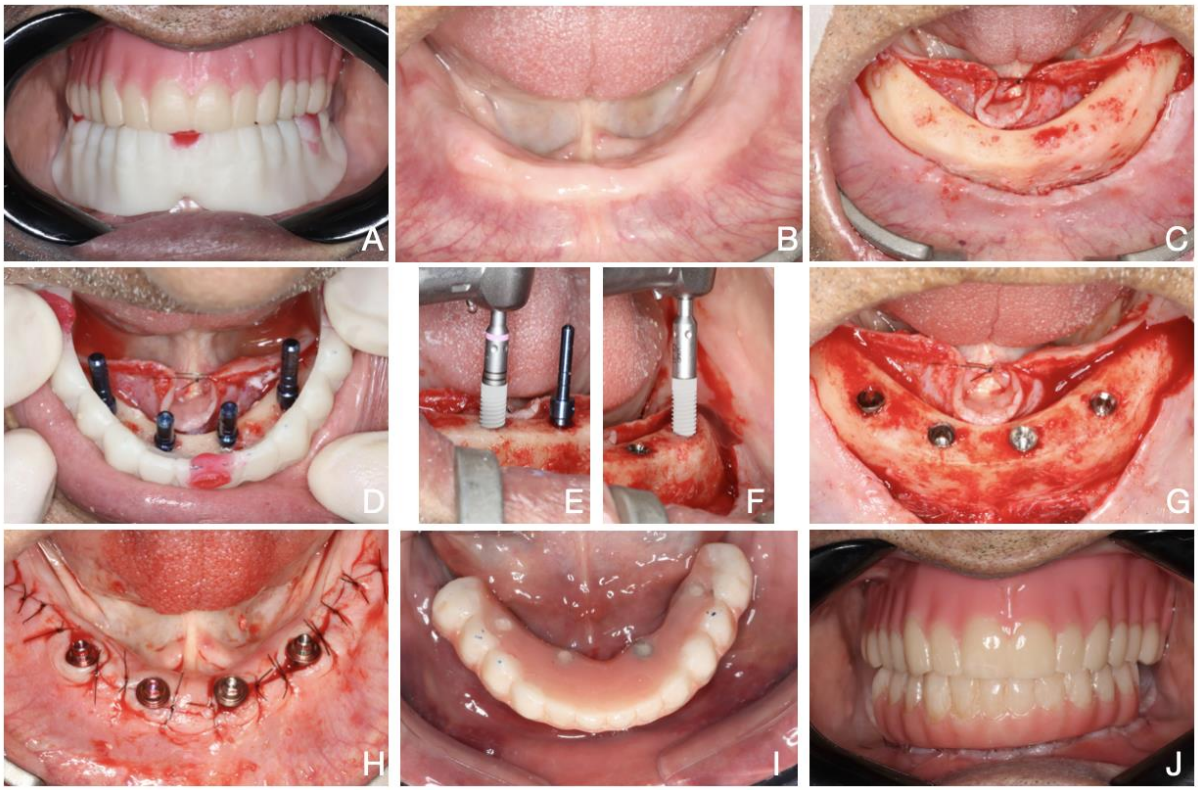

Figure 1 - Example of a representative surgical sequence. (A) initial clinical condition of the patient with the multifunctional guide in position; (B) initial clinical condition of the edentulous ridge; (C) mandibular ridge after regularization; (D) checking parallelism of the perforations before implant installation; (E) CF implant; (F) IF implant; (G) implants installed at bone crest level; (H) mini-pilars installed and suture; (I) temporary prosthesis installation; (J) final clinical condition with the temporary prosthesis installed.

Follow-up (Figures 2 and 3)

All included patients were recalled for follow-up visits 6 months after implant loading. Clinical and radiographic re-evaluations were performed. Implant loss, technical complications, and peri-implant soft tissue conditions were recorded at every recall appointment. Peri-apical radiographs of the implants and photographs of the restorations were taken for radiographic and esthetic evaluations. Patients received oral hygiene reinstruction at every follow-up visit and biofilm removal if needed.

