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Non-autologous human bone graft applied to upper maxillary sinus elevation

Injerto de hueso humano no autólogo aplicado a la elevación del seno maxilar superior

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Abstract

The objective of this study was to evaluate the effectiveness of the use of non-autogenous human bone using the maxillary sinus floor elevation technique to create favorable conditions for the placement of dental implants. Longitudinal clinical study of partially edentulous patients of both genders (included in this study n = 11), older than 18 years. The data were recorded in three time periods: a) at the time of operation: b) control at 7 days, c) control at 180 days, these last two postoperative. The human bone grafts used were lyophilized and irradiated, with a particle size of 0.2 and 1 mm, manufactured by the Hemoderivatives of the National University of Córdoba. The increase in bone tissue was measured by digital orthopantomography, as the distance obtained between the lower basal edge and the resulting alveolar ridge. The population was composed of 8 women and 3 men. The increase in bone reached, at 7 and 180 days, was observed radiographically. There was a significant increase in the mean values of bone mm. Variations were 4-8 mm at the time of operation at mean values of ≥ 14 mm at 7 and 180 days after surgery.
The results indicate that lyophilized human bone can be considered an alternative to bone grafts of animal origin or those of patients.

KEY WORDS: human bone graft; dental implant; sinus elevation

Resumen

El objetivo de este estudio fue evaluar la eficacia del uso de hueso humano no autógeno utilizando la técnica de elevación del piso del seno maxilar para crear condiciones favorables para la colocación de implantes dentales. Estudio clínico longitudinal de pacientes parcialmente edéntulos de ambos géneros (incluidos en este estudio n = 11), mayores de 18 años. Los datos se registraron en tres momentos temporales: a) al momento de la operación: b) control a los 7 días, c) control a los 180 días, estos dos últimos pos operatorio. Los injertos de hueso humano empleados fueronliofilizados e irradiados, con un tamaño de partícula de 0.2 y 1 mm, manufacturados por el Laboratorio de Hemoderivados de la Universidad Nacional de Córdoba. El aumento en el tejido óseo se midió mediante ortopantomografía digital, como la distancia obtenida entre el borde basal inferior y la cresta alveolar resultante. La población estaba compuesta por 8 mujeres y 3 hombres. El incremento de hueso alcanzado, a los 7 y 180 días, se observó radiográficamente. Se observó un aumento significativo en los valores medios de mm de hueso. Las variaciones fueron de 4-8 mm al momento de la operación a valores medios de ≥ 14 mm a los 7 y 180 días después de la cirugía.
Los resultados indican que el hueso humano liofilizado puede considerarse una alternativa a los injertos óseos de origen animal o a los propios del paciente.

PALABRAS CLAVE: injerto óseo humano; implante dental; elevación pido de seno

Introduction

The adult population of the city of Córdoba currently has a high percentage of individuals with experience of dental extractions, single or multiple, which leads to a high incidence of esthetic and functional difficulties[1]. In the posterior sector of the upper jaws, bone remodeling following dental extractions coupled with the pneumatization of the maxillary sinus, leads to an unfavorable situation for rehabilitating the sector with osseointegrated implants that meet the basic biomechanical standards to support the corresponding prosthesis[2,3]. One of the therapeutic strategies commonly used in surgical practice is the elevation of the maxillary sinus floor by placing autologous, allogeneic or other types of bone grafts, in order to create sufficient bone height in the sector to place osseointegrated implants that meet the basic biomechanical requirements to support stable and predictable prosthetic rehabilitation[4,5].

Although, in general, the results are successful with these types of grafts, most researchers agree that the patient's own bone combines the best qualities since it is osteogenic, osteoinductive and osteoconductive[6]. But it has the disadvantages of the post-surgical sequelae at the donor site, the need for longer and more bloody surgery, as well as the limited amount of bone that can be obtained, which is counter-productive for treatment[7]. One valid alternative is the use of Lyophilized Human Bone (LHB), which acts only as an osteoconductive material, favoring the formation of bone at the site where it is applied. When selecting the biomaterials, the effectiveness of each of the forms of presentation should be specially studied.

