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Esthetic outcomes of immediate implants placement following immediate restoration: Controlled clinical trial

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Abstract

The aim of this controlled clinical trial was to evaluate the variation in the thickness of the buccal bone plate and the position of the gingival margin in single implants installed in extraction socket and in healed ridges, both with immediate loading in aesthetic region.

Materials and Methods: individuals in group 1 (n=7) were treated with minimally invasive tooth extraction, cone morse implant (Neodent®), xenogene bone “gap” filling (Bio Oss®) and cementation of provisional crown. Individuals in group 2 (n=3), in edentulous unitary ridges, received a cone morse implant (Neodent®) and provisional crown cementation. The coronal (C), mid (M) and apical (A) points of the buccal bone plate (BBP) were measured by means of computed tomography and, with the aid of a probing guide, the measurements of the position of the gingival margin (PGM) were performed at the mesial (M), vestibular (V) and distal (D) points, both analyzes were assessed in the preoperative (T0), immediate postoperative (T1) and six months postoperatively (T2).

Results: in the analysis of buccal bone plate (BBP), no statistical differences were observed in the interaction of period and group factors, the same happened when comparing only the different periods. Group 1, when compared to group 2 in T1, presented higher averages in the buccal bone plate (p < 0.05), and this statistical difference was significant. In the PGM analysis, there was no significant statistical difference between the groups and periods interaction, the same could be observed when comparing the groups with each other (p > 0.05). A statistical difference between time T0 and T2 was observed, with time T2 having a mean of the measurements greater than the time T0 in both groups.

Conclusions: the treatment conferred in group 1 was shown to be a reliable option, with results of vestibular bone thickness and gingival level stable in the observed periods, when compared with group 2 treatment. With similar results between groups, the advantages of immediate implant as reduction of postoperative morbidity, reduction of medication use and maintenance of the perimplant framework become attractive for indication of the technique tested

Keywords: Bone and bones; Dental implants; Gingival recession; Tomography

1 Introduction

The loss of dental elements in the aesthetic area, demands fast intervention, because in addition to the tissue reactions, the aesthetic and functional importance, there's the emotional factor involved [1,2]. The bone loss, vertical and horizontal, around the implants[3] modifies the morphology of the superjacent mucosa, which can damage the

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obtaining of a pleasant aesthetic result in the units rehabilitations making the treatment challenging[4,5]. Besides that, it may induces a bag formation, unfavorable to long-term perimplant health[6].

Important parameters were evaluated in a work done by Belser et al [7] where using cone morse implants with narrow platform, it was observed the reduction of perimplant marginal bone resorption, improvement of the space for the favorable prosthetic intermediates to the establishment of biological distance, juxtaposition between implant and prosthetic abutment reducing the inflammatory infiltrate and displacement of masticatory forces towards the central axis of the implant. The correct three-dimensional positioning is of fundamental importance in preserving the adequate volume of bone and gingival tissues[8]; and the position of the implant shoulder below the bone crest favors the maintenance of the papillae[9,10].

The extraction results in volumetric tissue contraction where the vestibular wall is the one that suffers bigger variation; however, only the interposition of the implant in the extraction site is not enough to contain the collapse of this structure; a work conducted by Araújo et al [11] demonstrated that the alveoli lose approximately 30% of its post-extraction volume; other studies have shown loss of volume up to 50%[12]; the interposition of biomaterial in the gap (space between the implant surface and the vestibular bone wall) favors the maintenance of the proximal and vestibular bone structure[3,11,13].

Minimally traumatic extraction[14] followed by immediate implant installation, gap filling and installation of the provisional crown allows: the elimination of a second surgical stage, the maintenance of bone and gingival architecture, reduction of the treatment time, discomfort of the patient[15], medicines use, and increases the degree of satisfaction with the treatment[16].

The purpose of this study was to evaluate clinically, the position of the gingival margin and radiographically the thickness of the buccal bone plate of implants submitted to immediate loading in extraction socket with interposition of xenogeneic bone graft (group 1) and on healed ridges (group 2) in the preoperative times (T0), in the immediate postoperative period (T1) and with six months (T2).