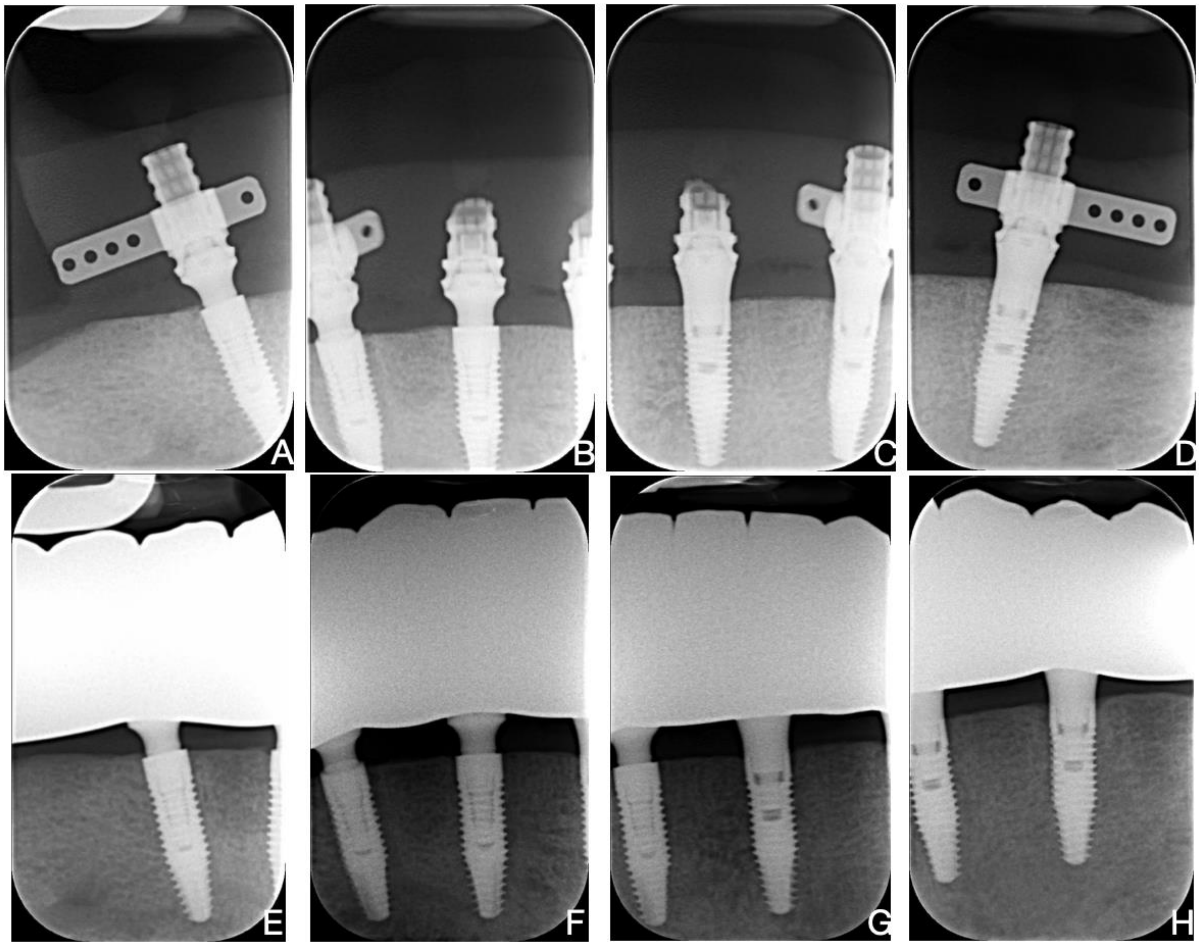

Figure 2 – Example of radiographic control at T0 e T6. (A – D) periapical radiographs at implant and temporary prosthesis installation at T0 control; (E – H) periapical radiographs at final prosthesis installation and T6 implant control.

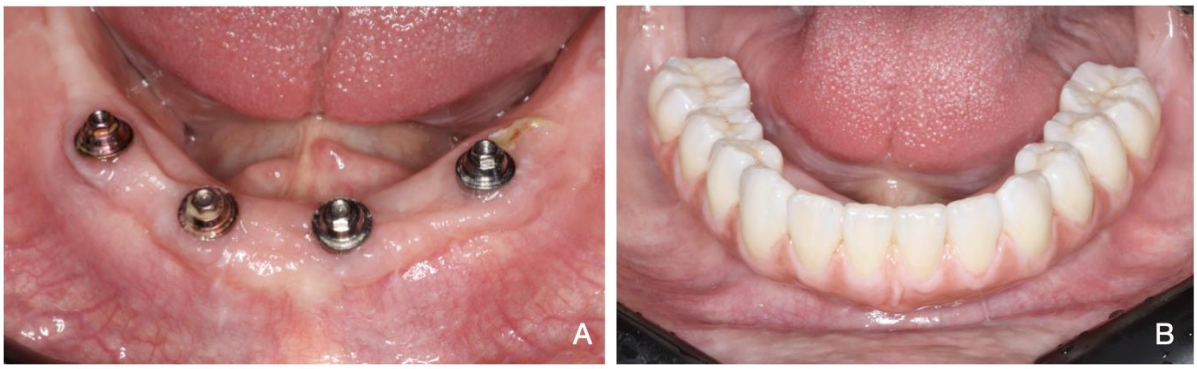

Figure 3 – Example od clinical control at T6 and final prosthesis installation. (A) clinical aspect os soft tissue at T6 control; (B) final prosthesis installed after 6 months.

Outcome

Implant survival and success

Survival was considered when the implant was present and functioning in the oral cavity during the follow-up visit. A failure was defined as an implant that was mobile, outside the oral cavity, or planned for removal.

