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Luciene Dornas Mendes

INFLUÊNCIA DO PESO DOS BIOMATERIAIS UTILIZADOS PARA ELEVAÇÃO DO SEIO MAXILAR NA ALTERAÇÃO VOLUMÉTRICA DOS ENXERTOS

Belo Horizonte
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Dissertação apresentada ao Programa de Pós-graduação em Odontologia da Pontifícia Universidade Católica de Minas Gerais, como requisito parcial para obtenção do título de Mestre em Odontologia, Área de Concentração em Clínicas Odontológicas, Área Temática: Periodontia.

Linha de Pesquisa: Propriedades físicas, químicas e biológicas dos materiais odontológicos.

Orientador: Prof. Dr. Elton Gonçalves Zenóbio

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Aos meus filhos,

Marcela, Henrique e Arthur

e ao meu marido Marcelo

Família! Que orgulho!

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“TotusTuus Mariae”

RESUMO

Este estudo observacional retrospectivo estabeleceu uma correlação entre a quantidade (em peso-grama) utilizada dos biomateriais: xenógenos Bio-Oss® Small e Large (Geistlich, Wolhusen, Switzerland); Endobon® (RegenerOsst, BIOMET3i. Palm Beach Gardens, FL, EUA); e aloplásticos OsteoGen® (Intra-lock®System); Cerasorb® (M Dental Curasan, Frankfurt/Main, Alemanha); Straumann® BoneCeramic® and Emdogain®), com o volume do enxerto obtido inicial, V1(15 dias) e o volume final V2 (180 dias); após a elevação do seio maxilar, por meio das imagens tomográficas computadorizadas de feixe cônico (TCCB). Uma amostra de 68 pacientes, com 74 levantamentos de seios maxilares, distribuídos em: 18 Bio-Oss® Small, 10 Bio-Oss® Large, 08 Osteogen®, 10 BoneCeramic® + Emdogaim®, 11 Cerasorb®, 17 Endobon®. Foram avaliadas 148 imagens TCCB, por meio do software Osirix® MD Imaging 6.5 (Pixmeo Genebra Suíça), obtidas nos dois períodos. A quantidade dos biomaterias foi categorizada em intervalos de grupos de acordo com a quantidade utilizada. O teste não paramétrico de Kruskal-Wallis avaliou as contrações entre os biomateriais, a influência do peso em gramas do biomaterial com o volume inicial V1 e a contração final dos enxertos V2. A quantidade média utilizada em gramas dos biomateriais, foi de Bio-Oss® Small (1,58g); Bio-Oss® Large (1,35g); Endobon® (0,72g); BoneCeramic® + Emdogaim® (0,96g); Cerasorb® (1,13g) e Osteogen® (2,70g). Observou-se que o valor médio do volume obtido em T1, para o Bio-Oss Small® foi de 2,036cm³; Bio-Oss® Large® de 1,821cm³; Endobon® de 1,599cm³; BoneCeramic® + Emdogaim® de 1,735cm³; Cerasorb® de 1,705cm³ e Osteogen® de 2,204cm³. Em relação à influência da quantidade do biomaterial utilizado, com o volume inicial (V1) não se observou diferença estatística significante. Para a contração média, aos 180 dias (V2)observou-se: (-0,271cm³); (-0,227cm³); (-0,138cm³); (-0,391cm³); (-0,715cm³) e (-0,409cm³), respectivamente, sem diferença estatística significante (p>5%). Observou-se uma diferença estatisticamente significativa somente para os grupos (Cerasorb® G_8x Bio-Oss® Small G_2 - 25,35%); (Cerasorb® G_8 x Endobon® G_5 - 21,13%) (Cerasorb® G_8 x Endobon® G_6 - 33,80%); (Cerasorb® G_8 x Bio-Oss® Large G_3- 28,17%) correlacionando-se a quantidade inicial utilizada com a contração média em V2. Concluiu-se que a quantidade média de material utilizada não está diretamente relacionada ao volume obtido inicial e contração final aos 180 dias. Quando categorizados, o biomaterial Cerasorb® comparado aos biomateriais investigados foi o que apresentou uma maior contração.

Palavras-chave: Elevação do seio maxilar. Tomografia computadorizada de feixe cônico. Biomaterial.

ABSTRACT

This retrospective observational study established a correlation between the amount (in weight-gram) used of biomaterials: xenogenous small and large Bio-Oss® (Geistlich, Wolhusen, Switzerland); Endobon® (RegenerOsst, BIOMET3i. Palm Beach Gardens, FL, EUA); and alloplastic OsteoGen® (Intra-lock®System); Cerasorb® (M Dental Curasan, Frankfurt/Main, Germany); Straumann® BoneCeramic® and Emdogain®), with the initial obtained bone graft volume, T1(15 days) and the final volume V2 (180 days); after the maxillary sinus lift, by means of Cone Beam Computed Tomography (CBCT).A sample composed by 68 patients, and 74 maxillary sinus lift allocated in: 18 small Bio-Oss®, 10 large Bio-Oss®, 08 Osteogen®, 10 BoneCeramic® + Emdogaim®, 11 Cerasorb®, 17 Endobon®. By means of a software Osirix® MD Imaging 6.5 (Pixmeo Geneva Switzerland), 148 Cone Beam Computed Tomography (CBCT) images were assessed, obtained in both periods. The amount of biomaterial was categorized in group intervals according to the amount used. The Kruskal-Wallis test which is a non-parametric alternative has assessed the contractions among the biomaterials, the influence of the weight in grams of the biomaterial with the V1 initial volume and the V2bone graft final contractions. The average amount of the biomaterials used in grams, Small Bio-Oss® (1,58g); Large Bio-Oss® (1,35g); Endobon® (0,72g); BoneCeramic® + Emdogaim® (0,96g); Cerasorb® (1,13g) and Osteogen® (2,70g). It has been established that the volume average value obtained in T_1 for Small Bio-Oss® was 2,036cm³; Large Bio-Oss® 1,821cm³; Endobon® 1,599cm³; BoneCeramic® + Emdogaim® 1,735cm³; Cerasorb® 1,705cm³ and Osteogen® 2,204cm³. Concerning to the influence of the amount of biomaterial used, with the initial volume, it has been established no difference statistically significant. For the average contraction to the 180 days, it was noticed that: (-0,271cm³); (-0,227cm³); (-0,138cm³); (-0,391cm³); (-0,715cm³) e (-0,409cm³), respectively, and no difference statistically significant (p>5%). A difference statistically significant was noticed only for the groups (Cerasorb® G_8x Small Bio-Oss® G_2 - 25,35%); (Cerasorb® G_8 x Endobon® G_5 - 21,13%) (Cerasorb® G_8 x Endobon® G_6 - 33,80%); (Cerasorb® G_8 x Large Bio-Oss® G_3- 28,17%) when correlated to the initial amount used with the average contraction in T2. It was concluded that the average amount of material used is not directly related to the initial volume obtained and the final contraction at 180 days. When categorized, the biomaterial Cerasorb® compared to the investigated biomaterials, was the one that presented a greater contraction.

