REBRAM
REVISTA BRASILEIRA MULTIDISCIPLINAR
e-ISSN: 2527-2675

Analysis of bone alterations around dental implants placed with flapless guided surgery technique, with or without immediate loading: a retrospective 1-year follow-up

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Keywords
Immediate dental implant loading; Three-dimensional imaging; computer-assisted surgery; Cone-beam computed tomography; Bone loss
Palavras-chave
Carga imediata em implante dentário; Imageamento tridimensional; Cirurgia assistida por computador; Tomografía computadorizada de feixe cônico; Reabsorção óssea

Abstract: The aim of this study was to assess, after 1-year follow-up, the marginal bone alterations around dental implants placed by using the flapless guided surgery technique with and without immediate loading. For this, conventional loading was placed in 8 patients (G1), whereas immediate loading was placed in the other 8 patients (G2). Tomographic measurements of the buccal and palatal bone wall thickness and buccal, palatal, mesial, distal bone wall height were measured in the cone beam computed tomography after the surgery (T0) and 1 year after the prosthesis installation (T1). The results showed of the 16 patients treated, ten were female and six were men. There were statistically significant differences between T0 and T1 in both groups regarding buccal bone resorption (buccal-G1-P=0.0185;G2-P=0.0017), palatal bone resorption (palatal-G1-P=0.008) and loss of vertical bone height in the buccal (G1-P=0.0066;G2-P=0,0015), palatal (G1-P=0,0015;G2-P<0.001), mesial (G1-P=0.0029; G2-P=0.001), and distal (G1-P<0.002;G2-P<0.005) walls. Regarding the comparison between G1 and G2, there were no statistically significant differences for all parameters evaluated at time T0 and T1. This study indicates that the flapless guided surgery technique with or without immediate loading did not influence in the marginal bone loss around dental implants after 1-year follow-up.

Resumo: O objetivo deste estudo foi avaliar, após 1 ano de acompanhamento, as alterações ósseas marginais ao redor de implantes dentários instalados com a técnica de cirurgia guiada sem retalho, com e sem carga imediata. Para isso, foi realizado carga convencional em 8 pacientes (G1), enquanto a carga imediata foi realizados nos outros 8 pacientes (G2). As medidas tomográficas da espessura da parede óssea vestibular e palatina e da altura da parede óssea vestibular, palatina, mesial e distal foram medidas na tomografia computadorizada de feixe cônico após a cirurgia (T0) e 1 ano após a instalação da prótese (T1). Os resultados mostraram que dos 16 pacientes tratados, dez eram do sexo feminino e seis do sexo masculino. Houve diferenças estatisticamente significativas entre T0 e T1 em ambos os grupos em relação à reabsorção óssea vestibular (vestibular-G1-P=0,0185;G2-P=0,0017), reabsorção óssea palatino (palatino-G1-P=0,008) e perda de altura óssea vertical na vestibular (G1-P=0,0066;G2-P=0,0015), palatino (G1-P=0,0015;G2-P<0,001), mesial (G1-P=0,0029; G2-P=0,001), e distal (G1-P<0,002;G2-P<0,005). Quanto à comparação entre G1 e G2, não houve diferenças estatisticamente significativas para todos os parâmetros avaliados nos tempos T0 e T1. Este estudo indica que a técnica de cirurgia guiada sem retalho, com ou sem carga imediata não influenciou na perda óssea marginal ao redor dos implantes dentários após 1 ano de acompanhamento.

10.25061/2527-2675/ReBraM/2026.v29i1.2341

Introduction

The proper planning is crucial for a clinical success and optimal prosthetic outcomes in Implant Dentistry. A good three-dimensional positioning of the implants enables prosthetic procedures to be more easily performed, and in terms of biomechanics, also allows axial loads to be better distributed through bone tissue and prosthetic components of the implants (BRUGNAMI; CALEFFI et al., 2005). As a result, higher rates of implant survival and better aesthetic outcomes can be obtained (BRUGNAMI; CALEFFI, 2005). Therefore, improving implants placement accuracy has been of great interest to the Implantology.