2 Material and methods

2.1 Ethical Considerations

The study was conducted according to the Code of Professional Dental Ethics and it was started with approval of the Research Ethics Committee of the Western Paraná State University under the number 1.973.349. All patients were informed, by a professional involved in the study about the risks and benefits of therapies used and they gave formal consent. The recruitment happened at the graduation and postgraduate clinics of Paranaense University and Western Paraná State University (both in Cascavel, Paraná, Brazil)

2.2 Inclusion criteria

Patients with needs of unitary dental replacement in the upper arch (including incisors, canine, first and second premolars) both in the presence of the condemned elements as in the existence of edentulous ridges. Extracted elements indicated shouldn't present acute infection at the site and after extraction socket were classified in EDS 1 (characterized by an intact uni-root alveolus, with thick periodontal biotype) or EDS 2 (slight degree of bone crest damage, not bigger than 2 mm, with a thin or thick biotype, and a thickness of the vestibular bone wall of at least 1 mm), according to Caplanis et al[17]. Edentulous ridges should have osseous conditions of implant installation, without any reconstructive procedure associated and they should passed by a healing period of at least three months. Patients should present a good plaque control and they should have a minimum of twenty teeth.

2.3 Exclusion Criteria

It was excluded from the study patients with systemic alterations that could interfere in the healing process (liver disease or kidney disease, SIDA, alcoholism, collagen vascular disease, diabetes, immunodeficiency); with drugs use reports that interfere with healing (corticosteroids, chemotherapeutics, antibiotics) in period more than six months from the starting of the study and/or that inhibiting bone resorption (bisphosphonates). Patients who presented periodontal disease, poor oral hygiene condition, occlusal dysfunction such as absence of disocclusion and parafunction guides.

2.4 Sample and grouping: surgical and prosthetic technique

2.4.1. Group 1 (n=7)

In this group were admitted patients with dental elements with indication of exodontia and those who were in agreement with the inclusion criteria of the study. These patients received infiltrative terminal anesthesia with mepivacaine 3% with vasoconstrictor adrenaline (Mepiadre®, DFL, Rio de Janeiro, Brazil) and they had their teeth extracted in order to preserve the buccal bone plate; the buccal bone wall was properly inspected and; if EDS1 or EDS2 classification was obtained; a conical implant cone morse (Neodent®, Curitiba, Brazil) with 3.5 mm diameter and 11.5 mm in length was installed anchored in the palatine alveolar wall, searching an intentional gap of approximately 2.5 millimeters in the horizontal direction and 2 to 3 mm infra-osseous in the vertical direction[18], searching primary stability equal to or greater than 32N, enabling immediate prosthetic loading. After that it was installed an abutment universal cone morse (Neodent®, Curitiba, Brazil) of 3.3 millimeters diameter for cemented prosthesis; adequate transmucosal measurement for each case and 6 mm core height; which received torque of 32N followed by the preparation of provisional with help of an acrylic cylinder (Neodent®, Curitiba, Brazil) of 3,3 mm X 6 mm and on top of this was made a provisional crown. After that the gap was filled with xenogeneic bone graft (Bio Oss® - Geistlich, Wolhusen, Switzerland) until the level of surrounding bone crest and no sutures were performed. The provisional was cemented with temporary cement (Temp Bond®, Kerr, Italy) and excesses were carefully removed with the help of an analogue of the cementation abutment.

2.4.2. Group 2 (n=3)

In this group were admitted patients with edentulous unitary ridges and who were in agreement with the inclusion criteria. The anesthesia, the implant, the installation of the intermediary and the provisional were performed in the same way as in group 1. The incision was made at the ridges crest at an equidistant point of the mesio-buccal angle, mesio-lingual disto-vestibular and disto-lingual and a full thickness flap was removed. Due to the execution of the mucoperiosteal flap, this group received two simple interrupted sutures with nylon thread 5.0 (Shalon, São Luiz M Belos, Goiás, Brazil), one in the mesial papilla and another on the distal papilla.