Success was evaluated according to Buser(7,8) considering the factors below:

1) Absence of persisting subjective discomfort such as pain, foreign body perception, and or dysesthesia.
2) Absence of recurrent peri-implant infection with suppuration (an infection was termed recurrent when observed at two or more follow-up visits after treatment with systemic antibiotics).
3) Absence of implant mobility on manual palpation.
4) Absence of any continuous peri-implant radiolucency.

Peri-implant bone level

Intraoral radiographs were taken at each patient's visit using SOREDEX DIGORA® Optime intraoral photostimulable phosphor plate scanner (Dexis, Quakertown, US). The periapical parallelism technique was used to obtain radiography with standardized distance . After image calibration using the implant diameter as a reference, linear mesial and distal peri-implant bone height measurements were performed (Figure 4) using the Sidexis 4 Software (Sirona). A reference line was drawn on the implant platform in the calibrated image. The measurement was obtained from the most apical point of the radiolucent image (at the bone/implant interface) to the implant platform reference line for implants with bone level below the implant platform line. In implants with bone level above the implant platform, the measurement was performed from the highest point of the alveolar crest to the implant platform line.

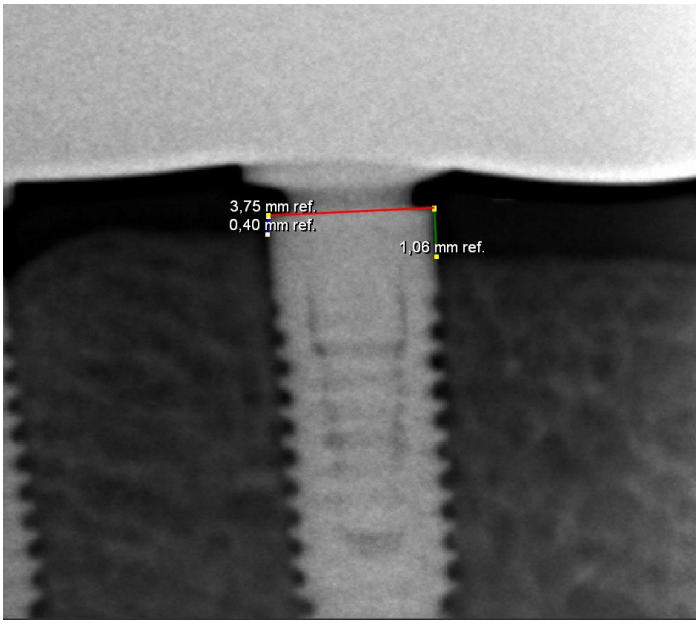

Figure 4 - Method for measuring bone height in an intraoral X-ray image.

Sample size calculation

The sample size was calculated based on previous studies, as well as on the clinical relevance of the present study´s primary parameter, considering an alpha level of 5% and a beta of 20% to detect a minimal mean difference between groups in peri-implant marginal bone loss of 0.50 mm, with a standard deviation of 0.68mm, up to 36 months after implant loading(9–11). Sample size calculation showed that a sample of 30 implants per group was needed.

Estimating a rate of 2 implants from each group per patient and a dropout rate of 15%, a sample size of 18 patients resulting in 36 implants from each group (72 total) was considered sufficient to allow the statistical analysis.

Randomization

A total of 18 participants were enrolled after screening 23 volunteers. Each participant was completely edentulous, and four implants were randomized into two groups: Group 1, CF Implant group (n = 36), and Group 2, IF Implant group (n = 36). The implants of each patient were labeled as the right side (1) and the left side (2). The random allocation sequence determined how each side was treated. Randomization was performed at the implant level using

a random allocation sequence generated by software, with a random ratio 1:1. Although this study was not blinded, access to the randomization list was not available to the study centers or the participants.

Statistical Analysis

The study's quantitative parameters were described by mean and standard deviation, and the qualitative parameters by frequencies and percentages.

The normality of the data distribution was verified by Kolmogorov–Smirnov tests. Considering the variables' non-normal distribution, intragroup analyses were conducted using Wilcoxon tests to compare the Bone Level values between each study time (T0 and T6). Intergroup analyses were performed using Mann-Whitney tests to compare the Bone Loss (change T0-T6) observed for the CF and IF Groups.

The results were considered significant at $p<0.05$. All analyses were performed using the Statistica program for Windows 10.0 (Statsoft, Tulsa, Okla.).

RESULTS

The sample consisted of 18 completely edentulous patients (11 women and 7 men) with a mean age of 65.8 (±1.9) years. None of the patients had non-controlled systemic diseases, and none were active smokers.

Thirty-six Nuvo CF implants and thirty-six Nuvo IF implants, all with a diameter of 3.75 mm and lengths ranging from 10 mm to 13 mm, were placed in the mandible to support 18 full-arch prostheses. None of the implant sites received bone or soft tissue grafting. Fourteen prostheses were subjected to immediate loading (insertion of Multi Unit Screw Retained Abutment) and 4 to delayed loading (Cover Screw for 3 to 4 months followed by installation

of Multi Unit Screw Retained Abutment). The implant survival and success rate was 100% in 6 months of follow-up.