Flapless guided surgery was defined as being a surgical procedure for placement of implants without mucoperiosteal flap (BRODALA, 2009). This technique consists of a one-step surgical procedure for minimal removal of the soft tissue to reach the alveolar crest before placement of dental implants and prosthetic abutments. The flapless implant surgery is considered a blind procedure because of the difficulty in evaluating contours and angles of the alveolar crest, which increases the risk of poor positioning of the implants in terms of angle and depth and consequently makes prosthetic procedures more difficult (NIKZAD; AZARI, 2010). Nowadays, the flapless guided surgical technique is aimed at pre-operative planning in which computed cone beam tomography (CBCT) and specific software are used (NIKZAD; AZARI, 2010). Therefore, the problems related to non-guided flapless surgeries would be minimized, leading to precise positioning of the implants to be placed in addition to preventing possible accidents as the procedure itself is virtually planned (TALLARICO; MELONI, 2017).

The advantage of the flapless guided surgery technique is the preservation of the blood circulation in the soft tissues, which may influence the loss of soft tissue (D'HAESE et al., 2016). This technique preserves the osteogenic potential and the blood supply to the bone and to the implant since avoids elevation of the mucoperiosteal flap and keeps the periosteum in contact with the bone. On the other hand, this approach is beneficial to patients because it causes less morbidity during the surgery and in the postoperative. From a clinical point of view, better safety, minimal surgical intervention, and also dental implant placement accuracy are also provide (PUTRA et al., 2020).

The literature is well established regarding the immediate load implants succeed and the marginal bone level changes in treatments with dental implants using conventional and immediate loadings (LAZAROV, 2019; MARTENS et al., 2014). However, the literature is still scarce on the use of other surgical techniques for placement of implants, such as flapless guided surgery when the conventional and immediate loadings were compared. It is important to emphasize that the flapless guided surgery use a surgical guide, software to plan the treatment and a 3D-printer to print the surgical guide. In this way, all these factors may or not may interfere with the maintenance or loss of peri-implant bone, and the literature on the guided surgery technique has shown no updated results.

Therefore, in order to create a base of evidence for marginal bone level changes occurring with the use of flapless guided surgery technique, the objective of the present clinical study was to assess whether there are marginal bone level changes around the implants placed with flapless guided surgery, with and without immediate loading, during a follow-up period of one year. The alternative hypothesis formulated was that there should be statistically significant difference regarding marginal bone level changes in the implants placed with flapless guided surgery technique with and without immediate loading.

Material and methods

Study Design

The patients included in the study were treated first and after the end of treatment, they were included in the study design and were evaluated retrospectively. This study received ethical approval from the Research Ethics Committee according to protocol number 53438116.0.0000.5502 and the manuscript was prepared according to the EQUATOR guidelines. The following inclusion criteria were applied: patients older than 18 years old, fully edentulous maxilla needing rehabilitation with dental implants, bone height greater than 9 mm, and bone thickness greater than 6 mm. If tooth extraction was needed, then a 4-month period was respected before surgical placement of the implants. The antagonist arch might have teeth, rehabilitated with total or removable prothesis and rehabilitated with full-Arch implant rehabilitation, implant-supported overdenture or implant-supporting fixed partial prosthesis.

The exclusion criteria regarding systemic alterations were the following: smoking; prolonged use of corticoids; history of neoplasm requiring chemo and/or radiotherapy; presence of renal disease, bone metabolism disorder, uncontrolled endocrine disorder or any coagulation disorder; being carrier of special needs interfering with proper oral hygiene performance; being HIV carrier; alcoholism; and use of illicit drugs. The exclusion criteria regarding local alterations were the following: presence of inflammation or local infection; history of local irradiation; presence of bone lesion; tooth extraction region with a repair process of less than 4 months; unsatisfactory mouth opening; poor oral hygiene; and persistent intra-oral infection.