Keywords: Maxillary sinus lift. Cone beam computed tomography. Biomaterial.

SUMÁRIO

1 INTRODUÇÃO

O levantamento do seio maxilar com acesso lateral tem sido estudado amplamente e demonstrado que a técnica é confiável e altamente previsível (MISCH, 2000; YILDIRIM et al., 2001). Esta técnica fornece quantidade e qualidade ósseas suficientes para a instalação segura e previsível de implantes, com excelente prognóstico (WOOD; MOORE, 1988; SUMMERS, 1994; BORNSTEIN et al., 2008; CHIAPASCO; CASENTINI; ZANIBONI, 2009; STERN; GREEN, 2012). Para prover adequado volume ósseo e estabilizar os implantes dentais na maxila edêntula, técnicas de enxerto e materiais têm sido descritos (LANDI et al., 2000; ZIDE, 2000; BORNSTEIN et al., 2008; FERMERGARD; ASTRAND, 2012).

A neoformação óssea é obtida nos enxertos de elevação de seio maxilar com utilização de diferentes tipos de materiais sendo o enxerto de osso autógeno considerado, por alguns autores, o padrão ouro (LYFORD et al., 2003; FELLAH et al.; 2008; GOMES et al., 2008; BARONE et al., 2009; BIAGINI et al., 2009; CONTAR et al., 2009). Entretanto utilizar osso autógeno implica em submeter o paciente a duas ou mais áreas cirúrgicas e exposição a complicações decorrentes dessas cirurgias. Além disso, os enxertos de osso autógeno possuem alto nível de reabsorção (FELLAH et al., 2008).

Na tentativa de se encontrar um material que possa substituir o osso autógeno, várias alternativas de enxertos têm sido utilizadas. Enxertos xenógenos, alógenos ou aloplásticos (BROWAEYS; BOUVRY; DE BRUYN, 2007; PJETURSSON et al., 2008) têm sido empregados nos procedimentos de reconstrução do rebordo maxilar, tanto em altura quanto em espessura. Xenoenxertos, aloenxertos, hidroxiapatitas, vidros bioativos e proteínas morfogenéticas têm sido utilizados nos procedimentos de levantamento de seio maxilar (BOYNE; JAMES, 1980; SUMMERS, 1994; MISCH 2000; BROWAEYS; BOUVRY; DE BRUYN, 2007; PJETURSSON et al., 2008; CHIAPASCO; CASENTINI; ZANIBONI, 2009). O uso destes materiais demonstrou vantagens em relação ao osso autógeno como: facilidade de obtenção, quantidade de material ilimitada, redução tempo cirúrgico, menor mobilidade, ausência de manipulação da área doadora e suas possíveis complicações (ABUKAWA et al., 2006; STEVENS et al., 2008; BHUMIRATANA; VUNJAK NOVAKOVIC, 2012).

Os materiais à base de fosfato de cálcio são biocompatíveis, osteocondutivos, possuem propriedades bioativas e apresentam constituição química inorgânica semelhante a do osso natural (FELLAH et al., 2008). Estudos relatam resultados em relação à estabilidade volumétrica de diferentes materiais utilizados nas cirurgias de elevação do seio maxilar e maior osseointegração na colocação de implantes (WANSCHITZ et al., 2006; KIRMEIER et al., 2008; KLIJN et al., 2012; ARASAWA et al., 2012; KIM et al., 2013; SBORDONE et al., 2013; UMANJEC-KORAC et al., 2014; COSSO et al., 2014).

A tomografia computadorizada é fundamental para o planejamento e realização de implantes e procedimentos de enxertos. É um método imaginológico que permite a reprodução de uma secção do corpo facilitando diagnóstico, planejamento e acompanhamento de tratamentos realizados (RODRIGUES; VITRAL, 2007).

Estudos realizados mostraram a confiabilidade e precisão das tomografias computadorizadas em calcular o volume dos enxertos ósseos realizados na maxila, podendo este método ser recomendado para estudos longitudinais de enxertos ósseos para a região maxilo-facial (JOHANSSON et al., 2001; SMOLKA et al., 2006; WANSCHITZ et al., 2006; KIRMEIER et al., 2008; ARASAWA et al., 2012; KIM et al., 2013; SBORDONE et al., 2013; COSSO et al., 2014; UMANJEC-KORAC et al., 2014; FAVATO et al., 2015).

No entanto, informações científicas de estudos até o presente momento, relacionando influência da quantidade de diferentes materiais utilizados como enxerto na elevação do seio maxilar no volume final do enxerto obtido não foi identificado na literatura.

Diante das diversas alternativas referentes à escolha dos materiais de enxerto para elevação do seio maxilar, esse estudo avaliou por meio de imagens tomográficas computadorizadas de feixe cônico, a influência da quantidade de biomaterial utilizada no enxerto, no volume inicial e final obtido com os diferentes biomateriais xenógenos e aloplásticos escolhidos para este estudo.

2 OBJETIVOS

2.1 Objetivo geral

Avaliar por meio de imagens tomográficas computadorizadas de feixe cônico, a influência do peso do biomaterial utilizado nos enxertos para elevação do seio maxilar e a variação volumétrica inicial e final do enxerto obtido.

2.2 Objetivos específicos

a) estabelecer uma correlação entre a quantidade (em peso-gramas) de diferentes biomateriais utilizados nos enxertos para elevação do seio maxilar com o volume inicial obtido em V1 (15 dias após a cirurgia), por meio das imagens tomografia s computadorizadas;
b) estabelecer uma correlação entre a quantidade(em peso-gramas) de diferentes biomateriais utilizados nos enxertos para elevação do seio maxilar com o volume final obtido em V2 (180 dias após a cirurgia), por meio das imagens tomográficas computadorizadas;
c) estabelecer uma comparação entre os diferentes biomateriais utilizados nos enxertos para elevação do seio maxilar quanto à contração.