Statistically significant differences were found concerning the mean bone level observed at different times of the study, considering the complete sample of implants (n=76; p<0.001) (Table 1) and each study group (n=36 per group; p<0.001) (Table 2).

Table 1 - Intragroup analysis for Bone Level observed at T0 (implant loading) and T6 (6 months of follow-up) for the complete sample (n=72; Wilcoxon Test)

Variable	**Mean ± SD**	**p**
T0 Mesial	0.17 ± 0.62	<0.001*
T6 Mesial	-0.48 ± 0.76	
T0 Distal	0.16 ± 0.41	<0.001*
T6 Distal	-0.31 ± 0.56	
T0 Mean	0.16 ± 0.43	<0.001*
T6 Mean	-0.39 ± 0.57	

*Statistically significant at p <0.05.

Table 2 - Intergroup analysis for Bone Level observed at T0 (implant loading) and T6 (6 months of follow-up) (n=72; Wilcoxon Test)

Variable / **Group**	**CF Group (n=36)**		**IF Group (n=36)**	
	Mean ± SD	**p**	**Mean ± SD**	**p**
T0 Mesial	0.15 ± 0.56	<0.001*	0.181 ± 0.671	<0.001*
T6 Mesial	-0.46 ± 0.74		-0.487 ± 0.785	
T0 Distal	0.10 ± 0.38	<0.001*	0.217 ± 0.420	<0.001*
T6 Distal	-0.27 ± 0.52		-0.349 ± 0.599	
T0 Média	0.12 ± 0.38	<0.001*	0.199 ± 0.469	<0.001*

T6 Média	-0.36 ± 0.58	-0.418 ± 0.553

*Statistically significant at p <0.05.

No statistically significant differences were observed for the mean bone loss that occurred in the T0-T6 period between Groups CF and IF (p>0.05) (Table 3).

Table 3 - Intergroup analysis for Bone Loss (T0-T6 change) (Mann-Whitney tests)

Variable / **Group**	**CF Group (n=36)**	**IF Group (n=36)**	**p**
	Mean ± SD	**Mean ± SD**	
T0-T6 Mesial	-0.62 ± 0.72	-0.68 ± 0.94	0.729
T0-T6 Distal	-0.37 ± 0.57	-0.56 ± 0.72	0.410
T0-T6 Mean	-0.49 ± 0.56	-0.61 ± 0.73	0.765

DISCUSSION

This study evaluated the survival and success rates and bone loss of two Nuvo implants with different implant-abutment connections, the conical and internal hexagon connection. To reduce the influence of other implant characteristics on bone loss, all implants had the same surface, thread, and body design. It is important to highlight that this study did not consider the external connection since there is extensive scientific evidence regarding its inferiority(3,12–14).

The survival and success rates of the Nuvo implants supporting full-arch prosthesis were 100%. This result is similar to another study that evaluated a different implant brand in completely edentulous patients rehabilitated with full-arch prostheses in the mandible as well as our study(15).

The literature shows significant peri-implant remodeling occurs in the first six months, especially in the one-stage protocol(13,16). In this study, most cases were immediately loaded, and the mean bone loss was 0.49±0.56 mm in the CF Group and 0.61±0.73 in the IF Group. Both groups presented a bone loss much lower than expected in the implant's first year of functional loading (2 mm)(17). The bone loss found in our study can be assumed to represent Nuvo Implants' stability and suggests the excellent maintenance of these numbers in the long term.

Our study did not find statistical differences in marginal bone loss between the CF and IF groups. This result is different from the one found by Szyszkowski & Kozakiewicz (2019)(18), where the median bone loss of conical and internal hex connections was 0.58 mm and 0.79 mm in 1 year of follow-up, presenting a significant peri-implant bone loss difference toward better results in the conical connection. This can be explained by the fact that despite Szyszkowski & Kozakiewicz's caution to compare the same implant surface and raw material (Ti-6Al-4V-ELI), they compared implants from different brands, which can present different macro geometries that can interfere in bone loss. Conversely, Corvino et al. (2020)(19) did not find statistical differences in bone loss between conical and internal hex connections, with a bone loss of 0.33 ± 0.34 mm for conical and 0.43 ± 0.37 mm for internal hex connection. These results are similar to that found in this study.

In this study, the implants were placed at bone level to maintain the same conditions between groups, enabling a more reliable comparison. Extensive literature data compare the subcrestal and equicrestal position of cone morse implants, and animal and clinical studies indicated that the subcrestal position benefits the cone morse implants by reducing bone loss(20–22). In this way, the sucrestal position could interfere with CF implant bone loss found in our study.

Even though there was no statistical difference in bone loss between the CF and IF groups, a tendency toward higher bone loss in the IF group can be observed. This is in line with literature data that shows that conical connections, also known as Morse Taper connections, present less bacterial infiltration due to minimizing the micro gap. Additionally, conical connections reduce micromovements during loading and better dissipate forces at the implant neck and peri-implant tissues(23). All these factors can reduce the marginal bone loss.