An 80% power was adopted to recognize a significant difference between groups (conventional and immediate loading) with a 95% confidence interval (α = .05) and standard deviation (SD) of 0.36 considering a significant minimum difference in peri-implant bone loss between the groups (conventional and immediate loading) as the primary outcome variable (ALFADDA, et al.,2019). Thus, a sample size of seven patients per group was needed.

Pre-Clinical Procedures

According to the sample calculation and inclusion and exclusion criteria, 16 patients were selected – six men and ten women. This study was performed at the Imppar Dental Clinic in the city of Londrina, state of Paraná, Brazil. Initially, the patients underwent clinical examination during anamnesis and radiographic exams (i.e. CBCT and panoramic radiography) and laboratory tests were ordered to evaluate the patients' general health condition. In order to avoid surgical and prosthetic complications for the patient, only an oral maxillofacial surgeon experienced in the field of implantology was chosen to performed the surgical and prosthetic procedures, that is, a professional who had treated many cases (CASSETTA et al., 2017).

Next, impression procedures, bite impression, functional and aesthetic try in of complete dentures and assessment of the preoperative exams results were performed. The results were all within the reference values, thus ascertaining that the patients' health condition was stable. After approval of the aesthetic test by the patient, a laboratory sequence was given to make the provisional prosthesis and the tomographic and multifunctional guides were planned. The tomographic guide was performed with duplication of the provisional prosthesis.

The technique to prepare the surgical guide for guided surgery consisted of two tomographic images, that is, one of the guide inside the patient's mouth and another of the guide only. Tomographic images were taken from all patients by using the I-CATVision TM software (Imaging Science International) and the resulting DICOM data were sent to the Neodent Guided Surgery Center (Neodent®, Curitiba, Paraná, Brazil). Specific software was used to overlap both tomographic images so that data on thickness of the gingiva, bone anatomy, anatomical details and future position of the teeth could be obtained. This software allows planning the placement of the implants in a suitable three-dimensionally position.

During the surgery planning, 4 to 6 implants (DAUDT POLIDO et al., 2018) (Titamax EX, Neodent®, Curitiba, Paraná, Brazil) with porous surface treatment (abrasive blasting followed by acid etching) were selected as well as Morse taper connections. After virtual surgical planning, the dental surgeon received the surgical planning of the Neodent Center and in case of agreement, approved the three-dimensional position of the implants. If the dental surgeon did not agree with the project, it would disapprove and request the necessary changes. Only after final approval by the dental surgeon, the surgical guide was manufactured by using CAD-CAM system (Fig. 1).

Figure 1 - Surgical guide positioned in the maxilla.

Surgical Procedures

Four to six implants were placed in edentulous maxilla. The drillings was performed according to the length and thickness of the implant following manufacturer's recommendation. The bone level for implant placement was standardized in all cases, that is, 2 mm below the bone. This was made according to previous studies (DE SIQUEIRA et al., 2020; DE CASTRO et al., 2014) on bone level for placement of Morse taper implants, showing that infra-osseous placement of implants leads to stability of the bone tissue. Based on the primary stability achieved at the moment of implant placement, eight patients receive conventional prosthetic loading (G1) and eight received immediate prosthetic loading (G2)

(ALFADDA et al., 2019; CASSETTA et al., 2017; DAUDT POLIDO et al., 2018; DE SIQUEIRA et al., 2020; DE CASTRO et al., 2014; DE BRUYN et al.,2008). The primary stability was measured with torque dental implant torque wrench from Neodent®, Curitiba, Paraná, Brazil. After that, the surgical guide was removed, and the abutments were chosen for patients with immediate loading according to the pre-surgical project. For patients with conventional loading, the cover screws were placed and the implant osseointegration time recommended by the manufacturer for the re-opening procedure was awaited (i.e. 4 months).