3 ARTIGO

Influence of weight of different biomaterials used for maxillary sinus lift in the graft volumetric change

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INFLUENCE OF WEIGHT OF DIFFERENT BIOMATERIALS USED FOR MAXILLARY SINUS LIFT IN THE GRAFT VOLUMETRIC CHANGE

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Keywords: Maxillary Sinus Lift. Cone Beam Computed Tomography. Biomaterial.

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Abstract

Objective: This retrospective observational study has correlated the amount (in weight-grams) of xenogenic biomaterials used: Bio-Oss® small and large; Endobon®; And alloplastics: OsteoGen®; Cerasorb®; BoneCeramic® + Emdogain®, with the initial graft volume obtained, V1 (15 days) and the final volume V2 (180 days) after the maxillary sinus elevation, by means of cone beam computed tomographic images (CBTB).

Material and Methods: Seventy four maxillary sinuses were evaluated from sixty-eight patients, distributed into grafts with: Bio-Oss® small = 18, Bio-Oss® Large = 10, Osteogen® = 08, BoneCeramic® + Emdogaim® = 10, Cerasorb® = 11, Endobon® = 17; 148 CBTC images, by means of Osirix® MD Imaging 6.5 software (Pixmeo Geneva, Switzerland), obtained in both periods. The amounts of biomaterials were categorized into group intervals according to the amount used. The non-parametric Kruskal-Wallis test has evaluated the contractions among the biomaterials, the influence of weight in grams of the biomaterial with the initial volume V1 and the final contraction of V2 grafts.

Result: The average amounts of biomaterials used, Bio-Oss® Small (1,58g); Bio-Oss® Large (1.35g); Endobon® (0.72g); BoneCeramic® + Emdogaim® (0.96g); Cerasorb® (1.13g) and Osteogen® (2.70g). It was found that the average volume obtained in V1, was 2,036cm³-Bio-Oss Small®; 1,821cm³ - Bio-Oss® Large®; 1,599cm³ - Endobon®; 1,735cm³ - BoneCeramic® + Emdogaim®; 1,705cm³-Cerasorb® and 2,204cm³ - Osteogen®, and no significant difference concerning to the influence of the amount of biomaterial used. At 180 days, an average contraction of: (-0.271cm³); (-0.222cm³); (-0.138cm³); (-0.391cm³); (-0.715cm³) and (-0.409cm³), was found, respectively, and also without significant statistical difference. A difference, statistically significant has occurred for the groups (Cerasorb® G_8 x Bio-Oss® Small G_2 = 25.35%); (Cerasorb® G_8 x Endobon® G_5 - 21.13%;) (Cerasorb® G_8 x Endobon® G_6- 33.80%); (Cerasorb® G_8 x Bio-Oss® Large G_3 - 28.17%) when the initial amount used with the mean contraction in V2, p <0.001 were correlated.

Conclusion: The biomaterials amount used did not present significant statistical difference concerning to the graft volume obtained in V1. However, at 180 days, 4 categorized groups had a mean percentage difference of contraction which was statistically significant concerning to the final volume obtained from the graft. All grafts contracted significantly at 180 days, but they did not prevent the implant installation.

Keywords: Maxillary sinus lift. Cone beam computed tomography. Biomaterial.

Introduction

Several biomaterials, having great osseoconductive capacity, were evaluated in maxillary sinus lift procedures, aiming at achieving the results obtained with the autogenous grafts when installed in the maxillary sinus (Moy et al. 1993; Barone et al. 2009). Thus, the xenogenic hydroxyapatite, as well as the alloplastic biomaterials, are presented as a viable alternative for maxillary sinus floor lift (Skoglund et al. 1997; Schlegel et al. 1998; Hallman et al. 2002; Zijderveld et al. 2005; Browaeyes et al. 2007; Pjetursson et al. 2008; Manso et al. 2010; Chackartchi et al. 2011; Rokn et al. 2011; Kuhl et al. 2013; Ramirez-Fernandez et al. 2013).

Regardless the kind of material used for grafting, it is clear that, over time, it undergoes dimensional changes that may influence the final bone volume grafted, even altering the stability of the installed implants (Hurzeler et al. 1997; Haas et al. 1998; Browaeys et al. 2007). The bone tissue replacement is still an unsolved problem, and further research on the several materials used is required (Ramirez-Fernandez et al. 2011).

The use of computed tomography (CT) to analyze the bone volume achieved after surgical procedures of maxillary sinus lift has been mentioned in the literature as an accurate method, which produces reliable images with little distortion (Nystrom et al. 1995; Peleg et al. 1999; Johansson et al. 2001; Smolka et al. 2006; Sbordone et al. 2013; Cosso et al. 2014; Favato et al. 2015; Gultekin et al. 2016; Jelusic et al. 2016).

In this context, there are studies that present the use of xenogenic hydroxyapatites evaluating the contraction of biomaterials and bone formation (Chackartchi et al. 2011; Ramírez-Fernández et al. 2011; Testori et al. 2012; Testori et al. 2013; Cosso et al. 2014; Stiller et al. 2014; Berberi et al. 2015; Favato et al.

2015; Gorla et al. 2015; Xavier et al. 2015; Gultekin et al. 2016; Jelusic et al. 2016). However, scientific information from studies so far, concerning to the influence of the amount of material used as graft on maxillary sinus lift in the initial and final volume of the graft obtained have still not been identified in the literature.

Face to several alternatives regarding the choice of graft materials for maxillary sinus lift, this study intends to evaluate, by means of Cone Beam tomography, the influence of the amount of biomaterial used in the graft, in the initial and final volume obtained with 3 xenogenic hydroxyapatites (Bio-Oss® Small; Bio-Oss® Large e Endobon®) and 3 synthetic hydroxyapatites (BoneCeramic®; Cerasorb® e Osteogen®),as well as to perform a comparative analysis of the volumetric changes of grafts carried out with these biomaterials.

Materials and Methods

The study was approved by the Ethics Committee, number CAAE 02663212.9.0000.5137.