2.4.3. Clinical analysis - positioning of the gingival margin (PGM)

the upper arch was molded with alginate (Hydrogum®, Zermack, Badia Polesine, Italy) and the models obtained with gypsum stone type 3 (Herostone®, Coltene, Rio de Janeiro, Brazil); on the top of that was made a polyvinyl acetate board with 2.0 mm thick. This board served as a guide and was personalized with acrylic resin (Duralay®, Reliance, Alsip, United States) allowing three points of penetration of the probe (PCP UNC, Hu Friedy®, Chicago, United States). in the distal, in the midpoint and the mesial of each implant. The measurements were performed with periodontal probe in the guide points described above, coupled to an endodontic slider (Angelus, Londrina, Brazil) and checked using a digital parking meter (Mitutoyo Sul Americana Ltda, Suzano, Brazil). To determine the position of the gingival margin, (PGM) free gingival margin was used as the reference point for the probe, while for the cursor the reference was the outer edge of the probe guide.

2.4.4. Tomographic analysis - tomographic parameter

buccal bone plate (**BBP**): tomographic shots were performed with the tomograph I CAT (Kavo®, Biberach, Germany) model 9140-0000-0000R, NS: ICU071026, 120 kVp, 36.12. But, with 40 seconds of exposure, 0,2 Voxel and the images were processed in a software I Cat Vision (CT Dent, North Penn Road, USA) compatible with the tomograph.

The tomographic cut mediating both in the mesio-distal direction, as in the vestibular-palatal sense, was selected for the measures, according to figure 1.

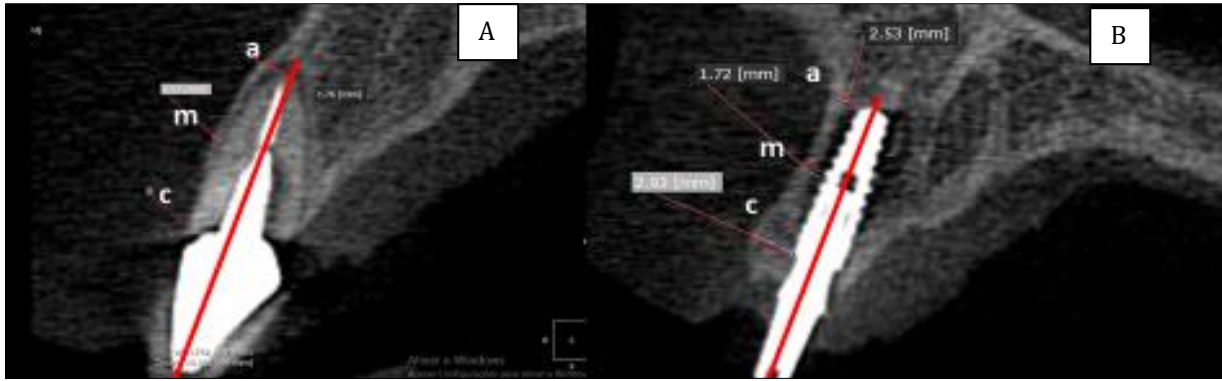


Figure 1 Measures of the thickness of the buccal bone plate (BBP) where *c* represents the most coronal point, *m* the median point and *a* the most apical point. The image (A) represents the scheme of measures of group 1 in T0 (preoperative) in the presence of the dental element and the image (B) represents the scheme of measures of groups 1 and 2 in times T1 (immediate postoperative) and T2 (six months)

2.5 Statistical analysis

All data has been evaluated as normality wherewith the test of Shapiro-Wilk. For statistical analysis of comparison between groups 1 and 2 and the different periods of the variables of BBP and PGM, it was used the analysis of variance for repeated measures (ANOVA), followed by the follow-up test of LSD-Fisher. Being carried out by the program Statistica 7.0 (Statsoft, 2004), assuming a significance level of 0.05. The method error intra-examiner was analyzed by the intraclass correlation coefficient with insignificant result.