At the beginning of implantology, six to eight implants were recommended to support a full-arch prosthesis. However, this indication was evolving, and we used four implants in this study. A recent meta-analysis demonstrated that marginal bone loss is not influenced by the number of implants used to support full-arch prostheses. The bone loss in implants supporting full-arch prostheses in a follow-up period of between 5 and 15 years was 1.22 ± 0.49 mm for fewer than 5 implants per jaw and 1.46 ± 0.46 mm for more than 4 implants per jaw(24). Thus, the four implants used in this study are reliable and cannot impact marginal bone loss.

One limitation of this study is the follow-up time. While 6 months of follow-up is sufficient to analyze the early bone loss, more follow-up time is necessary to confirm the long-term stability of the Nuvo CF and IF implant. Additionally, to confirm their good outcomes, more clinical studies should be performed using these implants in different clinical conditions, such as maxillary full-arch and single-unit prostheses.

CONCLUSION

Within the limitations of this study, it can be concluded that there is no significant difference in the marginal bone loss between implants with conical and internal abutment-connection types. Therefore, both types of implants are reliable treatment options for rehabilitating patients completely edentulous in the mandible.

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2. Artigo científico 2

Artigo de acordo com as normas da Faculdade ILAPEO

MANAGEMENT OF AN INITIAL PLAN CHANGE AFTER IMPLANT FAILURE IN A DOUBLE FULL-ARCH CASE: A CASE REPORT.

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RESUMO
Este relato de caso tem como objetivo descrever o caso clínico de um paciente de 61 anos com comprometimento da saúde, no qual foi realizada uma reabilitação de dupla arcada completa. Para tanto, foram empregados métodos de diagnóstico e planejamento, incluindo tomografia, radiografias panorâmicas, fotografias e moldagens. Inicialmente, foi proposta terapia de manutenção da saúde periodontal para os dentes inferiores, reabilitação com prótese híbrida superior na primeira fase do tratamento e implantes individuais com coroas cerâmicas na região dos dentes posteriores inferiores na segunda fase. No entanto, ocorreram complicações, o tratamento mandibular precisou ser alterado e um novo tratamento foi proposto. Todos os dentes mandibulares restantes foram extraídos, quatro implantes foram instalados e a reabilitação com prótese protocolo foi realizada. Conclui-se que as complicações podem forçar os clínicos a alterarem seu plano inicial. Dessa forma, o conhecimento do clínico é essencial para garantir o melhor tratamento nesse cenário.

Palavras-chave: Implante dentário; Prótese protocolo; Falha de implante.

ABSTRACT
This case report aims to describe the clinical case of a 61-year-old patient with compromised health in which a double full-arch rehabilitation was performed. To this end, diagnostic and planning methods were employed, including tomography, panoramic radiographs, photographs, and impressions. Initially, periodontal health maintenance therapy for the lower teeth, rehabilitation with an upper hybrid prosthesis in the first phase of treatment, and individual implants with ceramic crowns in the region of the lower posterior teeth in the second phase were proposed. However, complications occurred, the mandibular treatment needed to be changed, and a new one was proposed. All remaining mandibular teeth were extracted, four implants were placed, and rehabilitation with a full-arch prosthesis was performed. In conclusion, complications may force the clinicians to change the initial plan. In this way, the clinician's knowledge is essential to guarantee the best treatment in this scenario.

Keywords: Dental implants; Full-arch prosthesis; Implant failure.

INTRODUCTION

In the past, the rehabilitation of partial and total edentulous patients evolved using removable complete dentures. However, this rehabilitation has some limitations, and since Branemark discovered osseointegration, dental implants have become the main alternative to treat these cases. With more than 4 decades of clinical experience, dental implants are predictable, presenting a good prognosis and high success and survival rates(1,2). Nowadays, there are different implant designs to meet most patients' demands.

Decades of knowledge help clinicians plan treatment according to patient's needs and expectations. Planning before surgery is crucial to increasing treatment success, predicting possible complications, and facilitating the correct implant positioning(3). Even with the aid of radiographic and tomographic images and digital planning, complications such as implant failure can occur, leading to changes in the treatment.

As treatment can change during execution, requiring clinician expertise, this case report aims to present a case of a change of planning during treatment in a health-compromised patient.

CASE REPORT

A 61-year-old male patient presented to the ILAPEO clinic in Curitiba, complaining mainly of poor aesthetics, which prevented him from finding a new job (Figure 1). Regarding his medical history, he reported hepatitis, which can lead to an increased risk of bleeding, and having hypertension controlled by medication (Losartan 50 mg every morning). Additionally, he reported postoperative complications related to poor healing in osteosynthesis surgery on his leg.