Prosthetic Procedures

In those cases, in which primary stability was equal to or greater than 32N/cm (ALFADDA et al., 2019; CASSETTA et al., 2017; DAUDT POLIDO et al., 2018; DE SIQUEIRA et al., 2020; DE CASTRO et al., 2014; DE BRUYN et al., 2008), transfer impression of the abutments was performed with multifunctional guide. The next day, a new try in of the complete denture wax up was made to confirm aesthetics and to assess the passivity of the cobalt-chromium bar. One day after this procedure, Brånemark protocol prosthesis was placed, and occlusal adjustment performed. In the other eight patients, it was not possible to apply immediate loading because the primary stability of one or more implants was lower than 32 N/cm. For these patients, tissue punch was used to re-open the implants after four months from their placement. Next, transfer impression of the abutments was performed with a multifunctional guide. In another visit, passivity of the cobalt-chromium bar and aesthetic test were performed. In the last visit, the prosthesis was delivered to the patient and occlusal adjustment made according to the mutually protected occlusion principles.

Tomographic Analysis

1. Analysis of Buccal and Palatal Bone Thicknesses

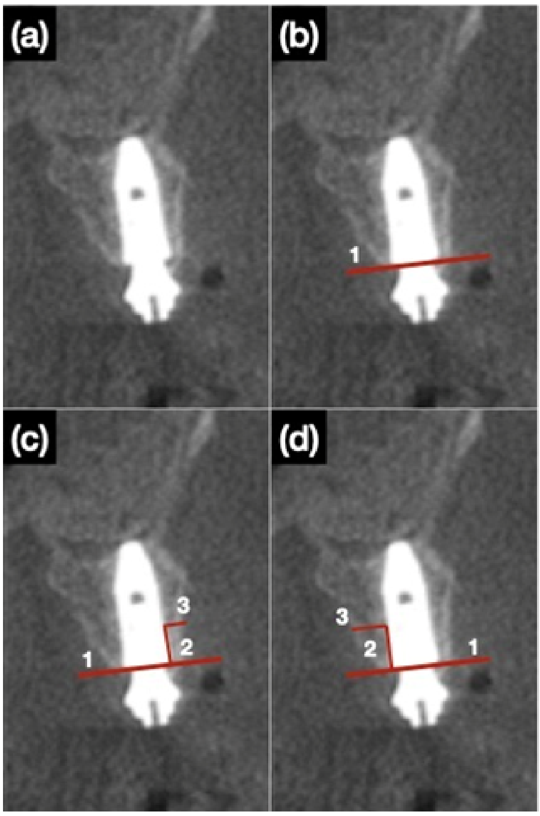
CBCT was performed after implant placement surgery (T0) and after 1 year from placement of implant-supported prosthesis (T1). All CBCT images were taken with a cone beam scanner (I-Cat®; Kavo, Brazil) at the Imppar Dental Center in the city of Londrina, PR, Brazil. CBCT slices of 0.2 mm thickness were acquired at 1-mm interval, 120 kVp and 100mA.

Intra-rater reliability was assessed prior to the retrospective study by using post-operative images of five cases in which maxillary implants were placed with flapless guided surgery. The same Dentist (radiologist) performed the measurement of all images three times during the pilot project, in addition to being responsible for all the measurements acquired during the present study. A total of 92 implants were studied, meaning that six measurements per implant face were performed (buccal and palatal bone thickness and buccal, palatal, mesial and distal bone height). Therefore, 552 measurements were made. The first (T0) and second measurements (T1) were continuously made after treatment of all patients. Specific software (I-CATVisionTM – Imaging Science International) was used for obtaining the images. It was standardised the lines of the maxilla measurement, positioned at the centre of the implants for sagittal section (measurements of buccal and palatal regions), axial section (distance between implants) and coronal section (measurements of mesial and distal regions).

For assessment of the buccal and palatal bone thicknesses at T0 and T1, some parameters were established to make analysis easier. Initially, it was necessary to standardise a CBCT slice for each implant before performing the analysis and it was made by selecting the para-sagittal slice of each implant. The CBCT slice of the selected implant was always corresponding to half the diameter of the implant. Therefore, the diameter of each implant was always checked in order to perform the procedures with accurately (Fig. 2a).