The documentation from 68 maxillary posterior edentulous individuals, (23) male and (45) female, aged on average 56 years, submitted to the maxillary sinus survey, totaling 74 sinus surgeries, were distributed according to the grafts of: Bio-Oss® small=18, Bio-Oss® Large=10, (Geistlich, Wolhusen, Switzerland); Osteogen®=08, (Intra-lock®System USA); BoneCeramic® + Emdogaim®=10, (Straumann, Basel, Switzerland); Cerasorb®=11, (M Dental Curasan, Frankfurt/Main, Germane); Endobon®=17 (RegenerOsst, BIOMET3i. Palm Beach Gardens, FL, USA).

A total of 148 TCCB images obtained in V1 (15 days) and V2 (180 days) were assessed after the surgeries. The images were analyzed by a single, expert, trained operator using Osirix® MD Imaging 6.5 software (Pixmeo Geneva Switzerland). The graft image was delimited manually by the evaluator, and the program semi-automatically defined all sagittal, axial and coronal reconstructions of the image (Favato et al. 2015). The amounts of biomaterials were categorized by the following intervals, according to Table nº:

Bio-Oss® Small	Group 1 (G_1) ≥ 1g ≤ 1,5g
Bio-Oss® Small	Group 2 (G_2) ≥ 2g ≤ 2,5g;
Bio-Oss® Large	Group 3 (G_3) ≥ 0,50g ≤ 1,0g
Bio-Oss® Large	Group 4 (G_4) ≥ 1,5g ≤2,0g;
Endobon®	Group 5 (G_5) ≥ 0,49 ≤ 0,73g
Endobon®	Group 6 (G_6) = 0,96g;
BoneCeramic® + Emdogaim®	Group 7(G_7) ≥ 0,51 ≤ 1,01g;
Cerasorb®	Group 8 (G_8) ≥ 0,89 ≤ 1,77g
Osteogen®	Group 9 (G_9) ≥ 1,8g ≤ 2,5g;
Osteogen®	Group 10 (G_{10}) ≥ 3g ≤ 4,0g.

Smoking patients, with autoimmune diseases, diabetes mellitus, alcoholism, stress, active periodontal diseases, maxillary sinus diseases and surgeries that had some intercurrence during the graft procedure, were excluded.

All the graft surgeries for maxillary sinus lift were performed following Cosso et al. (2014) surgical and drug protocol by varying the graft materials Bio-Oss® Small; Bio-Oss® Large; Endobon®; BoneCeramic® + Emdogaim®; Cerasorb® e Osteogen®.

The variables evaluated were: the initial volume in 15 days, the final volume in 180 days, the calculation of the volumetric change of the graft between the two periods of study, the ratio of the amount of biomaterial used (weight grams) to the initial and final volume of the graft obtained and the difference among contractions of different materials

For statistical analysis, the Kolmogorov - Smirnov normality tests were used which determined the sample non-normality, the Kruskal-Wallis nonparametric test which has compared the contractions among the materials and it has evaluated the influence of biomaterial weight used in the original volume V1 and final V2 of the obtained grafts.

Results

The average amounts of assessed biomaterials used in grams was: Bio-Oss® Small (1,58g); Bio-Oss® Large (1,35g); Endobon® (0,72g); BoneCeramic® + Emdogaim® (0,96g); Cerasorb® (1,13g) e Osteogen® (2,70g).

The mean, median and standard deviation values of the graft volume obtained by all materials evaluated in the two study periods were described in Table 1.

Table 1. Descriptive statistics of the volume cm^3 in V1 and V2

Variable	Material	Mean	StDev	Median
V1	Bio-Oss® Small	2,036	1,306	1,79
	Bio-Oss® Large	1,821	0,703	1,815
	Endobon®	1,599	0,442	1,530
	BoneCeramic®	1,735	0,567	1,8
	Cerasorb®	1,705	0,408	1,66
	Osteogen®	2,204	0,873	2,205
V2	Bio-Oss® Small	1,765	1,237	1,215
	Bio-Oss® Large	1,594	0,586	1,575
	Endobon®	1,461	0,354	1,400
	BoneCeramic®	1,344	0,459	1,325
	Cerasorb®	0,990	0,433	0,890
	Osteogen®	1,795	0,846	1,575

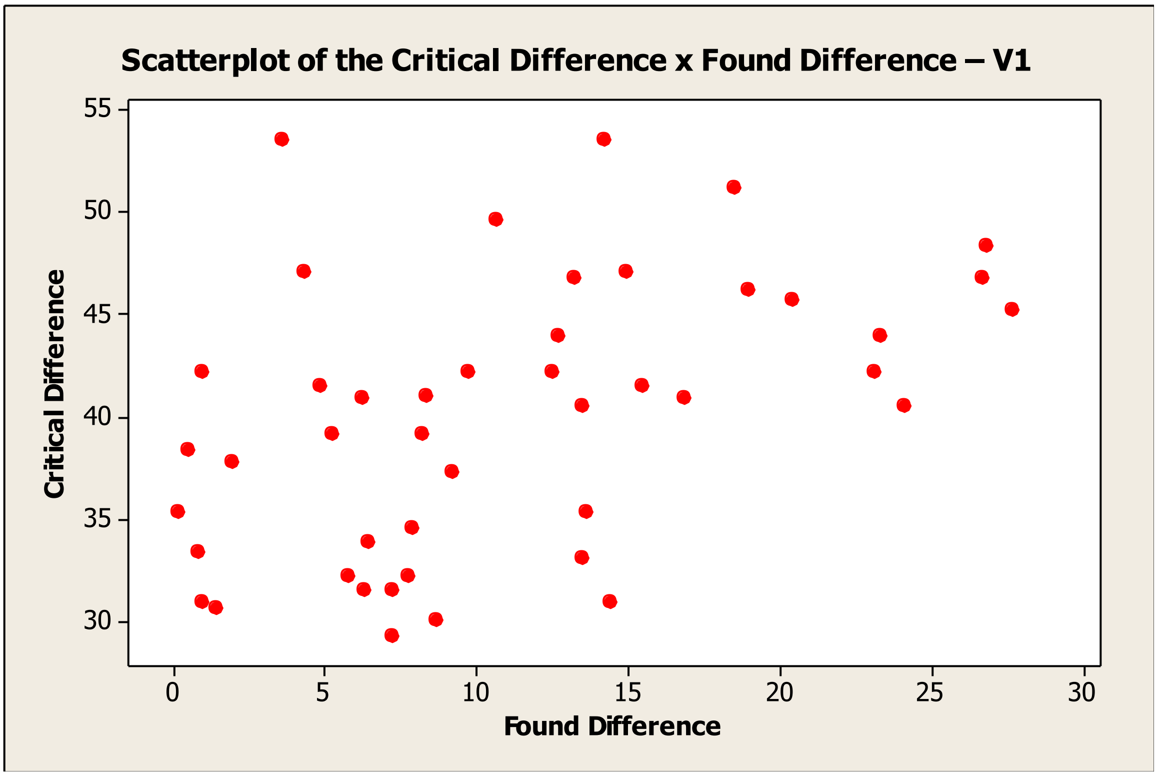
The relationship of the influence of the mean number of biomaterials, categorized by groups (weight-grams), in the initial and final volume is described in table 2. A percentage ratio of 18.71% of the initial volume was observed in 180 days.

