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ALTERAÇÕES DIMENSIONAIS NO REBORDO ÓSSEO APÓS EXODONTIA

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Dissertação apresentada ao Programa de Pós-Graduação em Odontologia Integrada, da Universidade Estadual de Maringá, para obtenção do título de mestre.

Orientador: Prof. Dr. Maurício G. Araújo

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Trabalho apresentado ao Departamento de Odontologia da Universidade Estadual de Maringá como pré-requisito para defesa da dissertação.
Orientador: Prof. Dr. Maurício G. Araùjo.

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“O método científico é comprovado e verdadeiro. Não é perfeito, é apenas o melhor que temos. Abandoná-lo, junto com seus protocolos céticos, é o caminho para uma idade das trevas.”

Carl Sagan

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SUMÁRIO

CONTEÚDO

1. Contextualização

As tabelas a seguir descrevem os principais artigos da literatura acerca das mudanças dimensionais após a exodontia em humanos.

Re-entry surgery						
Study	**Study design**	**Aim**	**Evaluation**	**Material**	**n**	**Healing time**
Tomasi et al. 2010	Prospective study	Evaluate bone dimensional variations at implants placed in fresh extraction sockets	Measurements at re-entry surgery		93	4 months after implant installation in fresh sockets
Hyunh-Ba et al. 2009	Prospective study	Analysis of the socket bone wall dimensions in the upper maxilla in relation to immediate implant placement	Measurements at re-entry surgery		93	4 months after implant installation in fresh sockets
Lecovik et al. 1997	Pilot study	Evaluate a bone regenerative approach to alveolar ridge maintenance following tooth extraction.	Re-entry surgery and model measurements	Polytetrafluoroethylene (ePTFE) membrane	20 extraction sockets: 10 ePTFE, 10 control	6 months
Lecovik et al. 1998	RCT	Evaluate effectiveness of biabsorbable membrane in preserving alveolar ridge after tooth extraction.	Re-entry surgery	Membrane of glycolide and lactide polymers	32 extraction sockets: 16 test and 16 control	6 months

Re-entry surgery		
Resultados	**Buccal bone thickness**	**Conclusão**
It was demonstrated that (i) the outer bony crest change was significantly affected by the thickness of the bone crest; (ii) the size of the residual gap was dependent of the size of the initial gap and the thickness of the bone crest; and (iii) the reduction of the buccal vertical gap was dependent on the age of the subject. Moreover, the position of the implant opposite the alveolar crest of the buccal ridge and its bucco-lingual implant position influenced the amount of buccal crest resorption.	Influenced the outer bony crest change, the size of the residual gap, and positioning of the implant	Clinicians must consider the thickness of the buccal bony wall in the extraction site and the vertical as well as the horizontal positioning of the implant in the socket, because these factors will influence hard tissue changes during healing.
The mean width of the buccal and palatal bony walls was 1 and 1.2 mm, respectively ($P<0.05$). For the anterior sites (canine to canine), the mean width of the buccal bony wall was 0.8 mm. For the posterior (premolar) sites, it was 1.1 mm ($P<0.05$). In the anterior sites, 87% of the buccal bony walls had a width ≤ 1 mm and 3% of the walls were 2 mm wide. In the posterior sites, the corresponding values were 59% and 9%, respectively.	In the anterior sites, 87% of the buccal bony walls had a width ≤ 1 mm	The data suggested that in the majority of extraction sites in the anterior maxilla, thin (≤ 1 mm) buccal walls were present. This, in turn, means that in most clinical situations encountered, augmentation procedures are needed to achieve adequate bony contours around the implant.
Results demonstrate better ridge dimensions at experimental sites than control ($p<0.05$)		The studied technique demonstrates predictable alveolar ridge maintenance enhancing the bone quality for dental implant procedures.
Test groups presented less loss of alveolar bone height, more internal socket bone fill, and less horizontal resorption of the alveolar ridge.		The tested membrane is a valuable treatment option in preserving alvolar bone after toth extraction.

Cast model					
Study	**Study design**	**Aim**	**Evaluation**	**n**	**Healing time**
Covani et al. 2011	Longitudinal study	Analysis of the pattern of the alveolar ridge remodelling following single tooth extraction	The amount of alveolar crest remodelling was assessed on standardized photos of study model	50 patients	6 months
Carlsson et al. 1967	Longitudinal study	Compare the effects of denture usage installed 2 months and immediately after extraction.	casts of complete edentulous patients + cephalometric xrays	50 patients	5 years

Cast model	
Results	**Conclusion**
The buccal re- absorption was 19.4 +- 9.4% at mesial point, 39.1 +- 10.4% at midpoint and 20.3 +- 10.7% at distal level. Moreover, the shift of the alveolar crest was 59.1 +- 11.2% at mesial point, 64.8 +- 10.5% at the midpoint and 56 +- 12.5% at distal point.	This study confirmed that buccal wall tends to re-absorb after the extraction according to a specific pattern. Thus, the re-absorption at the midpoint represent the double of bone loss at the distal and the mesial points. Furthermore, we have observed first how the alveolar crest shifts placing along the more lingual/palatal line which divides the original alveolar crest into three parts.
Relatively rapid reduction in the first 6 months in both vertical and horizontal dimension, followed by a gradual reduction thereafter; the reduction continued at a steady rate for up to 5 years	Major bone changes occurs in the first 6 months and, after this period, continues in a slower late

Histological analysis

Study	Study design	Aim	Evaluation	Material	n	Healing time
Crespi et al. 2011	RCT split mouth	Comparison of magnesium-enriched hydroxyapatite (MHA) and porcine bone (PB) in human extraction socket healing by histologic and histomorphometric analysis.	Histological	Magnesium-enriched hydroxyapatite and porcine bone	45 extraction sockets: 15 MHA, 15 PB, 15 control	4 months
Aimetti et al. 2009	RCT	Evaluate if placement of medica-grade calcium sulfate hemihydrate (MGCSH) in fresh sockets affect quality of newly bone formation and crestal bone changes	Histological and clinical	medica-grade calcium sulfate hemihydrate	40 patients: 22MGCSH, 18 control	3 months
Barone et al. 2008	RCT	To compare the bone dimensional changes following tooth extraction with extraction plus ridge preservation using corticocancellous porcine bone and a collagen membrane; and to an- alyze and compare histologic and histomorphometric aspects of the extraction-alone sites to the grafted sites.	Histological and clinical	Porcine bone	40 patients: 20 test group (RP), 20 control (EXT)	7 months

Histological analysis			
Results	**Height**	**Width**	**Conclusion**
Absence of inflammatory cells, bone formation in all treated sites, and the presence of biomaterial particles and connective tissue. Mean vital bone measurements for control groups was 30.3% ± 4.8%, respectively. Statistically significant differences were found between the MHA and control groups and between the PB and control groups; differences between the MHA and PB groups were not significant.			Histologic examination showed the same biologic behavior in bone formation and resorption processes for the two examined biomaterials.
Vertical resorption of the buccal socket walls and reduction of the buccopalatal width were more pronounced at control sites than at MGCSH sites (1.2 mm vs 0.5 mm, and 3.2 mm vs 2.0 mm, respectively). Formation of 100% living trabecular bone with woven and lamellar arrangements was found in both test and control sections. The average trabecular bone area fraction was greater in the grafted specimens than in control specimens (58.8% vs 47.2%). In the test group, the average percentage of lamellar bone increased from 16.4% to 43.6% from the crestal to the apical region and was greater than in unfilled specimens (11.1% coronally, 22.2% apically; $P < .0001$).	1.2mm reduction on buccal bone and 0.9mm reduction on palatal bone	3.2mm reduction	MGCSH seems to be effective in accelerating the bone healing process and minimizing alveolar ridge resorption in intact fresh extraction sockets.
A significantly greater horizontal reabsorption was observed at EXT sites (4.3 ± 0.8 mm) compared to RP sites (2.5 ± 1.2 mm). The ridge height reduction at the buccal side was 3.6 ± 1.5 mm for the extraction-alone group, whereas it was 0.7 ± 1.4 mm for the ridge-preservation group. Moreover, the vertical change at the lingual sites was 0.4 mm in the ridge-preservation group and 3 mm in the extraction-alone group. Forty biopsies were harvested from the experimental sites (test and control sites). The biopsies har- vested from the grafted sites revealed the presence of trabecular bone, which was highly mineralized and well structured. Particles of the grafted material could be identified in all samples. The bone formed in the con- trol sites was also well structured with a minor percentage of mineralized bone. The amount of connective tis- sue was significantly higher in the extraction-alone group than in the ridge-preservation group.	3.6mm reduction at buccal wall, 3mm reduction at palatal wall	4.3mm reduction	The use of porcine bone in combination with collagen membrane significantly limited the resorption of hard tissue ridge after tooth extraction compared to extraction alone. Furthermore, the histologic analysis showed a significantly higher percentage of trabecular bone and total mineralized tissue in ridge-preservation sites compared to extraction-alone sites 7 months after tooth removal.