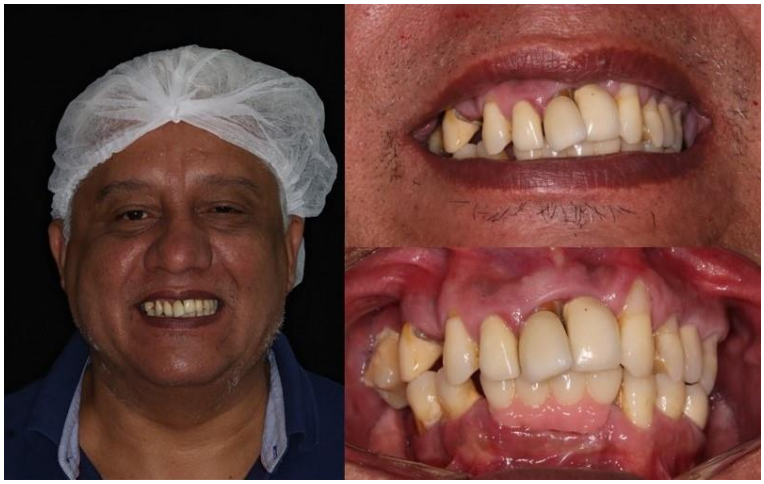

Figure 1 – Initial frontal smile.

A clinical examination was performed, and cone bean tomography and panoramic radiographs of the upper and lower arches were requested. The patient had multiple tooth losses in the upper arch and in the lower posterior region. The patient used a partial denture on two implants in the lower arch and had a single implant in the upper arch (Figure 2).

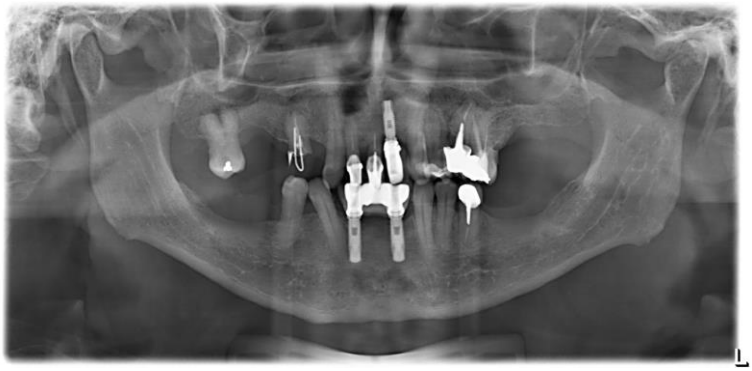

Figure 2 – Panoramic radiography

Based on clinical and imaging examinations, a diagnosis was made, and rehabilitation treatment was proposed as periodontal health maintenance therapy for the lower teeth, rehabilitation with an upper hybrid prosthesis in the first phase of treatment, and individual implants with ceramic crowns in the region of the lower posterior teeth in the second phase.

Prosthetic planning began with the impression for previous prosthetic planning, considering the ideal prosthetic position. The prosthetic laboratory produced the upper and

lower wax plan to determine the patient's VOD, and subsequently, a wax teeth try-in was performed. During the test, the patient's new midline was determined and transferred to the plaster model mounted on an articulator (Figure 3). Based on this information, the prosthetic laboratory produced an immediate provisional upper complete denture, a provisional lower removable partial denture, a multifunctional acrylic guide, and an osteotomy guide.

Figure 3 – (A) Extraoral frontal smile with midline marking. (B) Wax teeth try-in with planned midline transfer.

The patient was medicated with Amoxicillin (1g) and Dexamethasone (4mg) one hour before surgery, and Diazepam (5mg) thirty minutes before surgery. The patient's intraoral asepsis was performed with a 60-second rinse with Bluem and extraoral asepsis with chlorhexidine 2%. The patient underwent the surgical procedure under local anesthesia by blocking the posterior, anterior, and middle superior alveolar nerves. Infiltration anesthesia was performed on the anterior, middle, and posterior superior alveolar nerves bilaterally, followed by the nasopalatine and greater palatine nerves in the palate with mepivacaine HCL 2% with epinephrine 1:100,000.

With the patient anesthetized, a supracrestal incision was made in the toothless ridge region and an intrasulcular incision in the tooth region to reflect the total flap in the buccal area of the maxilla. After the flap detachment, all remaining upper teeth were extracted, and the implant was explanted in the region of tooth 21. The osteotomy was guided by an acrylic

osteotomy guide with the height predetermined after the tomography analysis (Figure 4A). Five Grand Morse Helix Acqua implants were placed in the maxilla (Neodent, Curitiba, Brazil) (Figure 4B): two 3.75 x 11.5 mm implants (insertion torques of 32 and 45 N.cm), and three 4.0 x 10 mm implants (insertion torques of 60 N.cm). GM cover screws (Neodent, Curitiba, Brazil) were installed and the flap was sutured (Figure 4C). The surgical procedure was completed without complications and a complete muco-supported prosthesis was provided to the patient.