Table 2. Measurement between volume cm3 (V1) x contractions of different kinds of biomaterials.

	Mean, Median and Standard Deviation by Biomateriais x Groups									
		T1				Contração				
		Group	**Mean**	**Median**	**Std. Deviation**	**Mean**	**Median**	**Std. Deviation**	**% Material Contraction**	**% Group Contraction**
BIOMATERIAIS	**Bio Oss Small**	Group 1	1,674	1,290	0,994	0,341	0,310	0,277	**14,98%**	22,28%
		Group 2	2,398	2,330	1,530	0,201	0,120	0,204		7,68%
	Bio Oss Large	Group 3	1,527	1,740	0,368	0,203	0,130	0,156	**11,93%**	12,95%
		Group 4	2,507	2,160	0,901	0,283	0,11	0,309		9,56%
	Osteogen	Group 5	2,077	2,200	1,096	0,330	0,285	0,160	**20,43%**	17,83%
		Group 6	2,330	2,205	0,730	0,488	0,515	0,220		23,04%
	Bone Ceramic	Group 7	1,735	1,800	0,567	0,391	0,385	0,236	**21,83%**	21,83%
	Cerasorb	Group 8	1,705	1,660	0,408	0,715	0,690	0,260	**43,36%**	43,36%
					-					
	Endobon	Group 9	1,550	1,500	0,489	0,150	0,105	0,1537	**8,04%**	8,79%
		Group 10	1,718	1,850	0,318	0,110	0,100	0,060		6,26%
									Mean and Amount	18,71%

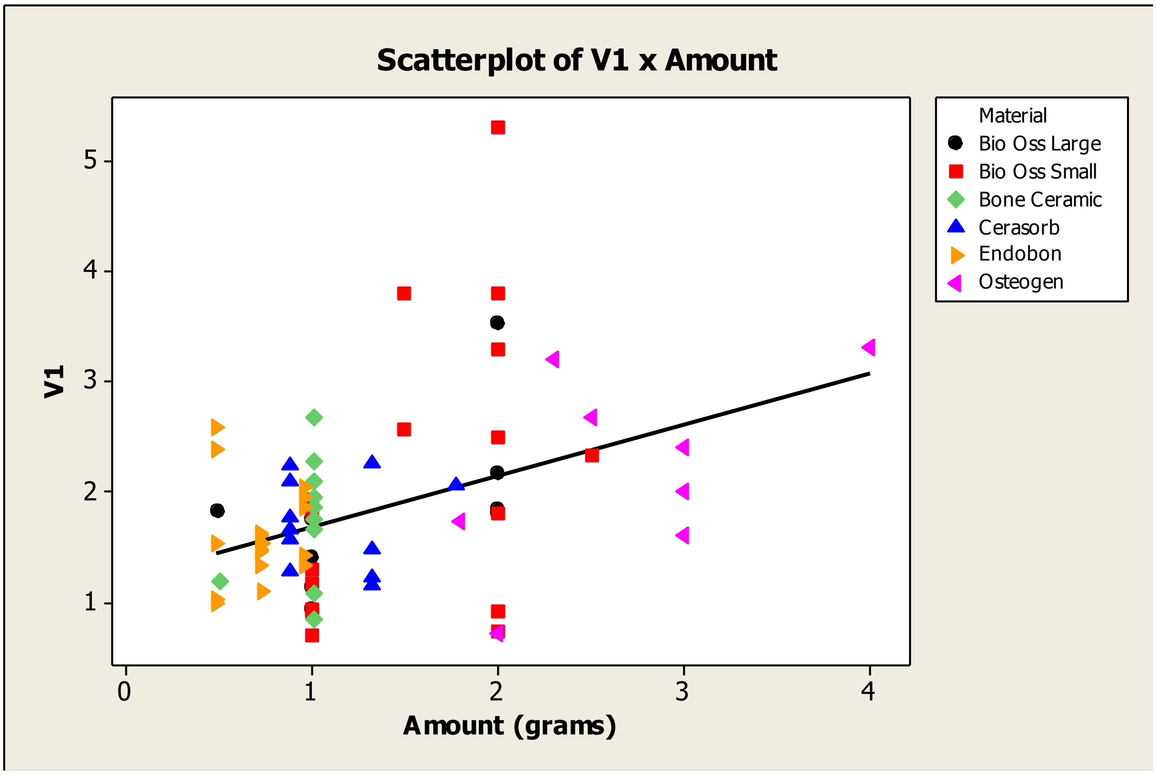
From these data, the multiple comparisons among the groups of the different biomaterials investigated were carried out. Concerning to the volume obtained in V1 it was not possible to found any statistical differences p = 0.415 (Graph 1).

Graph 1. Multiple comparison among groups in relation to the volume obtained in V1.