Histological analysis						
Study	**Study design**	**Aim**	**Evaluation**	**Material**	**n**	**Healing time**
Crespi et al. 2009	RCT split mouth	Comparison of magnesium-enriched hydroxyapatite (MHA) and calcium sulfate (CS) in human extraction socket healing by histologic and histomorphometric analysis.	Histological and radiographic	Magnesium-enriched hydroxyapatite and calcium sulfate	45 extraction sockets: 15 MHA, 15 CS, 15 control	3 months
Iasella et al. 2003	RCT	determine whether ridge preservation would prevent post-extraction resorptive changes as assessed by clinical and histologic parameters.	Histological and clinical	Tetracycline hydrated freeze-dried bone allograft (FDBA) and a collagen membrane	24 patients: 12 extraction-alone group (EXT), 12 ridge preservation (RP)	6 months

Histological analysis

Results	Height	Width	Conclusion
Histologic examination revealed bone formation in all treated sites; trabecular bone assessment did not differ among apical, mesial, and coronal portions of the specimens. Mean vital bone measurements for CS, MHA, and C groups were 45.0% ± 6.5%, 40.0% ± 2.7%, and 32.8% ± 5.8%, respectively. Statistically significant differences (P <0.05) were found among all groups. Connective tissue percentages averaged 41.5% ± 6.7% for the CS group, 41.3% ± 1.3% for the MHA group, and 64.6% ± 6.8% for the C group. Statistically significant differences (P <0.05) were found between CS and C groups and between MHA and C groups. The CS-grafted sockets showed 13.9% ± 3.4% residual implant material, whereas the MHA-treated sockets showed 20.2% ± 3.2% residual material. The difference between the groups was statistically signif- icant (P <0.05).	3.75 reduction - intraoral X-ray		Radiographs revealed a greater reduction of alveolar ridge in the CS group than in the MHA group. Histologic examination showed more bone formation and faster resorption in the CS group and more resid- ual implant material in the MHA group
The width of the RP group decreased from 9.2 ± 1.2 mm to 8.0 ± 1.4 mm (P <0.05), while the width of the EXT group decreased from 9.1 ± 1.0 mm to 6.4 ± 2.2 mm (P <0.05), a difference of 1.6 mm. Both the EXT and RP groups lost ridge width, although an improved result was obtained in the RP group. Most of the resorption occurred from the buccal; maxillary sites lost more width than mandibular sites. The vertical change for the RP group was a gain of 1.3 ± 2.0 mm versus a loss of 0.9 ± 1.6 mm for the EXT group (P <0.05), a height difference of 2.2 mm. Histologic analysis revealed more bone in the RP group: about 65 ± 10% versus 54 ± 12% in the EXT group. The RP group included both vital bone (28%) and non- vital (37%) FDBA fragments.	0.9mm buccal and 0.4mm lingual reduction	2.6mm reduction	Ridge preservation using FDBA and a collagen membrane improved ridge height and width dimensions when compared to extraction alone. These dimensions may be more suitable for implant place- ment, especially in areas where loss of ridge height would compromise the esthetic result. The quantity of bone observed on histologic analysis was slightly greater in preservation sites, although these sites included both vital and non-vital bone.

Histological analysis						
Study	**Study design**	**Aim**	**Evaluation**	**Material**	**n**	**Healing time**
Pelegrine et al. 2010	RCT	Evaluate effectiveness of biabsorbable membrane in preserving alveolar ridge after tooth extraction.	Histological and re-entry surgery	Autologous bone marrow graft	30 teeth:15 test and 15 control	6 months
Amler et al. 1960	Descriptive study	Describe alveolar healing after tooth extraction in a histological perspective	Biopsies of extraction sockets at different periods of time			

Histological analysis			
Results	**Height**	**Width**	**Conclusion**
The test group showed better results (P<0.05) in preserving alveolar ridges for thickness, with 1.14 +- 0.87 mm (median 1) of bone loss, compared with the control group, which had 2.46 +- 0.4 mm (median 2.5) of bone loss. The height of bone loss on the buccal plate was also greater in the control group than in the test group (P<0.05), 1.17 +- 0.26 mm (median 1) and 0.62 +- 0.51 (median 0.5), respectively. In five locations in the control group, expansion or bone grafting complementary procedures were required to install implants while these procedures were not required for any of the locations in the test group. The histomorphometric analysis showed similar amounts of mineralized bone in both the control and the test groups, 42.87 +- 11.33% (median 43.75%) and 45.47 +- 7.21% (median 45%), respectively.	1.17 mm reductiom	2.46mm reduction	The tested membrane is a valuable treatment option in preserving alvolar bone after toth extraction.
After extraction a blood clot prontly filled the extraction socket. After 7 days, the clot was replaced with granulation tissue. After 20 days, the granulation tissue was replaced by collagen, and bone began forming at the base and the periphery of the extraction socket. At 5 weeks, Amler estimated that on average two-thirds of the extraction socket had filled with bone. Epithelium was found to require a minimum of 24 days to completely cover the extraction socket, with some extraction sites requiring up to 35 days to completely cover the socket.			

X-ray analysis						
Study	**Study design**	**Aim**	**Evaluation**	**Material**	**n**	**Healing time**
Moya-Villaescusa et al. 2010	Prospective study	Measurement of ridge alterations following tooth removal	periapical X-ray		100 teeth	3 months
Braut et al. 2011	Transversal study	Analyse thickness of facial bone wall	CBCT scans		498 teeth	no tooth extraction
Canger et al. 2012	Transversal study	Evaluation of alveolar ridge heights of dentate and edentulous patients	Panoramic X-ray		147 individuals: 50 denture wearers, 50 non-denture wearers, 47 dentate	unkown
Chappuis et al. 2013	Prospective study	Investigate alterations of buccal bone in the esthetic xone after tooth extraction	CBCT scans		49 patients	2 months

X-ray analysis	
Results	**Conclusion**
Significant differences (P<0.05) emerged between mesial-distal distances of multiple- (8 mm) and single-root teeth (5.60 mm). However, mesial or distal angles or the most apical distance of alveolar ridge resorption did not differ (mean distance in height 4.32 mm; mean angle 24o).	The post-extraction mesiodistal bone distance between teeth adjacent to the edentulous ridge depends on the size of the edentulous space. Nevertheless, the distance does not affect the distance in bone loss height. The distance of bone resorption height reaches a balance at the midpoint, which we consider indicative of stable healing.
No existing bone wall was found in 25.7% of all teeth at MP1 and in 10.0% at MP2. The majority of the examined teeth exhibited a thin facial bone wall (< 1 mm; 62.9% at MP1, 80.1% at MP2). A thick bone wall (≥ 1 mm) was found in only 11.4% of all examined teeth at MP1 and 9.8% at MP2. There was a statistically significant decrease in facial bone wall thickness from the first premolars to the central incisors. The facial bone wall in the crestal area of teeth in the anterior maxilla was either missing or thin in roughly 90.0% of patients.	oth a missing and thin facial wall require simultaneous contour augmentation at implant placement because of the well- documented bone resorption that occurs at a thin facial bone wall following tooth extraction. Consequently, radiographic analysis of the facial bone wall using CBCT prior to extraction is recommended for selection of the appropriate treatment approach.
There were significant differences between the alveolar ridge heights of dentate and edentulous groups ($p < 0.001$). Between the denture wearer and the non-denture wearer groups there was no significant difference in the upper jaw ($p = 0.635$).	Reduction in residual alveolar ridge height was in close relation with gender, denture usage and edentulousness.
A risk zone for significant bone resorption was identified in central areas, whereas proximal areas exibited only minor changes. Thin-wall phenotypes displayed pronounced bone resorption (7.5mm vs 1.1mm- thin vs thick)	Facial bone thickness in central areas determines the extent of bone resorption