For this reason, the aim of this work was to evaluate the efficacy of the use of LHB in the partial reconstruction of maxillary atrophic residual alveolar ridges using the sinus floor lifting technique to obtain favorable conditions for the placement of dental implants.

Material and methods

A follow-up study was conducted of partially or totally edentulous patients, with mean residual bone height was 4-5 mm, of both genders (n=15), over 18 years old, at the Clinical Office of Surgery III (Dentistry School, National University of Cordoba, Argentina) between 2014 and 2015. The study consisted of three time-points: a) baseline; diagnosis and collection of data in clinical history; (b) control at 7 days, c) control at 180 days. The study was approved by the Research and Ethics Committee of the Ministry of Health of the Province of Cordoba (Facultad Odontología-Universidad Nacional Córdoba- n ODO67, ISRCTN11165901, DOI 10.1186/ISRCTN11165901) and informed consent forms were signed by all patients.

Patients with a history of type 1 diabetes mellitus, symptomatic hypo- or hyperthyroidism, immunodeficiency problems, sinusitis, chemotherapy and/or radiotherapy, arterial hypertension above 159/94, in the 6-month window period after acute myocardial infarction or cerebrovascular accident, with chronic periodontal disease, bone diseases such as osteomalacia, arthritis, infections, rheumatism or osteoporosis, cirrhosis, consumers of osteoactive drugs such as bisphosphonates, denosumab, raloxifene, teriparatide or corticoids or those who were pregnant, were excluded (Fig. 1).

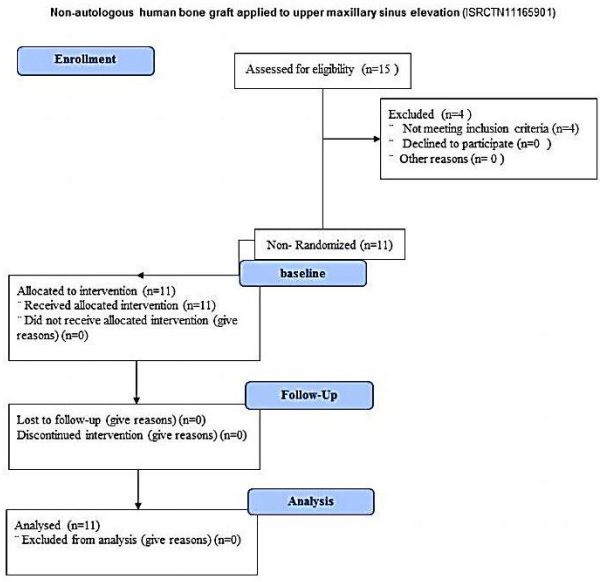


Figure 1. Consort flow diagram of study

Surgery

All the patients underwent the surgical technique of maxillary sinus floor elevation following the protocol of Tatum H Jr. 1986[8] for surgeons of the

team. To decrease the bacterial load, one minute's mouthwash with chlorhexidine was recommended every 12 hours for two days before the intervention and one prior to the intervention. An antibiotic prophylaxis regimen was established for all patients and consisted of the administration of amoxicillin/Clavulanic acid once 1 hour before surgery and for 7 days postoperatively[9-12]. To prevent inflammation and complications related to the intervention, the synthetic corticoids, dexamethasone or betamethasone (duo forms with phosphate and acetate salts) were used intramuscularly in a single dose, with a recommended start between 7 and 8 a.m. on the day of the intervention to avoid the suppression of the HPA (hypothalamic-pituitary-adrenal) axis. Local anesthesia was used with carticaine 4% and adrenaline 1:100,000. For the control of postoperative pain, ibuprofen or similar were recommended and in patients with intolerance to non-steroidal anti-inflammatory drugs, paracetamol every 6-8 h, depending on symptoms. This never exceeded 72 h Cryotherapy (local cold) was recommended, applied externally on the area affected as an alternative every 10 minutes during the first 24 hours, respecting the rest of the patient. All patients were instructed in post-surgical hygiene techniques to prevent local trauma.