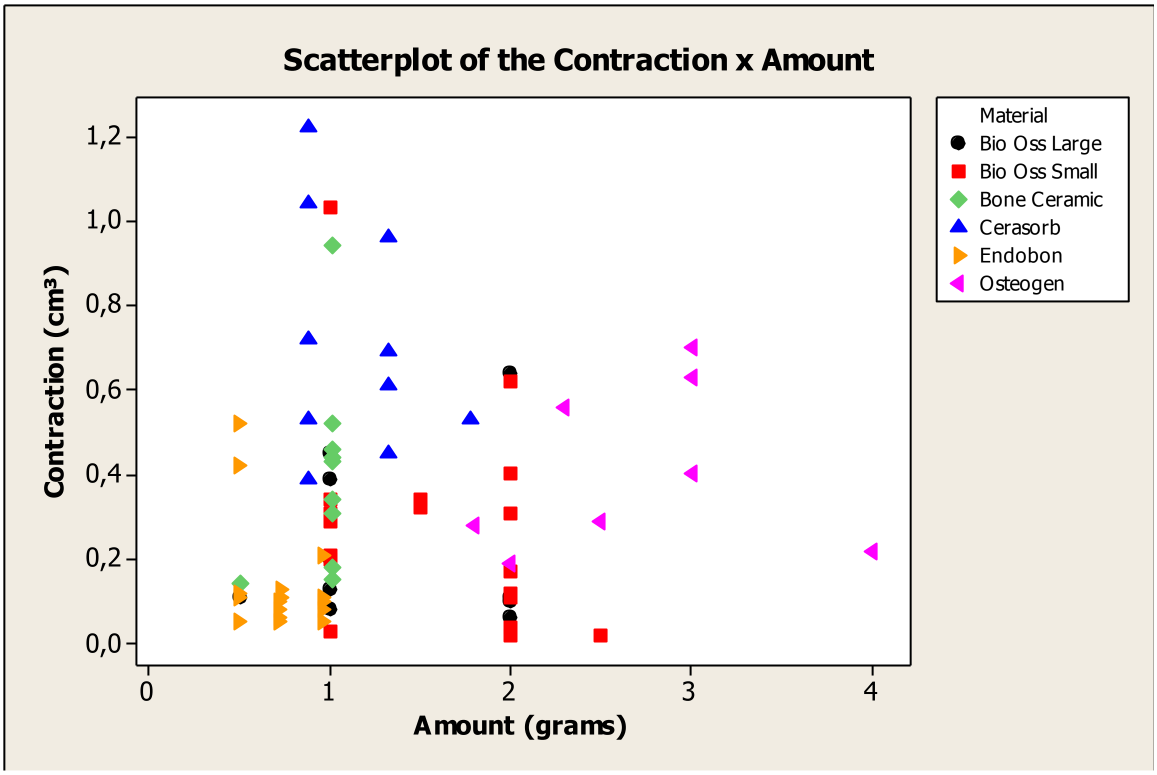
Tests on the initial volume V1 and final V2 x amount used were carried out in these groups. The results of the graft contraction x amount of material used (gram weight) in V1 are shown in figure 2 and they show that if the amount of the materials is increased the initial volume will not be increased. The volume of the graft (V1) in cm^3 x amount of material used (in gram weight) shows a larger amount in grams used from the Osteogen® biomaterial and that the increase of the amount of material used has not influenced the graft volume increase in (V1).

Graph 2. Graft volume (V1) x Quantity in grams used



The graph 3 shows the linear regression analysis between the biomaterials amount used and the final contraction, which measured the degree of relationship between the variables. In this case, the regression showed that the correlation is very low (close to zero) among the analyzed variables, and shows that if we increase the quantity of the materials we will not increase final volume.

Graph 3. Quantity of materials used x final volume obtained V2



Concerning to the final volume obtained in V2 (Graph 4), a significant statistical difference (p = 0.00003) for the final contraction variable can be found only in four groups: Cerasorb® G8 x Bio-Oss Small® G_2; Cerasorb® G8 x Endobon® G5; Cerasorb® G8 x Endobon® G6 and Cerasorb® G8 x Bio-Oss® Large G3 (Table 1).

Graph 4. Multiple comparison among groups with statistical differences in V2.

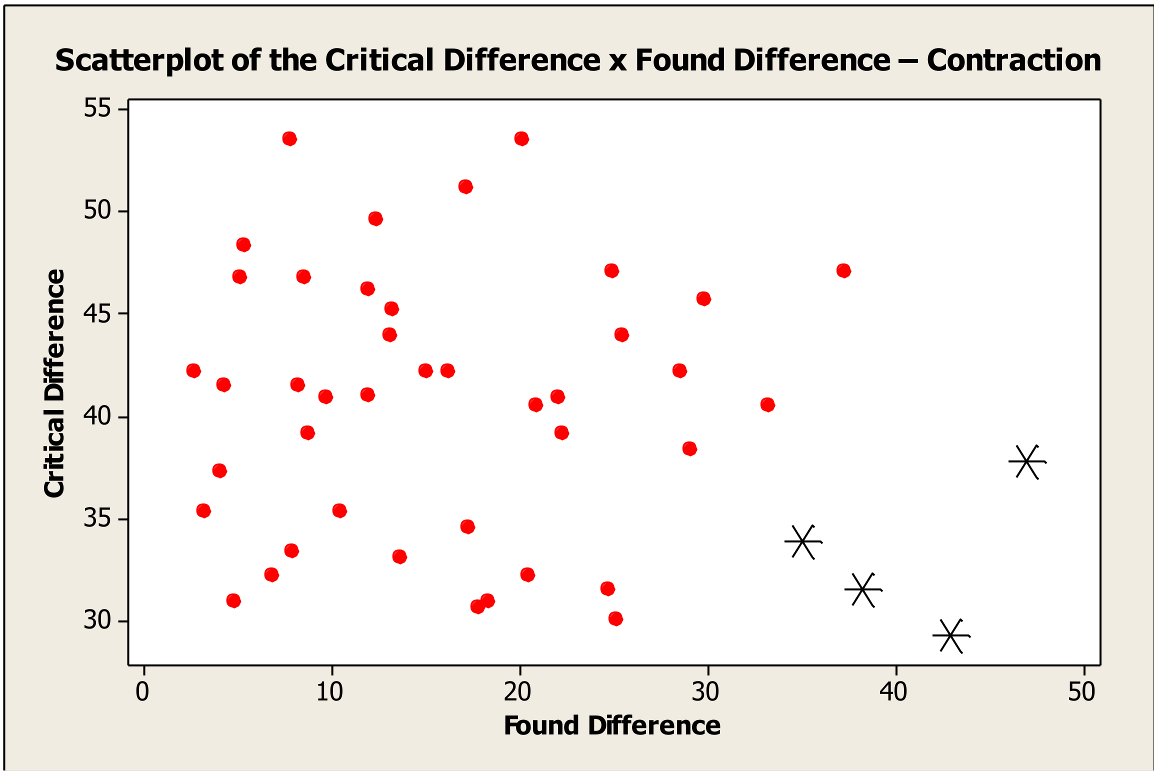
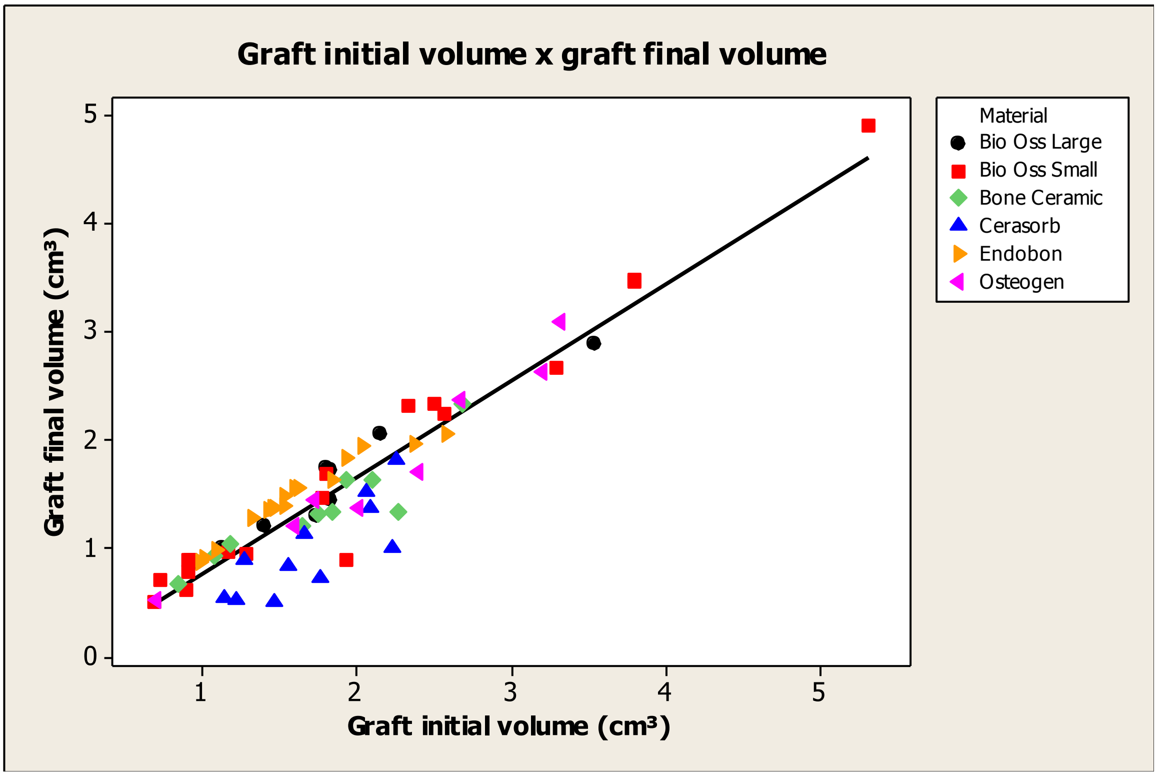