After selecting the parasagittal slice for measuring of the buccal and palatal bone thicknesses, a straight line was initially drawn parallel to the implant's platform (i.e. landmark of the implant level plane) in order to determine a fixed point (line 1) (Fig. 2b). This line was considered a parameter only. Next, another line was drawn in the buccal region of the implant, which started at the fixed point of line 1. This line was drawn with 3 mm in length (line 2) to determine another fixed point (Fig. 2b). The 3-mm length was chosen for all slices to standardise the study. Next, another line perpendicular to line 2 was drawn (line 3) in order to measure the buccal bone thickness (Fig. 2c). The same methodology was used for measurement of the palatal bone thickness.Line 2 was also drawn from the fixed point of line 1, but it was drawn in the palatal region of the implant, and it was also 3 mm in length. Next, another line perpendicular to line 2 (i.e. line 3) was drawn for measurement of the palatal bone thickness (Fig. 2d).

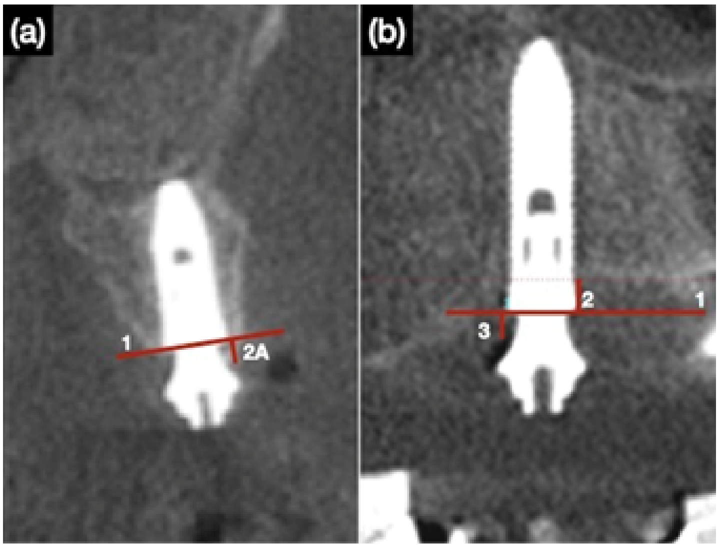
Figure 2 - (a) centralised implant; (b) line parallel to the implant's platform (fixed point); (c) line parallel to the implant's platform – fixed point (line 1); standardisation of the buccal fixed point 3 mm above the line 1 (line 2), measurement of the buccal bone wall thickness (line 3); (d) line parallel to the implant's platform – fixed point (line 1); standardisation of the palatal fixed point 3 mm above the line 1 (line 2), measurement of the palatal bone wall thickness (line 3).



2. Analysis of Buccal, Palatal, Mesial and Distal Heights

Line 1 (straight line parallel to the implant's platform) was again drawn to assess the bone height and determine whether vertical bone loss occurred in the buccal, palatal, mesial and distal regions at T0 and T1. Next, another line was drawn perpendicular to line 1 intersecting the mid-point of the buccal bone thickness and towards below the remaining bone crest (line 2A). Negative values corresponded to the bone height of the implant with Morse taper connection (Fig. 3a and Fig. 3b).

Figure 3 - (a) image showing buccal bone wall height at the site of implant placement (line 2A). (b) Image showing mesial and distal bone walls heights at the site of implant placement (lines 2 and 3).



All data obtained from the measurements (i.e. buccal and palatal bone thicknesses and buccal, palatal, mesial and distal bone heights) were in millimetres and were tabulated and submitted to statistical analysis.

Data Analysis

Data from all measurements were organised on an Excel spreadsheet (Microsoft Office Excel, Redmond, WA, USA) and analysed for data normality distribution (Shapiro-Wilk test) to evaluate if the data distribution followed the central distribution theorem. The data were distributed according to normality; thus, the independent t-test was used. All statistical tests were performed by using GraphPad Prism 6.0 software (GraphPad Software, La Jolla, California, USA) at a significance level of 5%, meaning that all results with $P < 0.05$ were considered statistically significant.

Results

Of the 16 patients treated, six were male and ten were female. The age of the patients ranged from 43 to 66 years old, with a mean age of 52.43 years. A total of 92 dental implants were placed. The implant characteristics is described in table 1 and 2.