X-ray analysis

Study	Study design	Aim	Evaluation	Material	n	Healing time
Fiorellini et al. 2005	RCT	Evaluate the efficacy of bone induction for the placement of dental implants by two concentrations of recombinant human bone morphogenetic protein-2 (rhBMP-2) delivered on a bioabsorbable collagen sponge (ACS) compared to placebo (ACS alone) and no treatment in a human buccal wall defect model following tooth extraction.	CT scans	two concentrations of recombinant human bone morphogenetic protein-2 (rhBMP-2) delivered on a bioabsorbable collagen sponge (ACS) compared to placebo (ACS alone) and no treatment	80 patients	4 months
Ghassemian et al. 2012	Transversal study	To measures the distance between the cemento-enamel junction (CEJ) and alveolar bone crest and the thickness of facial alveolar bone at points 1 to 5 mm from the bone crest for the six maxillary anterior teeth.	CT scans		396 teeth	no tooth extraction
Januário et al. 2011	Transversal study	To determine the thickness of the facial bone wall in the anterior dentition of the maxilla and at different locations apical to the cemento-enamel junction (CEJ).	CBCT scans		1500 teeth	no tooth extraction

X-ray analysis	
Results	**Conclusion**
Assessment of the alveolar bone indicated that patients treated with 1.50 mg/ml rhBMP-2/ACS had significantly greater bone augmentation compared to controls (P ≤0.05). The adequacy of bone for the placement of a dental implant was approximately twice as great in the rhBMP-2/ACS groups compared to no treat- ment or placebo. In addition, bone density and histology revealed no differences between newly induced and native bone.	The data from this randomized, masked, placebo- controlled multicenter clinical study demonstrated that the novel combination of rhBMP-2 and a commonly utilized collagen sponge had a striking effect on de novo osseous formation for the place- ment of dental implants
A high variation of CEJ–bone crest (0.8 to 7.2 mm) was detected. A significantly larger CEJ–bone crest was measured in smokers (P <0.05) and patients who were ‡50 years old (P <0.05). The average bone thickness at 3 mm from the CEJ for the maxillary right central incisor was 1.41 mm and for the maxillary left central incisor was 1.45 mm. For the maxillary right and left lateral incisors, the crestal bone thickness averaged 1.73 and 1.59 mm, respectively. For the maxillary right and left canines, the crestal bone thick- ness averaged 1.47 and 1.60 mm, respectively.	The present study supports the finding of a predominantly thin facial bone overlying the six maxillary anterior teeth. Therefore, it is essential to make informed treatment decisions based on thorough site evaluation before immediate implant placement.
he measurements demonstrated that (i) the distance between the CEJ and the facial bone crest varied between 1.6 and 3 mm and (ii) the facial bone wall in most locations in all tooth sites examined was 1 mm thick and that close to 50% of sites had a bone wall 0.5mm.	Most tooth sites in the anterior maxilla have a thin facial bone wall. Such a thin bone wall may undergo marked dimensional diminution following tooth extraction. This fact must be considered before tooth removal and the planning of rehabilitation in the anterior segment of the dentition in the maxilla.

X-ray analysis						
Study	**Study design**	**Aim**	**Evaluation**	**Material**	**n**	**Healing time**
Jin et al. 2002	Transversal study	Investigate bone thickness on the buccal and palatal aspects of the maxillary canine and premolars using cone-beam computed tomography (CBCT)	CBCT scans		120 teeth	no tooth extraction
Kerr et al. 2008	Pilot study - split mouth	evaluate the effect of ultrasound on the dimensional healing changes of alveolar bone following tooth extraction using cone-beam volumetric tomography	CBCT scans	novel, non-invasive treatment using ultrasound to accelerate healing following extraction to minimize alveolar bone loss.	24 teeth: 12 control 12 test	3 months
Saglam et al. 2002	Transversal study	The purposes of this study were to determine the variation in maxillary and mandibular vertical measurements made from panoramic radiographs and to assess differences in measurements between dentate anb edentulous jaws.	Panoramic X-ray		192 patients: 96 dentate and 96 edentulous	unkown

X-ray analysis	
Results	**Conclusion**
At the canines and first premolars regions, mean buccal bone thickness of at 3 mm and 5 mm apical to CEJ were less than 2 mm. In contrast, at the second premolar region, mean buccal bone thickness at 3 mm and 5 mm apical from CEJ were greater than 2 mm. Frequency of thick bone wall (≥2 mm) increased from the canine to the second premolar	At the canines and first premolars regions, mean buccal bone thickness of at 3 mm and 5 mm apical to CEJ were less than 2 mm. In contrast, at the second premolar region, mean buccal bone thickness at 3 mm and 5 mm apical from CEJ were greater than 2 mm. Frequency of thick bone wall (≥2 mm) increased from the canine to the second premolar
Analysis of dimensional changes in all measures of vertical height and horizontal width demonstrated no statistically significant differences between the ultrasound and control groups from baseline to 3 months postextraction. Evaluation of correlations between dimensional changes demonstrated a moderately strong correlation ($r = 0.67$; $P = 0.023$) in the ultrasound group between the change in buccal vertical height and the baseline crestal ridge width. Analysis of the change in buccal vertical height relative to baseline crestal width demonstrated a statistically significant benefit to ultrasound compared to control ($P=0.016$). This benefit was more pronounced in wider sockets compared to narrow sockets.	There was no significant benefit to ultra- sound in absolute bony dimensional changes following tooth extraction. There was a significant interaction between the treatment rendered (ultra- sound versus control) and the change in buccal ridge height relative to baseline ridge width at the crest and 3 mm apical to the crest.
n the dentate group, there was no statistically significant difference between men and women in the height of the maxilla. However, the height of the mandible was significantly greater in men than in women. In the edentulous group, the heights of the maxilla at the anterior and first premolar regions were significantly greater in men than in women. In the same group, mandibular heights were also significantly greater in men than in women. Reductions in the height of the edentulous mandible and maxilla were significantiy more pronounced in women than in men. The decrease in the vertical height of the maxilla was nol statistically significant in men.	There are differences between the sexes in aiveolar ridge résorption after tooth loss.

X-ray analysis						
Study	**Study design**	**Aim**	**Evaluation**	**Material**	**n**	**Healing time**
Zekry et al. 2013	Transversal study	To assess the width of the facial alveolar bone wall using cone-beam computed tomography images	CBCT scans		200 scans	no tooth extraction
Schropp et al. 2003	Prospective study	Assess bone formation in the alveolus and the contour changes of the alveolar process following tooth extraction	periapical X-ray and cast models		46 patients	12 months

X-ray analysis	
Results	**Conclusion**
There was no significant difference between the values of right and left sides, or between genders. However, statistically significant differences were observed between age groups at all levels. The distance from CEJ to BC varied from 0.4 to 4 mm, with an overall tendency to increase with age. The mean width of the facial alveolar bone wall at anterior teeth was 0.9 mm and increased toward posterior regions. Rarely, a width of 2 mm was yielded (0.6–1.8% for anterior teeth, 0.7–30.8% for posterior teeth). At a 5-mm distance from BC, minimal widths of facial alveolar bone were identified for the anterior teeth. The frequency of dehiscence ranged from 9.9% to 51.6% for anterior and 3.1% to 53.6% for posterior teeth, respectively.	A thin facial alveolar bone wall was usually present in both jaws. Hence, for most patients, adjunctive bone augmentation may be needed when installing implants in areas of esthetic concern.
Mean changes of model measuerements in buccal height; oral height; and width were, respectively, 0.4; 0.8; and 6.1 mm. On radiographic evaluation, bone formation took place in he extraction alveoli simultaneously with a loss of height of the alveolar crest. Remodeling of lamina dura was pronounced in the period from 6 to 12 months after tooth extraction.	The results demonstrated that major changes of an extraction site occurred during 1 year after tooth extraction

DIMENSIONAL BONE CHANGES FOLLOWING TOOTH EXTRACTION

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Abstract

The aim of this investigation was to describe dimensional bone alterations following tooth extraction on CBCT scans. Forty-six patients presenting a single edentulous area in the anterior region of the maxilla with corresponding contra-lateral tooth were included in this study. Alveolar cross-section area, height and width measurements were performed in Tooth and Edentulous sites. Patients were divided according to width of the buccal bone at 3mm below CEJ into: Thin (<1mm) and Thick (≥1mm) buccal walls groups. The differences between the groups were evaluated with the use of Wilcoxon rank-sum test (α=0.05). All measurements displayed statistically significant differences when comparing both sites ($p<0.05$). In Edentulous site, 76% of the subjects exhibited an alveolar ridge that was <80mm^2 large and in 20% of the sample < 8mm high. The thin buccal wall group demonstrated greater % reduction area compared with Thick group (39% vs. 24%). In conclusion, alveolar bone suffers significant dimensional reductions after tooth extraction. It is suggested that lack of bone will occur following implant installation at anterior region of the maxilla and that ridge augmentation procedures should be considered to compensate such bone loss.