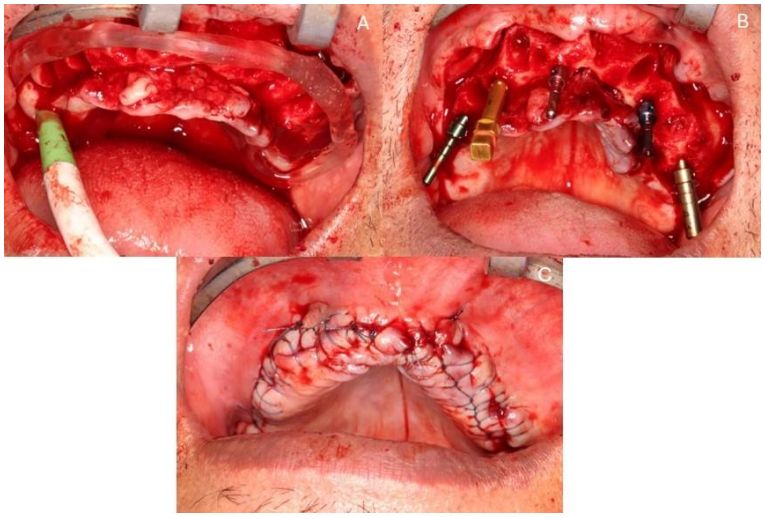

Figure 4 – (A) Osteotomy guide positioned in the mouth. (B) Five Helix GM implants placed in the maxilla. (C) Surgery completed and flap sutured.

After 4 months of healing, the flap was reopened for the installation of one GM 17-degree 3.5 mm Mini Conical Abutment (Neodent, Curitiba, Brazil), one GM 17-degree 2.5 mm Mini Conical Abutment (Neodent, Curitiba, Brazil), one GM straight 2.5 mm Mini Conical Abutment (Neodent, Curitiba, Brazil) and two straight GM 3.5 mm Mini Conical Abutments (Neodent, Curitiba, Brazil). Then, the implant-supported acrylic full-arch prosthesis was installed.

After maxillary rehabilitation, the mandible rehabilitation was performed. Two GM Titamax Acqua 3.75x7 mm implants (Neodent, Curitiba, Brazil) were placed in regions 45 and 46 (insertion torque of 60 N). GM Healing Abutments of 2.5 mm (Neodent, Curitiba, Brazil)

were installed in both implants. Three months after implant installation, extensive peri-implant bone loss was observed with implant mobility (Figure 5). As the bone loss was extensive, there was not enough bone remaining to install new implants in the posterior mandibular regions. The treatment options involving bone grafting or tooth extractions and installation of an implant-supported complete denture were explained to the patient. After considering the options, he found the second option to be better. Therefore, it was necessary to change the rehabilitation plan of the mandible to explant the lost implants and extract all remaining teeth for subsequent installation of the definitive full-arch prosthesis. The prosthesis laboratory was asked to remove the teeth from the plaster model, assemble the mandibular teeth, and make a multifunctional guide.

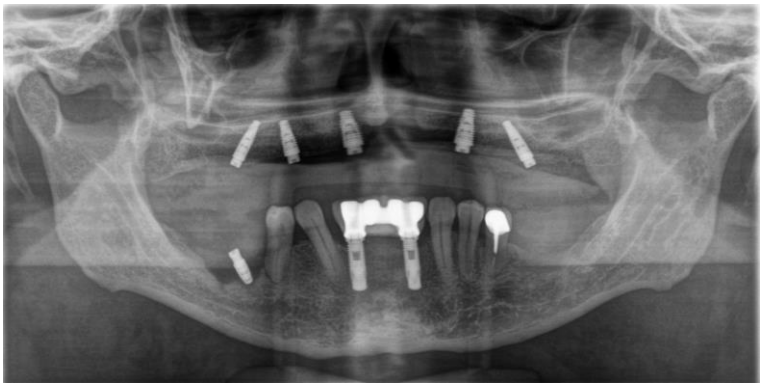

Figure 5 – Panoramic radiography showing the extensive bone loss in the posterior mandibular implant.

In a new surgical procedure, teeth 45, 44, 43, 33, 34, and 35 were extracted, and the implants were removed with retriever drivers followed by bone regularization. Four Grand Morse Helix Acqua implants (Neodent, Curitiba, Brazil) were placed: two 4.0x11.5 mm implants (insertion torques of 32 and 45 N.cm), and two 4.0x13 mm implants (insertion torques of 45 and 50 N.cm) with immediate loading. Two GM 17-degree 3.5 mm Mini Conical Abutments (Neodent, Curitiba, Brazil) and two GM straight 3.5 mm Mini Conical Abutments (Neodent, Curitiba, Brazil) were installed. The impression was performed with the multifunctional guide, and the final full-arch prosthesis was delivered after 48 hours. Following

the prosthesis installation, a panoramic X-ray was performed (Figure 6). No complications was reported and the patient was satisfied with the treatment (Figure 7).