3 Results

From the ten patients selected for the present study, 7 (2 men and 5 women) were allocated in the group 1 and 3 (1 man and 2 women) were allocated in the group 2. The average age obtained in the group 1 was 37 years old; in the group 2 was 41 years old, and the average age of the entire sample was 38 years old. It's considered three gingival biotypes according to Müller & Eger (slender, normal and thick) [19] and the importance of the gingival profile in the incidence of gingival recession in treatments with implants [19, 20], inside group 1, one patient presented a slender biotype, one patient represented thick biotype and five patients represented normal biotype, in group 2, one patient had a normal biotype, a slender and a thick biotype. In group 1 all implants were installed in the upper central incisor region; in group 2 was installed one implant in the central incisor one in lateral incisor and one second premolar, all jaws.

Table 1 Averages of values of the buccal bone plate (BBP) from Group 1 and 2 over the three different periods

	Group 1			Group 2		<i>P- value periods</i>	<i>P-valor groups</i>	<i>P- value Interaction</i>
	T0	T1	T2	T1	T2			
BBP (C)	0.5 ± 0.44	2.5±0.49 bA	2.18±0.56 Aa	0.72±0.74 aA	0.96±0.84 aA	0.76	> 0.01	0.06
BBP (M)	0.36 ± 0.36	2.92±1.24 aA	2.84±1.32 aA	2.38±1.97 aA	1.93±1.80 aA	0.22	0.48	0.36
BBP (A)	1.04 ± 0.83	2.9±1.23 aA	3.4±0.82 aA	4.63±3.23 aA	4.53±1.52 aA	0.59	0.19	0.42

P - Variance Analysis for Repeated Measures (ANOVA). Small letters represent statistical comparisons between groups within each period, and the different letters indicate significant statistical differences (P<0.05). Capital letters represent statistical comparisons between the periods within each group; and the different letters indicate significant statistical differences (P<0.05). Cervical level (C), middle level (M), and apical level (A) from the implants.

In the table 1, the averages obtained from the BBP measures are described in the coronal points (C) medium (M) and apical (A). BBP in T0 (preoperative) was measured only in group 1, when the dental element was present. At point

(C), no statistical differences were observed when evaluated the interaction of the factors periods and groups. The same happened when compared only the different periods (T1 and T2) ($P>0.05$), indicating the similarity between them. When the comparison was made between the different groups, we can observe a significant statistical difference ($P<0.05$), showing that group 1 has a bigger measure of bone board than group 2 T1.

When performing the same *statistical* test for the variable BBP (M) and BBP (A), differences were also not identified between the interaction periods and groups. The same could be observed when analyzing these factors separately ($P>0.05$), indicating that as the groups as the periods are equivalent between each other.

In table 2, the averages obtained from the PGM measures are described at the points: mesial (M), medium of vestibular face (V) and distal (D). There was not significant statistical difference between the interaction groups and periods. The same can be observed when compared the groups between each other ($p>0.05$). When comparing the different periods within each group, we can observe a statistical difference between the time T0 and T2, where we can say T2 shows an average of the bigger measures than in time T0 in both groups on the distal face.

Table 2 Averages of values from the gingival margin position (PGM) from groups 1 and 2 over the three different periods

	Group 1			Group 2			P-value periods	P-value groups	P-value interaction
	T0	T1	T2	T0	T1	T2			
PGM (D)	8.1±1.7 aA	8.52±1.1 aAB	9±1.0 aB	6.62±1.2 aA	7.46±1.7 aAB	7.83±2.6 aB	0.01	0.23	0.8
PGM (V)	10.14±1.38 aA	10.32±1.02 aA	10.4±1.18 aA	8.55±2.40 aA	8.13±2.46 aA	8.51±3.17 aA	0.71	0.13	0.56
PGM (M)	8.84±1.48 aA	8.83±1.47 aA	9.48±1.87 aA	7.02±1.99 aA	7.34±2.36 aA	8.26±3.37 aA	0.09	0.25	0.78

P - Variance Analysis for Repeated Measures - ANOVA, where the small letters show the statistical comparisons between groups within each period, the different letters show significant statistical differences ($p<0,05$) and the capital letters represent the statistical comparisons between periods within each group, the different letters indicate significant statistical differences ($p<0,05$). Distal point (D) vestibular point (V) and mesial point (M) from the implant.