INTRODUCTION

The periodontium's main purpose consists in supporting the tooth. Being a tooth-dependent tissue, it is predisposed by alterations tooth might go through (Cohn 1966, Pietrovsky & Massler 1967, Pietrovsky & Massler 1971). Tooth features such as shape, irruption axis and inclination guide the format and other characteristics of the alveolar process (Schroeder 1986). Thus, with the tooth loss it is expected to find critical damage to its attachment apparatus (i.e. cement, periodontal ligament, and bundle bone) (Araújo & Lindhe 2005), leading to an atrophy of the periodontium, followed by changes on the overlying soft tissue contour (Schropp et al. 2003).

Henceforward, as a result of tooth extraction, bone modeling/ remodeling process sculpts a shorter, thinner alveolar ridge (Pinho et al. 2006). Also, edentulous ridge is expected to be in a lingual position than formerly (Botticelli et al. 2004, Pietrokovsky & Massler 1967). When buccal bone wall is lost because of inflammatory processes or even because of the exodontia itself, alveolar ridge formation becomes even more complex (Iasella et al. 2003).

Understanding the magnitude of these dimensional changes on bone is an essential aspect in order to provide a reliable treatment plan that offers to the patient comfort, function and esthetics (Lang et al. 2011, Bartee 2001).

Studies on dogs (Araújo & Lindhe 2009, Araújo et al. 2005a, Cardaropoli et al. 2003, Araújo et al. 2008) demonstrated significant dimensional changes at the first 2 to 3 months following tooth extraction. On an initial stage, bundle bone is resorbed and replaced by woven bone. On a second stage, resorption occurs on the external part of both bone walls. Resorption on buccal wall was particularly more pronounced when compared to lingual wall. (Araújo & Lindhe 2005) As to horizontal resorption, it decreases as we distance from the edge and approach the base (Blanco et al 2011, Araujo & Lindhe 2009, Kerr et al. 2008).

Human studies indorse the results found on animals. Major bone alterations occur at the first 3 to 6 months after tooth extraction (Barone et al. 2008, Crespi et al. 2009, Kerr et al. 2008, Iasella et al. 2003), although crucial changes have been reposted between the period of 6 to 12 months (Schropp et al. 2003). Bone resoption seems to be more prominent on buccal than lingual wall (Botticelli et al. 2004, Iasella et al. 2003). Similarly to the animal models, horizontal resorption was greater at edge of the ridge, and more pronounced than vertical bone loss. (Covani et al. 2003, Schropp et al. 2003).

Although science investigation has led to important findings, more evidence is still necessary to provide a deeper understanding on bone´s dimensional alterations after tooth extraction, supporting the professional on the clinical decision-making. Thus, the purpose of this investigation was to describe dimensionally bone alterations following tooth extraction on CBCT scans.

MATERIAL AND METHODS

The Ethics Committee of Maringa State University approved the study protocol. Forty-six patients (26 female and 20 male) aged between 23 and 67 years (mean 40 years) that presented an edentulous area in the anterior region of the maxilla with the corresponding contra-lateral tooth present were included. The study involved 24 central incisor, 21 lateral incisor and 1 canine sites. The edentulous sites were occupied by removable prosthesis. All patients were referred to the clinic for a radiographic examination cone-beam computed tomography (CBCT) examination of the maxilla for the diagnosis of, e.g., potential root fractures, presence of periapical lesions (not on the studied region at the present investigation), and bone volume for anticipated implant placement, etc.

The following inclusion and exclusion criteria were applied to the dentate site.

Inclusion criteria

- Presence of neighboring teeth
- Presence of cortical bone at the alveolar crest
- Cement-enamel junction (CEJ) possible to identify in the radiograph

Exclusion criteria

- Teeth presenting with deep caries lesions, root resorption, large restorations
- Metallic artifacts that prevented proper CBCT examination
- History of advanced periodontal disease
- Improper tooth alignment

• Periapical lesions, cysts, supernumerary teeth or mesio-dens on the studied area

The CBCT scans were obtained using the iCAT unit (Imaging Sciences International Inc., Hatfield, PA, USA) and involved all Tooth and Edentulous sites in the maxillary dentition. The images were acquired by means of the iCAT software and processed by a computer. Acquisition was performed (with volumetric dimension of 6 x 8 cm) for 20s with the following iCAT tomography acquisition protocol: voxel size: 0.3 mm; grey scale: 14 bits; focal spot: 0.5 mm; image detector: amorphous silicon flat panel; image acquisition: single 360o rotation. The images were saved in DICOM format (for details, see Januário et al. 2008). For each region analyzed (Tooth and Edentulous site), CBCT parasagittal reconstructions of 1 mm apart were made. A software program for image analysis (Invivo 5.0; InVivoDental Application 5.0, Anatomage Inc®) was used for the CBCT scan reading that included the measurements of several variables.

Radiographic measurements

Tooth site

The following landmarks were identified on the parasagittal reconstructions at the center of the tooth: (i) the most coronal portion of the alveolar process; identified as an imaginary line that connected the buccal and lingual crests (BC-PC) and (ii) the most apical portion of the alveolar process; identified as an imaginary line parallel to the axial plane that crossed the tooth apex (AB-AP; Fig.1).

The following assessments were made (Fig. 1a-f):

a. The alveolar process cross-section area (mm2) was determined by outlining the surface of the alveolar process between BC-PC and AB-AP (Fig. 1a).

b. The root cross-section area (mm2) was determined by outlining the surface of the root extending from apex to BC-PC (Fig. 1b).

c. The height of the alveolar process (mm) was determined as the linear distance between BC-PC to AB-AP. This line was perpendicular to AB-AP and extended to the most coronal portion of BC-PC (Fig. 1c).

d. The width of the buccal and palatal bone (mm) measured at 3, 5, 7 and 10 mm apical of the CEJ (Fig. 1d).

e. The tooth inclination was expressed as the buccal angle between the long axis of the tooth and AB-AP (Fig. 1e).

Edentulous site

The most apical portion of the edentulous ridge was identified by the AB-AP line that extended from the Tooth to the Edentulous sites on the parasagittal reconstruction. This line (AB-APe) could be observed on panoramic and parasagittal reconstructions and, hence, the apical limit of the alveolar ridge could be identified.

The following measurements were carried out at the center of the edentulous ridge (Fig. 2a, b):

a. The alveolar ridge cross-section area (mm2) was determined by outlining the surface of the ridge from the level of AB-APe to the ridge crest (Fig. 2a).

b. The height of the alveolar ridge (mm) was determined as the linear distance between AB-APe and the most coronal portion of the ridge crest (Fig. 2b).

In addition, in the axial reconstruction the alveolar process and ridge widths were determined by measuring the distance between the outer surfaces of the buccal and palatal walls at the center of the alveolar process (Tooth site) and ridge (Edentulous site; Fig. 3a, b). The measurements were carried out at 3, 5, and 7 mm above the CEJ of the most apically located adjacent tooth.

Calibration

Calibration of the CBCT examination was performed to ensure consistency in identifying the anatomical landmarks. To calibrate the examiners prior to actual measurements, intra-observer error was determined by measuring the alveolar process cross-section area on 10 randomly selected CBCT scans. The variable was measured twice over 2 days, with an interval of at least 24h. The Kappa correlation coefficient obtained was 0.9.

Statistical analysis

Mean and standard deviation (sd) were calculated for each variable and site. Descriptive statistical analysis of all data was performed. The area of the alveolar process/ridge was considered the primary variable. It was performed Kolmogorov-Smirnov test to verify the normal distribution of the sample. After attesting normal distribution, paired Student's t-test was used to evaluate the differences between Tooth site and Edentulous site (α=0.05).

In addition, the patients were separated in two groups according to the width of the buccal bone at 3 mm below the CEJ into Thin (< 1mm) and Thick (≥ 1mm) buccal walls groups. The differences between the groups were evaluated with the use of Wilcoxon rank-sum test (α=0.05).