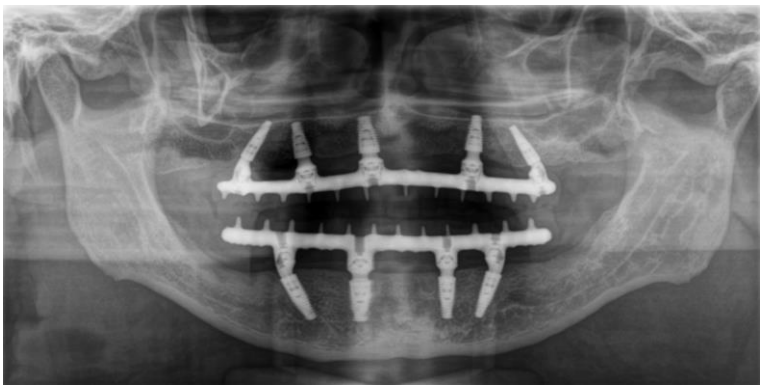

Figure 6 – Final panoramic radiography.

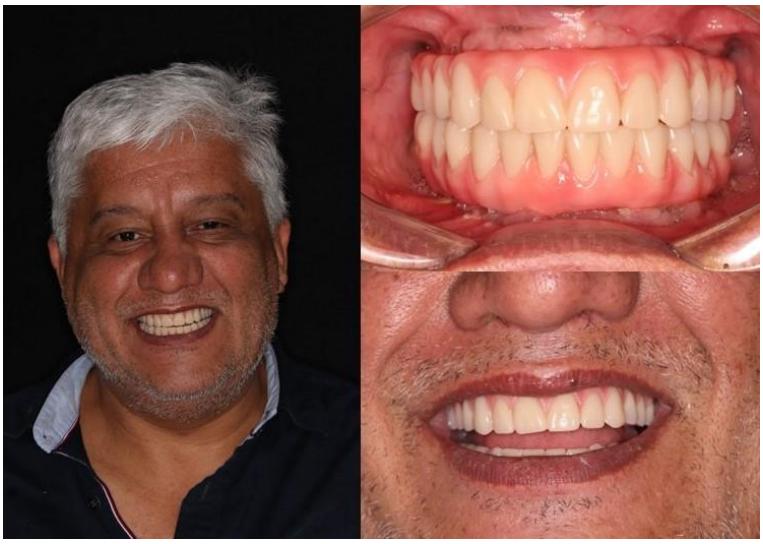

Figure 7 – Final frontal smile.

DISCUSSION

This case report describes the treatment of a health-compromised patient who had implant loss, leading to a change in the proposed treatment. Many factors may interfere with long-term dental implant success and survival, including the patient's health status. Some known systemic conditions such as hepatitis, cardiovascular diseases, and deleterious habits such as smoking have been related to affect dental implant rehabilitation outcomes(4). Our

patient, in this case, presented hepatitis, controlled hypertension, and healing problems. A systematic review found no association between hypertension and dental implant failure(5). In this way, the healing impairment and hepatitis may influence this outcome.

Implant failure may occur during implant treatment. This failure is classified as early and late failure. Early failure occurs during the first weeks after implant placement and can be related to surgical trauma, complicated wound healing, insufficient primary stability, and/or initial overloading(6). Our patient suffered from early failure, which in this case seems to be associated with his history of complicated wound healing since no overheating or excessive trauma occurred during the surgery, and the implant achieved sufficient primary stability.

In this case, the patient lost mandible implants, and because of this loss, the proposed treatment needed to be replanned. Implant failure can occur, and the clinician needs to be prepared to change the initial plan to offer better options to the patient. All patient's remaining teeth were removed in a new phase of treatment. Even with the trend to preserve the natural teeth as much as possible and the patient's teeth being health(7), it was decided to remove all teeth and follow full-arch rehabilitation for two main reasons: the absence of sufficient bone in the posterior area to place new implants and the patient's wishes.

Since the beginning of the treatment, the patient's wish was to remove all teeth and undergo double full-arch rehabilitation due to dissatisfaction with the esthetic; however, our team convinced him to maintain all the healthy mandible teeth. But when the implants failed, and no sufficient bone was available anymore, we decided to remove all teeth and proceed to full-arch rehabilitation. This decision was based on the sensitivity of the surgery to vertical bone augmentation in the posterior region, the treatment time increase, and costs(8). Additionally, replaced implants have a lower survival implant than the original one(9).

Then, the full-arch rehabilitation was the final treatment for both arches. Full-arch is a predictable treatment with high survival rates from 95.5% to 100%, as observed in the literature,

even for the double full-arch treatment(10–12). At the beginning of implantology, Branemark suggested placing 6 to 8 implants in the mandible and up to 14 in the maxilla. However, with the evolution of implantology, fewer implants are associated with lower biological complications, surgical time, and surgical costs(13). Due to its advantages, we decided to proceed with the all-on-4 technique in the mandible. Unfortunately, since the patient already had one implant in the maxilla, it was impossible to perform this technique. Besides the complication and change of plan during the treatment, the patient was satisfied and the treatment was successful.

CONCLUSION

Planning an implant treatment is challenging due to the many techniques available, but it is essential for successful rehabilitation. However, complications may force clinicians to change the initial plan and use their knowledge to readapt the treatment. This case presented a successful re-adaptation of a double full-arch rehabilitation with excellent results and patient satisfaction.

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