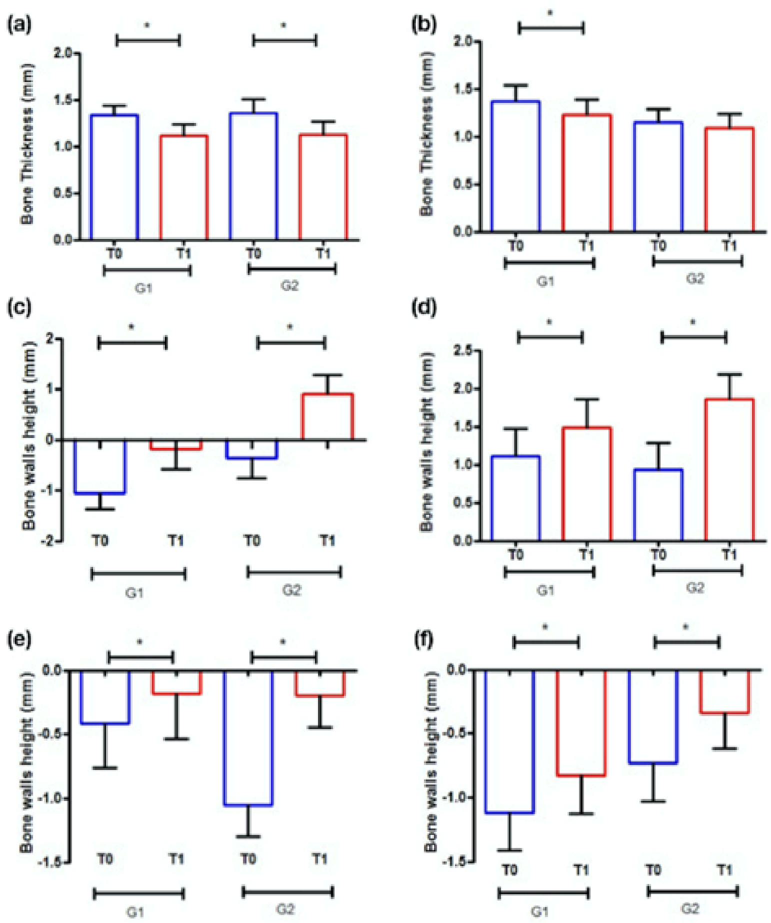
Among the 92 implants placed, only one implant that was installed with immediate loading (1.08%) was lost during the bone healing process in the region of tooth #24. After 3 months, the implant was successfully repositioned, and the rate of success was 98.92% after 1 year. Clinical complications involved fracture of crown/prosthesis in four patients (25%) and loosening of prosthetic screw in one patient (6.25%).

In the group of patients with conventional loading (G1), there was statistically significant difference between the experimental periods for buccal bone wall thickness This finding was also observed in the group of patients with immediate loading (G2), since there was a reduction in the buccal bone wall thickness at. In the comparison between G1 and G2, there was no statistically significant difference in the thickness of buccal bone wall at T0 and T1 (Fig. 4a).

Regard to the palatal bone wall thickness, the group with conventional loading (G1) showed statistically significant difference between the experimental periods. Nevertheless, in the group of immediate loading (G2), the palatal bone walls thickness had no reduction after 1 year. In the comparison between G1 and G2, no statistically significant difference (Fig. 4b).

Considering the buccal, mesial, palatal and distal bone wall height, the group with conventional loading (G1) showed statistically significant difference between T0 and T1, as well as in the group with immediate loading (G2). In the comparison between the groups, there was no statistically significant difference at T0 and T1 (Figs. 4c, 4d, 4e and 4f).