RESULTS

Tooth sites

The mean and standard deviation (sd) of the variables are shown in Tables 1-4. The mean cross-section area of the alveolar process was 94.7±29.9 mm^2. At the central incisor region the corresponding value was 103.3±32.4 mm^2 while at the lateral incisor and canine regions the value was 82.2±23.7 mm^2 and 127.1 mm^2, respectively. The mean cross-section area of the root was 43.8±12.3 mm^2 (Table 1).

The mean height of the alveolar process was 11.5±2.3 mm. The mean width of the buccal bone measured at 3, 5, 7 and 10 mm apical of the CEJ was, respectively, 0.4±0.5, 0.7±0.4, 0.9±0.6 and 0.7±0.4 mm (Table 02). The corresponding values at the palatal aspect of the alveolar process were 0.7±0.7, 1.6±1.0, 2.3±1.2 and 3.6±1.9 mm. The mean alveolar process width was

8.4±1.7 mm, 8.7±1.8 mm and 8.8±1.8 mm at 3, 5 and 7 mm apical of the CEJ, respectively.

Edentulous sites

The alveolar ridge in the Edentulous sites exhibited at the crestal region a distinct cortical bone that was in continuity with the cortical bone of the buccal and palatal aspects of the ridge. The outline of the previous inner socket walls was not distinguishable and the trabecular bone had a uniform structure. The shape of the alveolar ridge was in most of the sites triangular with its base in direct contact with basal bone. Occasionally, alveolar ridge with a rectangular shape could be observed.

The mean cross-section area of the alveolar ridge was 62.0±28.0 mm^2 (Table 03). This dimension was statistically smaller than the corresponding value in the Tooth sites ($p<0.001$). At central incisors, the corresponding mean was 72.7 mm^2, while in lateral incisors and canine was respectively, 51.8 and 80.3 mm^2. Close to 76% of all sites exhibited an alveolar ridge area smaller than 80 mm^2 and 50% smaller than 60 mm^2 (Table 04). The overall reduction of the cross-section area of the alveolar process was about 34%. Table 05 describes the frequency distribution according to different categories of area reduction. A reduction of ≥ 20% < 40% was observed in 34% of the sites while a reduction < 20% and ≥ 40% < 60% was found in, respectively, 29% and 27% of the sites. Only 10% of the sites showed an area reduction ≥ 60%.

The mean height of the alveolar ridge was 9.4±2.8 mm and it was found to be statistically shorter than the height of the alveolar process ($p<0.001$; Table 03). The mean height according to tooth group was, respectively, 10.20, 8.4 and 9.4 mm at central incisors, lateral incisors and canine. The mean height reduction of the alveolar ridge was 18%. About 55% of the alveolar ridges were between 8 to 12 mm, 20% were < 8 mm and 15% > 12 mm high (Table 06).

The mean alveolar ridge width at 3, 5 and 7 mm apical of the CEJ was, respectively, 3.3±2.6, 4.6±2.7 and 5.2±2.7 mm (Table 07). It was calculated that the alveolar ridge at all levels was significantly narrower from the corresponding values at the alveolar process in the Tooth site ($p<0.001$, $p<0.001$ and $p<0.001$). At 5 mm below the CEJ, the proportion of sites presenting an overall alveolar ridge width ≥ 7 mm was 20% while the corresponding proportion presenting ≥ 4 mm < 7mm and < 4 mm was 39% and 41%, respectively (Table 08).

The Tooth sites were divided into two groups according to the buccal bone width at 3 mm below the CEJ: Thin (< 1mm) and Thick (≥ 1mm) buccal wall groups (Table 09). Thirty-nine tooth sites (85%) were included into the Thin Group, whereas only 7 (15%) were allocated into the Thick Group. The percentage of cross-section area reduction was significantly larger in the Thin Group (39% vs. 24%; $p=0.04$). The mean alveolar ridge height at the Thin Group was also significantly shorter than at the Thick Group (9.3 vs. 11.3 mm, $p=0.03$) while the mean ridge width did not show any statistically significant difference.

DISCUSSION

The present study evaluated in CBCT reconstructions the dimensional alterations of extractions sockets sites after > 1 year of healing. The findings demonstrated that the cross-section area, height and width of the alveolar process were significantly reduced after the completion of the socket healing process. In addition, it was also demonstrated that the alterations were more conspicuous in the coronal third of the alveolar ridge.

The edentulous site in the present investigation was compared to the corresponding contralateral Tooth site. It was assumed that the alveolar bone structure at the right and left sides of the patients were fundamentally identical. This assumption is supported by the study of Pietrokovisky & Massler (1967) who compared in cast models the dimensions of edentulous sites to the contralateral corresponding dentate sites. The authors observed that the dimension of the dentate sites were similar in both sides of the jaws. This finding was also in agreement with the results from Januário et al. 2011 who assessed the width of the alveolar socket walls and found no difference between the dimension of the alveolar socket in right and left sides of the jaws.

The present study included Edentulous sites of single gaps which were considered to represent fully healed alveolar sockets. In a systematic review, Lang et al. 2011 reviewed human and animal studies that evaluated the dimensional changes following tooth extraction of single units up to 1 year of healing. The findings extracted from the various studies included in the review indicated that most of the dimensional alterations had occurred during the first 6 months following tooth extractions. In addition, in the Edentulous sites of the present sample, the CBCT scans revealed that a clear cortical crestal bone could be identified, the outline of the inner socket walls was not distinguishable and the trabecular bone had a uniform structure. The corticalization of the entrance of the socket is among the final steps of bone modeling process that occur during socket healing (Cardaropoli et al. 2003). Thereafter, only minor tissue changes occurred in the healed socket. Taken together, the above data supports the statement that the present sample represented clinically fully healed edentulous sites and that minimal additional dimensional changes should have been expected if longer periods of healing had been assessed.

Cross-section area

The values of the cross-section area observed in the Edentulous site demonstrated that the alveolar process was markedly reduced following tooth extraction (94 mm^2 vs. 62 mm^2). Thus, about 35% of the cross-section area of the alveolar process was lost after socket healing. Furthermore, it was also observed that 50% of the Edentulous sites occupied an area smaller than 60 mm^2. This result indicates that the installation of standard diameter implants (about 4 mm wide) in such a way that the buccal and palatal aspects of the implant to be cover with 2 mm of bone, as recommended in aesthetic areas by Grunder et al. 2005, would not be possible. Regarding the different tooth groups, central incisors and canines (mean cross-sectional alveolar ridge area 80 and 72.7 mm^2 respectively) wouldn´t be able to receive the indicated implant without bone augmentation. Lateral incisors also wouldn´t be able to receive a 3mm diameter implant without augmentation procedures (mean cross-sectional alveolar ridge area 52mm^2). Thus, it can be suggested that ridge augmentation procedures are often necessary to compensate for the post-extraction dimensional reduction of the alveolar ridge.

<u>Alveolar ridge height</u>

In the present sample, the height of the alveolar process was reduced to about 9 mm. Indeed, the vast majority of the sites (65%) exhibited an alveolar ridge high > 8 mm while only 20% were < 8 mm high. These findings are in agreement with previous clinical studies that evaluated the height changes following tooth extraction (Iasella et al. 2003, Barone et al. 2008, and Crespi et al. 2009). Iasella et al. 2003 studied 24 individuals who were scheduled for extraction of non-molar teeth. Following 6 months of healing, the authors observed that about 0.9 mm of height loss had occurred. In another clinical study, Barone et al. 2008 examined 40 patients that had their teeth extracted. Seven months later, several measurements were performed and it was shown that a mean loss of 3.6 mm of the alveolar ridge height had taken place. A similar amount of height loss (3.75 mm) was also observed in a clinical study by Crespi et al. 2009. Thus, the present study confirmed that the extraction of single tooth would promote height loss of the alveolar ridge.

<u>Socket wall width</u>

The width of the socket walls varied between from 0.4 to 0.9 mm at the buccal aspects while from 0.7 to 3.6 mm at the palatal aspect of the maxilla. In addition, socket walls < 1mm wide at the buccal aspect was identified in 85% of the Tooth sites. These findings are similar to data from previous studies that used CBCT scans to perform the radiographic measurements (Braut et al. 2011, Januário et al. 2011, Chappuis et al. 2013). Braut et al. (2011) evaluated in a sample of 90 individuals the buccal bone width at 4 mm below the CEJ and at the middle of the root. They reported that mean buccal bone width was 0.8 mm and that 90% of the individuals exhibited a buccal wall < 1 mm wide. Similarly, Januário et al. 2011 evaluated the socket walls width of 250 individuals at different levels. The results demonstrated that the socket wall at the buccal aspect was about 0.6 mm wide and < 1 mm wide in the 85% of the sample. Thus, the buccal bone at the anterior region of the maxilla is relatively thin and the occurrence of widths superior to 1mm are not frequent.