Table 1. Multiple comparison among groups with statistically significant differences concerning to the volume obtained in V2.

Test between amount used (Grams) x Volume T1 X Final Contraction			
Material	Volume T_1	Final Contraction	Difference
Cerasorb® G_8 x Bio-Oss® Small G_2	1,70cm³ x 2,25cm³	-0,71cm³/-0,18cm³	25,35%
Cerasorb® G_8 x Endobon® G_5	1,70cm³ x 1,55cm³	-0,71cm³/-0,15cm³	21,13%
Cerasorb® G_8 x Endobon® G_6	1,70cm³ x 1,46cm³	-0,71cm³/-0,24cm³	33,80%
Cerasorb® G_8 x Bio-Oss® Large G_3	1,70cm³ x 1,53cm³	-0,71cm³/-0,20cm³	28,17%
Cerasorb® G_1 ≥0,89g ≤1,77g; Bio-Oss® small G_2 ≥2g ≤ 2,5g; Endobon® G_1 ≥0,49g ≤ 0,73g; Endobon® G_2 = 0,96 g; Bio-Oss® large G_1 ≥0,50g ≤1,0g			
Volume V1 (15 days after the surgery); Contraction V1 – V2 (180 days after the surgery) P<0,001			

Concerning to the distribution of the mean values obtained in V1 and V2, a homogeneous distribution can be found with a strong linear correlation for all biomaterials evaluated. A high value for R^2 (0.887) was found, showing a strong correlation between the variables V1 X V2. Thus, it can be found that all materials have shown significant contraction between V1 and V2 (Graph 5).

Graph 5. Initial Volume V1 x Final Volume V2



Discussion

The present retrospective clinical study, for maxillary sinus lift in humans, has established a correlation of the amount in weight of the xenogenic hydroxyapatite biomaterials: Bio-Oss® Small; Bio-Oss® Large and Endobon® and alloplastic: BoneCeramic®; Cerasorb® and Osteogen®; with the initial and final volume of the graft obtained, as well as has determined the final volume changes of all the grafts obtained, by means of CT images of conical bundle. These relationships and variables, as assessed in the present study, have still not been identified in the literature.

Among the variables that may influence volumetric changes, it is important to highlight that factors such as the remaining border (Zheng et al. 2016) or even total size / volume of the maxillary sinus (Kolerman et al. 2008; Soardi et al. 2011) may also influence in this change. However, the study by Favato et al. (2015), when evaluating the variable maxillary sinus size, with different biomaterials for the graft in the maxillary sinus elevation, took into consideration as a volumetric alteration factor, only the type of biomaterial used in the graft.

The graft volume reduction should be expected for any graft material, particularly at the early stage of graft maturation (Shanbhag et al. 2014).

The average amount in grams of biomaterials, Bio-Oss® Small (1.58g); Bio-Oss® Large (1.35g); Endobon® (0.72g); BoneCeramic® + Emdogaim® (0.96); Cerasorb® (1.13g) and Osteogen® (2.70g) did not present a significant statistical difference. These quantities were used to establish the correlation between initial and final volumes, so that the influence of this variable could be evaluated on the volumes of the grafts, a proposition that was not reported in the literature.

The results of the present study concerning to xenogenic hydroxyapatites: Bio-Oss® Small; Bio-Oss® Large and Endobon® have demonstrated an average volume obtained of 2,036cm^3; 1,821cm^3; 1.599cm^3; And for allopathic hydroxyapatite: BoneCeramic®; Cerasorb® and Osteogen®, 1,735cm^3; 1.75cm^3 and 2.204cm^3, respectively, in V1, 15 days after grafting for maxillary sinus lift. The analysis of the correlation of this period shows that if we increase the quantity of the materials we will not increase the initial volume. It is suggested that these variations are associated with the structural features, particle size, volume weight ratio, from each evaluated material. Although there are no data in the literature to establish a discussion of this variable in this study period, noting that the long-term stability of the three-dimensional bone increase is a determining factor for dental implant and aesthetic success (Lambert et al. 2013).