Figure 4 - (a) analysis of the buccal bone walls thickness (mm) in G1 and G2 groups (mean ± SEM, *statistically significant intra-group difference, $P < 0.05$). (b) analysis of the palatal bone walls thickness (mm) in G1 and G2 groups (mean ± SEM, *statistically significant intra-group difference, $P < 0.05$). (c) analysis of the buccal bone walls height (mm) in G1 and G2 groups (mean ± SEM, *statistically significant intra-group difference, $P < 0.05$). (d) analysis of the palatal bone walls height (mm) in G1 and G2 groups (mean ± SEM, * statistically significant intra-group difference, $P < 0.05$). (e) analysis of the mesial bone walls height (mm) in G1 and G2 groups (mean± SEM, *statistically significant intra-group difference, $P < 0.05$). (f) analysis of the distal bone walls height (mm) in G1 and G2 groups (mean ± SEM, *statistically significant intra-group difference, $P < 0.05$).



Discussion

In the present study, the results show that the flapless guided surgery technique for placement of implants in edentulous maxilla can be as predictable and successful both for immediate loading and for conventional loading. There are no clinical studies or split mouth, randomized controlled trial in the literature comparing flapless guided surgery technique and conventional surgeries. However, the literature shows good outcomes with both techniques (DOAN et al., 2014; LALEMAN et al., 2016). In this study, the success rate of the 92 implants was 98.9%, with only one implant lost after 1-year follow-up. This finding is corroborated by RAVIDÀ et al. (2018); D'HAESE et al. (2017); TALLARICO, et al. (2017), who also reported high rates of success and predictability for the technique.

The advantage of the flapless guided surgery can be observed when the periosteum and blood supply are maintained to the bone after a flapless surgery, thus avoiding changes in gingival profile and also reducing surgery time, edema and pain in the surgical site, in addition to decreasing the post-operative time (ABAD-GALLEGOS et al., 2011). Therefore, it is a technique that benefits patients when compared with conventional surgery (D'HAESE et al., 2016). On the other hand, according to the literature, after implant installation and placement of the prosthesis, in general, the crestal bone suffers re-modelling and resorption during the first year (DE CASTRO et al., 2014), and after this period of time, the bone is expected to be maintained (BUSER et al., 2011). In this way, the results of this study are in accordance with the literature as bone thickness and vertical bone height were reduced around the implants following the 1-year follow-up.

There is no clinical study in the literature assessing peri-implant bone level changes in implants placed by means of flapless guided surgery technique and comparing conventional to immediate loading. In this sense, our study is a novel one and in order to obtain more reliable results, our study analysed all aspect of the implants, whereas the majority of the studies (BROWAEYS et al., 2014; LANDÁZURI-DEL BARRIO et al., 2011) performed a linear analysis of a single aspect (mesial and distal aspect) of the implant by using periapical radiograph.

CBCT might overcome some of the limitations of intra-oral radiographs, such as, the two-dimensional nature that does not allow an evaluation of the buccal and lingual bone levels (PATEL et al., 2009; KIVANÇ KAMBUROĞLU et al. ,2013) and also some authors used CBCT to evaluate the peri-implant marginal bone loss (GRASSI et al., 2019). In case of peri-implant defects, intraoral periapical images demonstrate the mesial and distal aspects of alveolar bone. However, the initial peri-implant bone loss occurs mostly on the facial or buccal aspect of the dental implant, and CBCT may be useful in determining the presence and dimensions of buccal marginal bone resorption when a peri-implant defect is suspected (BENAVIDES et al., 2012; DE FARIA VASCONCELOS et al., 2012). Thus, with CBCT there are possibility to evaluate and quantified all aspects of the dental implant (mesial, distal, buccal, and palatal), not just the mesial and distal aspects.

This way, some parameters were established for measurement of the thickness of the buccal and palatal bone walls. A straight line was drawn parallel to the implant's platform and a line was drawn above the vestibular region of the implant with 3 mm of length. The same was made for measurement of the palatal bone wall, but the line was drawn above the palatal region of the implant. All the patients included in our study were with implants with Morse taper connection, since the literature shows that this type of connection allows less bone remodelling around the implant (DE CASTRO et al., 2013). The literature has suggested that the subcrestal placement of implants with Morse taper connection provided positive results in terms of crestal bone re-modelling, so all implants used in the present study were 2 mm below the bone. Therefore, if a measurement below 3 mm were used as parameter, then there might be an impossibility to make measurements due to the crestal bone maintenance.