The material used as a graft in the surgery was LHB and irradiated, composed of ground bone particles ranging from 0.2 to 1 mm in size from the Blood Bank of the National University of Córdoba (http://unc-hemoderivados.com.ar/prodTejidos.php). Presentation: 0.5 and 1 cm^3 blocks of cortical-spongy bone.

The increase in bone tissue was measured by digital orthopantomographs taken by a specialist using the standard technique for orthopantomography, model Planmeca Autoprint, PM 2002, with automatic processor Kodak XP 400, of the Diagnosis Imaging Department A and B of the School of Dentistry, Córdoba University. The tomography sections were taken every 2 mm in the zones intervened to measure the distance in millimeters obtained between the resulting floor of the maxillary sinus and the alveolar crest.

Statistical analysis

The data were described by their position (Mean/Median) and dispersion (range/standard error) parameters for quantitative variables, while the qualitative variables were described by their absolute or relative frequencies. The efficacy outcomes were evaluated by the Wilcoxon test for paired samples and associations between categorical variables by Fisher's Test. In all cases, a p-value of 0.05 was set for statistical significance.

Results

Of the 15 patients who started the study only 11 were eligible for meeting the study criteria (Fig. 1). The included population (n=11) consisted of 8 women and 3 men. The mean age ± standard deviation of the patients was 55.25 ± 6.08 years for women and 55.2 ± 9.83 for men. A total of 17 grafts was placed, as in some cases the technique was performed bilaterally, 13 of which (76.4%) were placed in women and 4 (23.5%) in men. In women, 7 of the grafts were located in the right sector and 6 in the left while, in males, 3 were in the right and 1 in the left. No significant association was observed between sector and gender (Fisher's test, p = 0.4244). All the patients in the study received dental implants and no peri-implantitis or other sequel was recorded that would indicate a clinical failure of the restorative treatment.

Fig 2 shows, at radiographic level, the increase of bone achieved at 7 and 180 days. A variation was seen in mean values of mm of bone; it was initially 4-8 mm, which significantly increased to average values of 14 mm and more, at 7 and 180 days after surgery (Fig 3 and Fig 4).

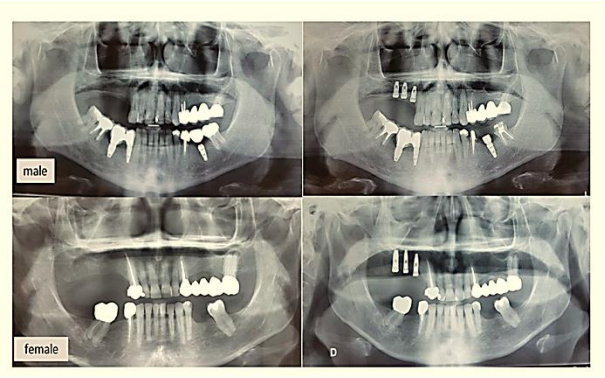


Figure 2. Orthopantomographic images of patients treated with maxillary sinus lifting surgery and with non-autogenous

lyophilized human bone grafts, at baseline (left) and final at 180 days (right)

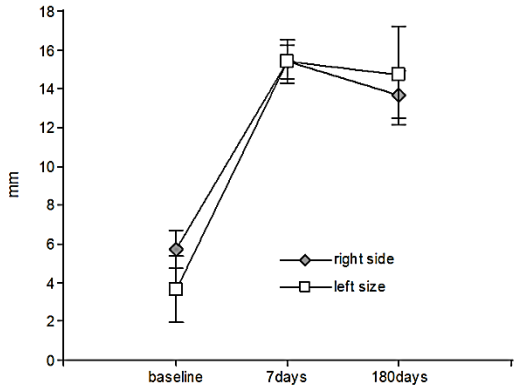
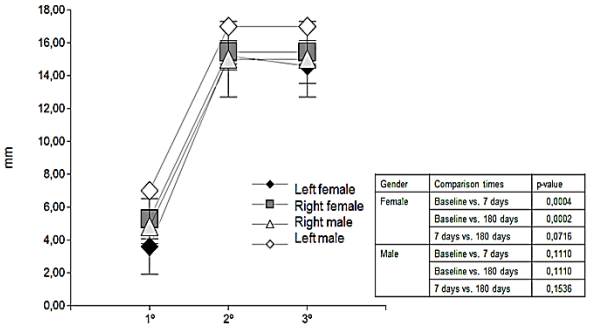