In subjects that exhibited at 3 mm below the CEJ in the Tooth site buccal bone width < 1 mm, a mean percentage cross-section area reduction of 40% had occurred in the Edentulous site. This reduction was significantly larger than in subjects with corresponding ≥ 1mm wide buccal bone wall. The height of the alveolar ridge was also found to be significantly shorter at subjects with < 1 mm wide buccal bone wall. This data in part is supported by data from the previous studies (Tomasi et al. 2010, Chappuis at al. 2013). Chappuis at al. 2013 evaluated 39 anterior sites with CBCT scans before the extraction and after 8 months of healing. It was reported that the mean buccal bone width was 0.8 mm and that in 69% of the sample such width was ≤ 1mm. Furthermore, they also showed that sites with buccal bone width < 1 mm exhibited significantly more vertical bone loss of the buccal bone wall. Thus, the data from the present study confirmed the concept that buccal bone wall < 1 mm wide are risk factor for post-extraction bone loss.

Alveolar ridge width

In the present study, the mean alveolar process width at 3, 5 and 7 mm apical of the CEJ was, respectively, 8.4, 8.7, and 8.8 mm. At the healed alveolar sites, the corresponding values were 3.3, 4.6, and 5.2 mm. The overall width reduction that had occurred was from about 5 to 4 mm and it was more evident at the most coronal part of the alveolar ridge, about 5 mm (60%). The mean alveolar ridge width reduction observed in studies of 6 months of healing was, however, less than observed in the present sample and ranged from 2.5 to 4.6 mm (Lecovik et al. 1997, Lecovik et al. 1998, Iasella et al. 2003, Pelegrine et al. 2000). In a study that evaluated the alveolar ridge width after only 3 months (Kerr et al. 2008), it was reported that at the crestal level the mean reduction was about only 2 mm. Thus, the above findings indicate that most of the dimensional alterations at the alveolar ridge occurred during the first 6 months of healing. Moreover, the above-mentioned data also demonstrated that a lack of adequate bone width at the middle and coronal portion of the alveolar ridge will frequently occur and that bone augmentation procedures maybe necessary.

FIGURE LEGENDS

1) Tooth site measurements. Alveolar process cross area (a), root area (b), alveolar process height (c), alveolar process width (d), tooth inclination (e).

2) Edentulous site measurements. Alveolar ridge area (a), alveolar ridge height (b).

3) Axial reconstruction on Tooth and Edentulous sites. Alveolar process width (a), alveolar ridge width (b).

TABLE LEGENDS

1) Mean and standard deviation (sd) of measurements performed in parasagittal reconstructions in the Tooth site.

2) Mean and standard deviation ± sd of alveolar process width (mm) at different levels from the CEJ performed in axial reconstructions in the Tooth site.

3) Mean and standard deviation of measurements performed in parasagittal reconstructions in the Edentulous site.

4) Frequency distribution of patients according to the cross-section area (mm2) of the alveolar ridge in the Edentulous sites.

5) Frequency distribution of patients according to various categories of cross-section area reduction.

6) Frequency distribution of patients according to various categories of alveolar ridge height (mm).

7) Mean and standard deviation of measurements in axial reconstruction in the Edentulous site.

8) Frequency distribution of patients according to the various categories of alveolar ridge width at different levels from CEJ.

9) Difference between the groups Thin buccal bone and Thick buccal bone.

REFERENCES

Araújo MG, Lindhe J (2005). Dimensional ridge alterations following tooth extraction. An experimental study in the dog. J Clin Periodontol 32: 212-8.

Araujo MG, Lindhe J (2009). Ridge alterations following tooth extraction with and without flap elevation. An experimental study in the dog. Clin. Oral Impl. Res. 20: 545–549.

Araújo MG, Sukekava F, Wennström JL, Lindhe J (2005). Ridge alterations following implant placement in fresh extraction sockets: an experimental study in the dog. J Clin Periodontol 32: 645-52.

Araújo MG, Linder E, Wennström JL, Lindhe J (2008). The influence of bio-oss collagen on healing of an extraction socket: an experimental study in the dog. Int J Periodontics Restorative Dent 28:123–135.

Barone A, Aldini NN, Fini M, Giardino R, Guirado JLC, Covani U (2008). Xenograft versus extraction alone for ridge preservation after tooth removal: a clinical and histomorphometric study. J Periodontol 79:1370-1377.

Bartee BK (2001). Extraction site reconstruction for alveolar ridge preservation. Part 1: rationale and materials selection. J Oral Impl 27: 187-193.

Blanco J, Mareque S, Liñares A, Muñoz F (2011). Vertical and horizontal ridge alterations after tooth extraction in the dog: flap vs. flapless surgery. Clin. Oral Impl Res 22: 1255–1258.

Botticelli, D, Berglundh, T, Lindhe, J (2004). Hard tissue alterations following immediate implant placement in extraction sites. J Clin Periodontol 31: 820-8.

Braut V, Bornstein MM, Belser U, Buser D (2011). Thickness of the anterior maxillary facial bone wall — a retrospective radiographic study using cone beam computed tomography. Int J Periodontics Restorative Dent 31:125-131.

Canger EM, Çelenk PC (2012). Radiographic evaluation of alveolar ridge heights of dentate and edentulous patients. Gerodontology 29: 17–23.

Cardaropoli G, Araujo M, Lindhe J (2003). Dynamics of bone tissue formation in tooth extraction sites. An experimental study in dogs. J Clin Periodontol 30: 809–818.

Chappuis V, Engel O, Reyes M, Shahim K, Nolte LP, Buser D (2013). Ridge alterations post-extraction in the esthetic zone: a 3d analysis with CBCT. J Dent Res 92: 195S.

Covani U, Cornelini R, Barone A (2011). Bucco-lingual bone remodeling around implants placed into immediate extraction sockets: a case series. J Periodontol 74:268-273.

Covani U, Ricci M, Bozzolo G, Mangano F, Zini A, Barone A (2011). Analysis of the pattern of the alveolar ridge remodelling following single tooth extraction. Clin. Oral Impl. Res. 22: 820–825.

Crespi R, Capparé P, Gherlone E (2009). Magnesium-enriched hydroxyapatite compared to calcium sulfate in the healing of human extraction sockets: radiographic evaluation at 3 and months histomorphometric. J Periodontol 80:210-218.

Iasella JM, Greenwell H, Miller RL, Hill M, Drisko C, Bohra AA, Scheetz JP (2003). Ridge preservation with freeze-dried bone allograft and a collagen membrane compared to extraction alone for implant site development: a clinical and hidtologic study in humans. J Periodontol 74: 990-9.

Januário AL, Duarte WR, Barriviera M, Mesti JC, Araújo MG, Lindhe J (2011). Dimension of the facial bone wall in the anterior maxilla: a cone-beam computed tomography study. Clin Oral Impl Res 22: 1168–1171.

Kerr EN, Mealey BL, Noujeim ME, Lasho DJ, Nummikoski PV, Mellonig JT (2008). The effect of ultrasound on bone dimensional changes following extraction: a pilot study. J Periodontol 79:283-290.

Lecovik V, Kenney EB, Weinlaender M, Han T, Klokkevold P Nedic M, Orsini CM (1997). A bone regenerative approach to alveolar ridge maintenance following tooth extraction. Report of 10 cases. J Periodontol 68: 563-570.

Lecovik V, Camargo PM, Klokkevold PR, Weinlaender M, Kenney EB, Dimitrijevic B, Nedic M (1998). Preservation of alveolar bone in extraction sockets using bioabsorbable membranes. J Periodontol 69: 1044-1049.

Moya-Villaescusa JM, Sánchez-Pérez A (2010). Measurement of ridge alterations following tooth removal: a radiographic study in humans. Clin Oral Impl Res 21: 237–242.

Pelegrine AA, da Costa CES, Correa MEP, Marques JFC Jr (2000). Clinical and histomorphometric evaluation of extraction sockets treated with an autologous bone marrow graft. Clin Oral Impl Res 21: 535–542.