4 Discussion

The importance of the bone thickness about the implants is widely discussed in literature[7,16,17,18,21,22], because it represents the framework of perimplant architecture conferring support to the gingival tissue[23], proper contour of the alveolar process, optimizing the results of prosthetic rehabilitation with an emergency profile harmonized with neighboring teeth[24], opacification of the metallic coloring of implants[5,7] and the prevention of the bone resorption, once that bigger thicknesses also confer bigger vascular supply for its maintenance [14]. The modeling process and bone remodeling around the implant in an extraction socket (group 1) differs from that of an implant placed in an edentulous ridge, (group 2) [25] which motivated the comparison between these two groups in the present study.

In order to observe the thickness of the buccal bone about implants it's important to highlight some aspects. First is that the points C and M are more relevant when the intention is to know how much this parameter changed and its aesthetic consequences. The apical point, which sometimes is leveled with the anterior nasal spine, or other anatomical structures of the base of the maxilla, suffer less variation[26,27].

Analyzing the results within group 1 in the preoperative period (T0), measured in the presence of the dental root, there was an average among points C, M and A of 0.54 mm, this result indicates few thickness as found in most of the cases and with similar reports in the literature[26,27]. This factor could suffer an increase if the included patients in the sample would present only thick gingival biotype which, in addition to check larger BBP measures, also would show less tendency to gingival recession [28,29], this also could generate bigger tissue stability in other periods besides generating a lower variation of the averages. In the immediate postoperative period (T1) of group 1 at point C,

BBP presented an average of 2.18mm (± 0.56) and at point M presented an average of 2.84mm (± 1.32) these values are bigger than the results obtained in the work done by Buser et al[22], which presented averages of 1.05mm at the level corresponding to point C and averages of 1.96mm at the corresponding level to point M. Although these values are bigger than the cited works, they are not so clinically representative because it is the immediate postoperative evaluation that counts, besides other factors, with post anesthetic edema, intra-sulcular incision hemorrhage and rupture of fibers of the periodontal ligament in the dental extraction process. In the analysis of six months (T2) the averages remained stable in relation to T1, without large variations and without statistical difference, which represents clinically good maintenance of the gap filling process. Other works with similar methodology got worse results, indicating a higher degree of bone resorption of the buccal wall between the initial period and the final evaluation period[25].

The installation of the narrow platform implant (3.5 mm), with an approach more palatinate in the horizontal direction[8], intra-osseous in the vertical direction[18] and interposition of xenogeneic bone graft in the gap showed positive results, when compared to group 2 in T1 (immediate postoperative) when evaluated all points. In the comparison between groups in T2, when evaluated all points, there was not significant difference, however, when evaluated the most relevant points are observed bigger averages in group 1, which can be an indicative data of positive results of the graft use six months after the surgical procedure (T2). Another aspect that may have influenced in the results is the fact that group 2, there was a small and heterogeneous sampling, including a second premolar, which may also have increased the average at the apical point due to anatomy close to the first molar bone pillar. As in group 2 the implants were performed in healed ridges and without bone regeneration procedures these sites were likely to loss of volume which may vary according to the studies between 30%[11] and 50%[30], and when the buccal bone plate is slender or less than 1mm suffer bigger post-extraction resorption[28].

The position of the gingival margin (PGM) is strongly influenced by gingival biotype of each patient[28] since patients with a thin gingival biotype has lower tissue stability a more accentuated tendency to develop gingival retraction, whereas patients with normal or thicker biotype present more stable behavior [29]. The morphology given to the provisional crown can make the measurements suffer variations in all measured points, however, variations in point V are more representative when the objective is define the visual criterion for gingival retraction because it defines the height of the crown clinically visible. The presence of implants in the neighboring teeth can also produce bigger changes in measures because quantity and speed of bone resorption mainly at the height of the proximal ridges are more accentuated which may lead to the contraction of the papilla[18]. Biologically, surgery without flap of group 1 was less traumatic, once there is less vessel rupture and gum fibers inserted and loss of blood supply to the underlying bone; but in group 2 there was mucoperiosteal flap elevation and the contraction factor of the alveolus suffered since tooth extraction[31].