To measure the bone heights in the buccal, palatal, mesial and distal regions, a straight line was drawn parallel to the implant's platform and another line was drawn perpendicular to that line, which intersected the mid-point of the buccal bone thickness towards below the remaining bone crest. The point of election and standardisation of this perpendicular line intersecting the mid-point of the buccal bone thickness was chosen because this region was considered very important for bone re-modelling after placement of the implants (BUSER et al.,2011).

The present retrospective study investigated whether there was marginal bone loss of buccal and palatal wall thickness as well as of vertical height in buccal, palatal, mesial and distal walls, with and without immediate loading, by using CBCT for comparative analysis at T0 and T1. Local thermal injury is one of the surgical factors favouring bone resorption around the implant. This injury can result in necrosis due to friction heat generated during surgical preparation with repeated perforations using drills, as well as the cutting power of the drill, which should be used according to the manufacturer's recommendations (CARVALHO et al., 2011). External irrigation ensures the non-heating of the bone bed when performed in open field. However, in the flapless surgical technique the external irrigation is unfavourable (DOS SANTOS et al., 2014).

Dos Santos et al. (2013) investigated the effect of repeated perforations on the cell viability by assessing the expressions of matrix proteins from cells and bone (i.e. osteocalcin, RANKL, osteoprotegerin and caspase 3) during placement of implants with both conventional techniques and guided surgery technique. The conventional perforation technique for implant osteotomy had less negative influence on the cell viability compared to the guided surgery technique. In this way, the bone loss observed in our study during the 1-year follow-up in both G1 and G2 may be due to poor external irrigation, since the surgeries were performed without flap elevation.

In G1, there were statistically significant differences in the resorption of buccal and palatal bone walls at T0 and T1, as well as vertical bone loss in the bone walls evaluated. G2 had similar results, but analysis of the thickness of palatal bone walls showed no thickness reduction at T1 compared to T0 (T0: 0.9 ± 0.14 mm; T1: 0.9 ± 0.15 mm; P value = 0.118). This is one of the limitations of the study, since this result can be explained due to a more palatalised implant placement, and according to the assessment methodology used, it was not possible to measure the palatal bone tissue in some cases. Another limitation of the study is that it is retrospective study. Generally, this kind of study have more bias since the data collected, data entry of all implants evaluation were not planned ahead of time. However, it was chosen a convenience sample based in power analysis and this does not make the clinical study lose its relevance. Regarding bone resorption of buccal and palatal walls and the loss of vertical bone height in the bone walls evaluated, can be explained due to the physiological resorption occurring in the first year after insertion of the implants and placement of the prosthesis (BUSER et al., 2011; LANDÁZURI-DEL BARRIO et al., 2011) and when G1 was compared to G2, no statistically significant difference was observed at T0 and T1.

There is no study in the literature assessing marginal bone level changes around dental implants placed with flapless guided surgery with conventional or immediate loading. The literature present data regarding to the failure of the implant or prosthesis by comparing the survival rate of the implants. There are also reports on peri-implant bone loss related to different loading times (AL-SAWAI.; LABIB, 2015). The methodology used in this study is unique in terms of the analysis of the marginal bone level changes. Thus, due to the study design, it is difficult to compare the results with those of other studies reported in the literature. Therefore, it is possible to develop a base of evidence for marginal bone level changes occurring with the use of flapless guided surgery technique.

Conclusion

According to the results of the present study, flapless guided surgery is a feasible and predictable alternative to rehabilitation of the maxillae. Nevertheless, there was marginal bone level changes around the implants after 1-year follow-up period for both conventional and immediate loaded implants. However, this bone loss that the results showed is not clinically relevant. No statistically significant differences were observed in marginal bone level changes when the groups were compared, thus evidencing that either conventional or immediate loading did not influence the marginal bone level changes around implants after one year. It is suggested that further studies should be carried out with different follow-up periods to assess whether there is maintenance or loss of bone tissue around the implants in the long term. Based on these findings, the hypothesis was rejected.

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