Pietrokovsky J, Massler M (1967) Alveolar ridge resorption following tooth extraction. J Prosthet Dent 17: 21-7.

Pinho MN (2006) Titanium membranes in prevention of alveolar colapse after tooth extraction. Implant Dent 15: 53-61.

Saglam AA (2002). The vertical heights of maxillary and mandibular bones in panoramic radiographs of dentate and edentulous subjects. Quintessence Int 33: 433-438.

Schroeder HE (1986). The periodontium. In: Oksche A, Vollrath L. Handbook of microscopic anatomy, vol. V-5: 129-164. Berlin: Springer.

Schropp L, Wenzel A, Kostopoulos L, Karring T (2003) Bone healing and soft tissue contour changes following single-tooth extraction: a clinical and radiographic 12-month prospective study. Int J Periodontics Restorative Dent 23: 313-23.

Tan WL, Wong TLT, Wong MCM, Lang NP (2012). A systematic review of post-extraction alveolar hard and soft tissue dimensional changes in humans. Clin Oral Impl Res 23(Suppl 5): 1-21.

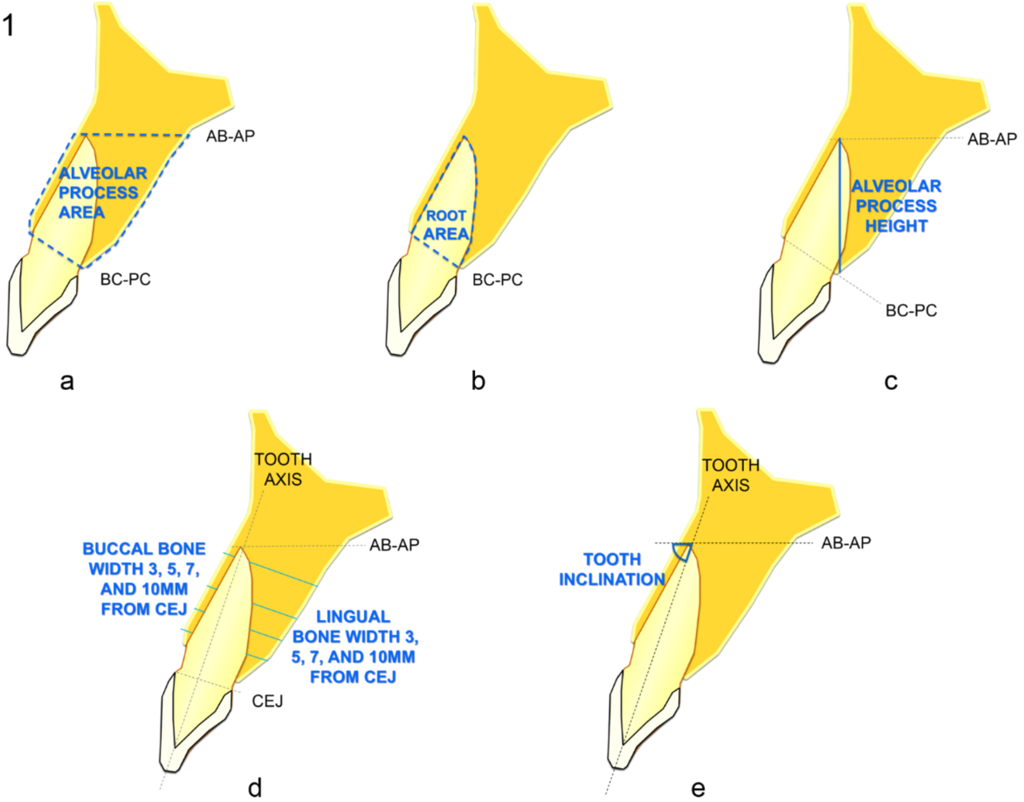
Tomasi C, Sanz M, Cecchinato D, Pjetursson B, Ferrus J, Lang NP, Lindhe J (2010). Bone dimensional variations at implants placed in fresh extraction sockets: a multilevel multivariate analysis. Clin Oral Impl Res 21: 30–36.

Trombelli L, Farina R, Marzola A, Bozzi L, Liljenberg B, Lindhe J (2008). Modeling and remodeling of human extraction sockets. J Clin Periodontol 35: 630–639.

Van der Weijden F, Dell'Acqua F, Slot DE (2009). Alveolar bone dimensional changes of post-extraction sockets in humans: a systematic review. J Clin Periodontol 36: 1048-58.

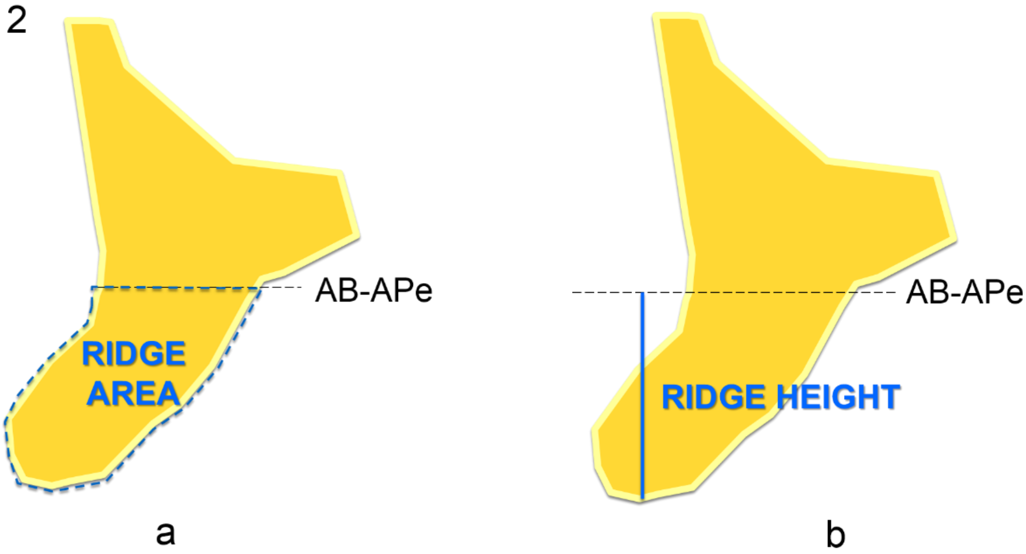
FIGURES

Fig. 1



1) Tooth site measurements. Alveolar process cross area (a), root area (b), alveolar process height (c), alveolar process width (d), tooth inclination (e).

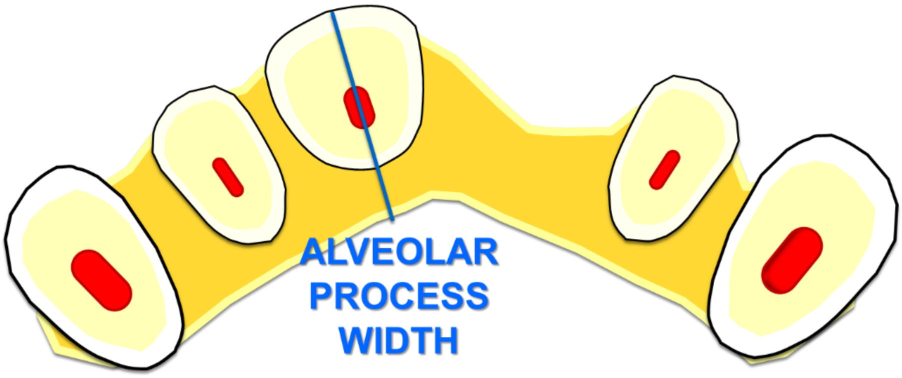
Fig. 2



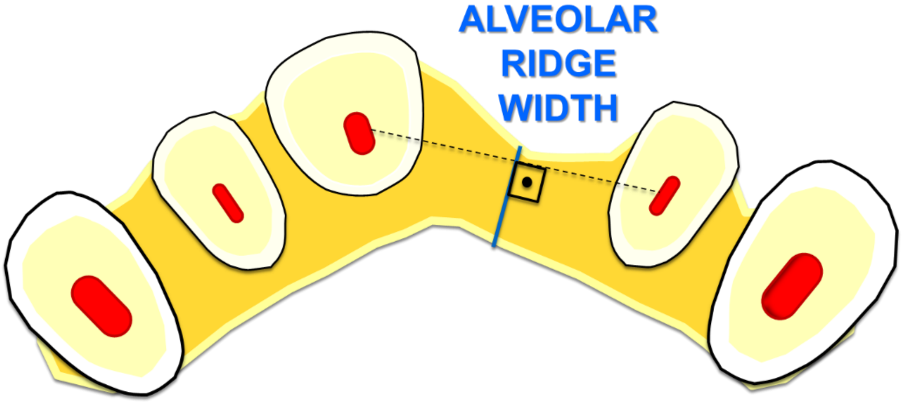
2) Edentulous site measurements. Alveolar ridge area (a), alveolar ridge height (b).