Thus, regardless the type of graft material used, it is clear that, over the time, it undergoes dimensional changes that may influence the final grafted volume;

Suggesting, moreover, the compromise of the stability of the installed implants (Hürzeler et al. 1997; Haas et al. 1998; Browaeys et al. 2007).

Shanbhag et al. (2014) reported a volume reduction, averaging 45%, for autogenous bone over six months to two years. Bone substitutes or mixed grafts may offer a greater volumetric stability than only the autogenous bone may. Bone substitutes such as demineralized bovine bone or biphasic calcium phosphate, when used singly or in combination with other materials, for example the autogenous bone itself has an average of 18% to 23% volumetric reduction. In the present study we have found a final general mean contraction of all biomaterials in the 180-day period of 18.71% concerning to the initial volume V1.In an individual basis for the grafts of: Bio-Oss® Small = 14.98%; Bio-Oss Large = 11.93%; Endobon® = 8.04%; BoneCeramic® = 21.83%); Cerasorb® = 43.36% and Osteogen® = 20.43% lower data in percentage, except for Cerasorb®, which presents reabsorption similar to the autogenous graft resorption pattern that can induce to 40% reduction in the volume of the graft (Browaeys et al. 2007), but in agreement with the trend of the results of this systematic review.

Concerning to the amount of biomaterial and the final contraction with the use of xenogenic hydroxyapatites in maxillary sinus lift, the similarity of the results to the studies of Chackartchi et al. (2011), Ramirez-Fernandez et al. (2011), Testori et al. (2012), Testori et al. (2013), Cosso et al. (2014) can be inferred.

Unlike and in order to determine the influence of the amount of biomaterial on the volumetric changes of the grafts, the present study has categorized groups by gram interval and it has established multiple comparisons among them. Thus, no difference was found in the volume obtained in V1. However, for the multiple comparisons with final volume, V2 was found that among the Cerasorb® G8 x Bio-

Oss Small® G 2; Cerasorb® G8 x Endobon® G5; Cerasorb® G8 x Endobon® G6 and Cerasorb® G8 x Bio-Oss Large® G3, there was a significant difference, $p = 0.00003$, in the mean contraction with a percentage ratio of 25.35%; 21.13%; 33.80% and 28.17%, respectively. These data are important for the planning, as well as the average establishment of the amount of these biomaterials to be used for maxillary sinus lift.

In contrast to the findings of the literature, which present Cerasorb® (pure β-TCP phase) as a bone substitute that has presented comparable results with other biomaterials used in maxillary sinus surgeries (Burger & Patel 2007; Müller-Mai & Knabe 2014), the present study has found results showing Cerasorb with a higher resorption rate than all other biomaterials already investigated. Analyzing the composition of the material, it was found that this material is fully absorbable according to the study where no residues of the graft material were found and apparently the whole material was resorbed and replaced by bone, which was portrayed with a faster resorption rate than BCP and β TCP in contrast to Bio-Oss type materials (Khatiblou 2011). Endobon, a non-absorbable porous bovine hydroxyapatite with porosity between 45% and 80% (Spies et al. 2010; Ramirez-Fernandez et al. 2011) was the material that presented less resorption when compared with the evaluated materials.

As observed in a few reported studies (Kehr & Gosset 2000; Wanschitz et al. 2006; Kirmeier et al. 2008; Pjetursson et al. 2008; Lambert et al. 2013; Klijn et al. 2012; Arasawa et al. 2012; Kim et al. 2013; Sbordone et al. 2013; Umanjec-Korac et al. 2014), there is still a deficiency determining the best osseointegration, predictability for installed implants, as well as for aesthetics, concerning to the volumetric stability of grafts obtained after maxillary sinus lift. Further controlled and longitudinal investigations are becoming increasingly important so that in the results of oral rehabilitation by means of osteointegrated implants, changes in the volume of the grafts obtained by means of different biomaterials can be evaluated in longer control periods, as well as the impact of these contractions.

As a final consideration, there is no correlation between the mean amounts of biomaterials studied and the initial volume of grafts obtained at 15 and 180 days. However, the data from the analyses quantity x contraction have shown a statistically significant difference between the following groups: Cerasorb® G8 x Bio Oss Small® G2; Cerasorb® G8 x Endobon® G5; Cerasorb® G8 x Endobon® G6 and, Cerasorb® G8 x Bio Oss Large® G3.

Conclusion

The average amount of material used is not strictly related to the initial volume obtained and the final contraction at 180 days. When categorized, the Biomaterial Cerasorb, compared to the investigated biomaterials, was the one with the greatest contraction.

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4 CONSIDERAÇÕES FINAIS

Como observado na literatura revista, ainda há uma deficiência de estudos determinando a melhor osteointegração, previsibilidade para implantes instalados, assim como para a estética, em relação a estabilidade volumétrica dos enxertos obtidos após a elevação do seio maxilar.

Os dados do presente estudo determinaram que não existisse correlação entre a quantidade média dos biomateriais estudados e o volume inicial de enxerto obtido aos 15 dias. A quantidade média em gramas dos biomateriais avaliados apresentou diferença estatística significante apenas na contração final dos enxertos.

Na correlação da quantidade do biomaterial utilizado, diferenças estatisticamente significativa para a variável contração final foi observada somente entre os seguintes grupos, Cerasorb® G_8 x Bio-Oss Small® G_2; Cerasorb® G_8 x Endobon® G_5; Cerasorb® G_8 x Endobon® G_6 e Cerasorb® G_8 x Bio-Oss Large® G_3.

Estes dados são importantes para o planejamento, assim como o estabelecimento em média da quantidade a ser utilizada destes biomateriais para elevação do seio maxilar.

Devido às características estruturais e no preparo dos biomateriais, estudos longitudinais, devem ser realizados para avaliação do comportamento destes enxertos. Assim pesquisas adicionais controladas e longitudinais, tornam-se cada vez mais importantes, para que nos resultados da reabilitação oral por meio de implantes osteointegráveis, possa se avaliar as mudanças no volume dos enxertos obtidos por meio de diferentes biomateriais, em períodos maiores de controle, bem como o impacto dessas contrações.

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