When evaluating the point D in group 1, we observed a statistical difference between the times, indicating retraction [20]. This factor is important because all the elements of group 1 were central incisors; therefore, the papilla involved in this process is related to the lateral incisor, which is quite aesthetically evident, in agreement with the results found by Chen et al[32]. At point V, the measures remained stable with variation smaller than 0.5mm, which did not characterize gingival retraction, without statistical differences[23]. At point M also without statistical differences and with averages practically identical in T0 e T1, a result that corroborates as good prognosis of the minimally invasive technique; between T1 and T2 there was an increase of 0.65 mm, also without statistical significance, however with some clinical significance once visual difference in this size scale is perceptible visually [23].

In group 2, at point D there was statistical difference between times indicating gingival retraction at that point, with results similar to those obtained in another study by Bashutski et al[31]. At points V and M there was no statistical difference, however, the variation of the measures was large which can be justified by the heterogeneity of the sample as towards the teeth involved as with the sample number. The presence of the temporary crown installed immediately may also cause tissue compression according to its anatomy. At point V, which is more expressive in the evaluation of gingival retraction the measures remained stable over the three periods[33].

In the comparison between the two analyzed variables, there was similarity of the behavior between the thickness of the buccal bone and gingival retraction which is in agreement with the findings of the studies of Buser et al[15,21,22]. However, despite these satisfactory results, there are several issues that is necessary to be considered. A larger group of patients to be included in the study possibly would modify the results according to tendencies observed in the evolution of the measures, the small sample limited the constancy of the data, which on the other hand suffered with the anatomical variations being demonstrated in the increase of the standard deviation and the heterogeneity of the sample in the tangent to the gingival biotype, mainly at group 2.

When comparing BBP measurements obtaining the averages of points C and M with PGM at point V, which are more clinically relevant, within each group between the times, we can observe in group 2 BBP average of 1.55mm with PGM 8.13mm in T1 and 144 mm of BBP and 8.51 mm PGM in T2, showing a decreasing numerical value of thickness of BBP followed by a slight increase in the height of the clinical crown. In group 1 in T1, BBP obtained an average of 2.71mm and PGM 10.32mm and in T2, BBP obtained an average of 2.51mm and PGM of 10.4mm, we also observed a tissue contraction in group 2, although with larger averages numerically, which can be influenced by applied methodology to the clinical treatment of group 1. An important systematic review performed by Chen & Buser[34] related the behavior of the perimplant parameters in implants performed in extraction socket, in which a higher index of gingival retraction was observed where the buccal bone plate could not be detected by CT scan. Another study accomplished by Crespi et al[20], showed higher rates of gingival retraction statistically significant in patients with a keratinized gingiva width less than 2 mm.

The continuity of the studies it is necessary in order to optimize the sample as in the qualitative sense, seeking homogeneity of anatomical regions included in the study and gingival biotype, as in the quantitative to make the results more relevant and adequate with the reality of the population

5 Conclusion

Considering the results obtained in the present study, we can be concluded that the thickness of the buccal bone and gingival level were stable in the groups and periods observed. Thus, the installation of implants in extraction socket, associated with xenogeneic bone graft in the gap, with execution in minimally invasive surgical technique has proved to be a reliable option, when compared with implants in healed ridges both loaded immediately, in aesthetic region. With similar results between groups, the advantages of immediate implant such as reduced treatment time, reduction of postoperative morbidity, reduction of medication use, improvement of associated psychological aspects associated with the of the dental restoration technique in a single session and maintenance of the perimplant framework become attractive for indication of the technique tested.

Compliance with ethical standards

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Disclosure of conflict of interest

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

Statement of ethical approval

The study was conducted according to the Code of Professional Dental Ethics and it was started with approval of the Research Ethics Committee of the Western Paraná State University under the number 1.973.349.

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