Fig. 3

a



b



3) Axial reconstruction on Tooth and Edentulous sites. Alveolar process width (a), alveolar ridge width (b).

TABLES

Table 01. Mean and standard deviation (sd) of measurements performed in parasagittal reconstructions in the Tooth site.

Measurement	Mean ± sd
Alveolar process area	94.7 ± 29.9
Alveolar process height	11.5 ± 2.3
Alveolar process width	8.6 ± 1.7
Buccal bone width 3	0.4 ± 0.5
Lingual bone width 3	0.7 ± 0.7
Buccal bone width 5	0.7 ± 0.4
Lingual bone width 5	1.6 ± 1.0
Buccal bone width 7	0.9 ± 0.6
Lingual bone width 7	2.3 ± 1.2
Buccal bone width 10	0.7 ± 0.4
Lingual bone width 10	3.6 ± 1.9

Table 02. Mean and standard deviation ± sd of alveolar process width (mm) at different levels from the CEJ performed in axial reconstructions in the Tooth site.

Level (mm)	Mean ± sd
3	8.4 ± 1.7
5	8.7 ± 1.8
7	8.8 ± 1.8

Table 03. Mean and standard deviation of measurements performed in parasagittal reconstructions in the Edentulous site.

Measurement	Mean ± sd
Edentulous ridge area (mm^2)	62.0 ± 28.0
Edentulous ridge height (mm)	9.4 ± 2.8

Table 04. Frequency distribution of patients according to the cross-section area (mm^2) of the alveolar ridge in the Edentulous sites.

Alveolar ridge cross-section area (mm^2)	Number of patients(%)
<40	10 (22%)
≥40 <60	14 (31%)
≥60 <80	11 (24%)
≥80 <100	5 (11%)
≥100	6 (12%)

Table 05. Frequency distribution of patients according to various categories of cross-section area reduction.

% cross-section area reduction	Number of patients (%)
<10%	2 (4%)
≥10% <20%	11 (25%)
≥20% <30%	6 (14%)
≥30% <40%	9 (20%)
≥40% <50%	7 (16%)
≥50% <60%	5 (11%)
≥60% <70%	2 (4%)
≥70% <80%	2 (4%)
≥80% <90%	0
≥100%	1 (2%)

Table 06. Frequency distribution of patients according to various categories of alveolar ridge height (mm).

Alveolar ridge height (mm)	Number of patients(%)
<6	5 (11%)
≥6 <8	9 (20%)
≥8 <10	16 (35%)
≥10 <12	9 (20%)
≥12 <14	5 (11%)
≥14	2 (4%)

Table 07. Mean and standard deviation of measurements in axial reconstruction in the Edentulous site.

Measurement	Mean ± sd
Alveolar ridge width 3mm from CEJ	3.3 ± 2.6
Alveolar ridge width 5mm from CEJ	4.6 ± 2.7
Alveolar ridge width 7mm from CEJ	5.2 ± 2.7

Table 08. Frequency distribution of patients according to the various categories of alveolar ridge width at different levels from CEJ.

Levels (mm)	Category (mm)	Number of patients(%)
3	<4	28 (60%)
	≥4 <7	15 (33%)
	≥7	3 (7%)
5	<4	19 (41%)
	≥4 <7	18 (39%)
	≥7	9 (20%)
7	<4	12 (19%)
	≥4 <7	20 (49%)
	≥7	9 (22%)

Table 09. Difference between the groups Thin buccal bone and Thick buccal bone.

Variable	Thin Group Mean ± sd	Thick Group Mean ± sd	Difference	p
% Alveolar cross-section area reduction	39%	24%	15%	0.04
Alveolar ridge height	9.3 ± 2.5	11.3 ± 2.7	2.0 (18%)	0.03

Wilcoxon rank-sum test ($p<0.05$)

ANEXOS

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UNIVERSIDADE ESTADUAL DE MARINGÁ

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Avaliação clínica da modelação óssea após extração dentária
Pesquisador: Mauricio Guimarães Araújo
Área Temática:
Versão: 1
CAAE: 05372213.5.0000.0104
Instituição Proponente: Universidade Estadual de Maringá
Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 267.652
Data da Relatoria: 06/05/2013

Apresentação do Projeto:
A reabsorção óssea após extração muitas vezes gera problemas estéticos em restaurações implanto-suportadas ou de próteses convencionais, e dificultam o posicionamento ideal do implante. Apesar disso, informações sobre a perda óssea real pós-extração ainda são escassas. O objetivo deste estudo retrospectivo é analisar radiograficamente as mudanças morfológicas que ocorrem após a extração dentária nas paredes vestibular e lingual ou palatina na maxila e mandíbula.

Objetivo da Pesquisa:
Objetivo Primário: O objetivo deste estudo é analisar as mudanças morfológicas a nível ósseo que ocorrem após a extração dentária, isto é, os padrões de reabsorção óssea e formação de rebordos residuais edêntulos que seguem a extração dentária na maxila e mandíbula.

Objetivo Secundário: Contribuir para a evolução estética e funcional do melhor posicionamento de implantes e próteses implanto-suportadas.

Avaliação dos Riscos e Benefícios:
Riscos: Não são previstos riscos ou desconfortos inaceitáveis à participação no estudo, pois serão utilizadas tomografias já realizadas com indicação odontológica, sendo que os pacientes não serão submetidos a intervenções. O investigador garante o sigilo e o anonimato dos sujeitos da

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Continuação do Parecer: 267.652

pesquisa.

Benefícios: Todas as tomografias computadorizadas que serão analisadas foram realizadas com o propósito de utilizar a imaginologia como ferramenta auxiliar no diagnóstico e no plano de tratamento, sendo indicadas pelo próprio dentista de cada paciente.

Comentários e Considerações sobre a Pesquisa:

Serão selecionadas tomografias computadorizadas de prontuários de pacientes, avaliadas em cortes parassagitais realizados no centro do elemento dentário e do rebordo edêntulo, assim como em cortes axiais, comparando-se o rebordo edêntulo com a morfologia óssea do rebordo dentado correspondente. Serão obtidas diversas medidas dimensionais dos rebordos e, subsequentemente, realizados testes estatísticos. Serão analisadas 100 tomografias computadorizadas de prontuários de pacientes com idade mínima de 18 anos. O início da coleta de dados está previsto para: 01/05/2013. Todos os recursos serão providos pelos próprios pesquisadores no valor de R$ 18.742,50.

Considerações sobre os Termos de apresentação obrigatória:

A Folha de rosto e o formulário do projeto foram devidamente apresentados. Os dados são de dois locais específicos, o IEPI - Instituto de Endodontia Periodontia e Implantodontia, representada pelo Centro Odontológico Alessandro Januário, de Brasília, DF, com autorização assinada em papel timbrado, com CNPJ no próprio texto, entretanto sem CRM, e a Odonto Bio Imagem: Centro de Diagnóstico por Imagem em Odontologia, de Salvador, BA, representada por João Carlos Costa da Silva, com autorização apresentada em papel não timbrado, com CNPJ no próprio texto, assinado sem CRM nítido. O proponente solicita dispensa do TCLE, justificando se tratar de um estudo retrógrado, onde serão analisados apenas exames que já foram realizados, indicados por outros dentistas por motivos de tratamento odontológico, não sendo necessária a identificação do paciente.

Recomendações:

Conclusões ou Pendências e Lista de Inadequações:

O Comitê de Ética em Pesquisa Envolvendo Seres Humanos da Universidade Estadual de Maringá é de parecer pela aprovação do protocolo de pesquisa.

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Aprovado

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Necessita Apreciação da CONEP:

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Considerações Finais a critério do CEP:

Face o exposto e considerando a apreciação do protocolo à luz da normativa ética vigente, este comitê de ética em pesquisa se manifesta pela dispensa do TCLE e pela aprovação do protocolo em tela.

MARINGA, 09 de Maio de 2013

Assinador por:
Ricardo Cesar Gardiolo
(Coordenador)

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