Figure 3. Measurement in millimeters (mm) of the increment in maxillary bone from human bone graft with the maxillary sinus floor elevation technique.Wilcoxon's (paired samples) test. P-value $_{(\text{between 0 and 7 days})}$=0.0030; p-value$_{(\text{between 0 and 180 days})}$=0.0324; p-value$_{(\text{between 7 and 180 days})}$ =0.7116. Wilcoxon's (paired samples) test. P-value estimated by sampling of all possible permutations (n = 5000). P-value<0.05 set for statistical significance



Gender	Comparison times	p-value
Female	Baseline vs. 7 days	0,0004
	Baseline vs. 180 days	0,0002
	7 days vs. 180 days	0,0716
Male	Baseline vs. 7 days	0,1110
	Baseline vs. 180 days	0,1110
	7 days vs. 180 days	0,1536

Figure 4. Measurement in millimeters (mm) of the increment in maxillary bone from human bone graft with the maxillary sinus floor elevation technique, by gender. Wilcoxon's (paired samples) test. P-value estimated by sampling of all possible permutations (n = 5000). P-value<0.05 set for statistical significance - *Axis X:* 1st: baseline; 2nd: 7 days; 3rd: 180 days.

Discussion

The grafted bone in this study was not autogenous but was of human origin. In general, the gold standard of grafts is considered to be that performed with autogenous bone belong to patient, but xenogenic bone or synthetic materials are also used[13]. Most studies indicate that the use of autogenous bone is better but that it also has negative consequences for the patient in the surgical sequelae in the bone extraction area[14].Autogenous bone graft has been that most commonly used for the sinus floor elevation procedure for two decades. However, studies are now successfully using bone of non-human or synthetic origin in this type of surgical interventions[15,16].

One of the most commonly used materials is Bio-Oss (applied alone or with a proportion of autogenous bone). A systematic review has concluded that the volumetric stability of the graft after lifting the sinus floor increased significantly with the use of Bio-Oss alone or with a proportion of autogenous bone. The biological explanation of this has not yet been clearly established because of the scarce scientific animal studyliterature[17]. Research by Schmitt et al. 2015 showed no significant differences between the histology of the formation of *de novo* bone and residual bone in grafts from inorganic bovine bone or from autologous bone[18].However, there is limited information on bone formation and the stability of autogenous bone grafts, because the graft is subject to bone remodeling of the site in which it is introduced[19]. Experimental studies in animals have shown that there is a slight increase in the percentage of neo-formed autogenous bone at 6 months[20]. Another experiment in animal models comparing the result in bone formation of autogenous and bovine grafts, combined or alone with platelet-rich plasma, showed histologically a greater contact surface in grafts made with autogenous bone[21].

Our study opted for sinus floor lift surgery because it is a procedure that has been carried out for 40 years with a high success rate. Tatum was the first to propose the placement of dental implants in sites with bone graft by raising the sinus floor with the lateral approach technique and its clinical application. This technique allowed the indication of the posterior maxillary region implant to be extended, with the advantage of a direct view when performing the surgery, the control of the height, effective protection of the sinus mucosa, the convenience of the bone graft and a precise positioning of the dental implant[22,23]. A drawback

is the angle of the burr of each patient. Research results suggest that maxillary sinus floor lifting is a relatively simple, safe, and predictable technique for rehabilitation via implant in patients who have reduced vertical bone height in the posterior sector of the upper maxilla[23]**.** The objective proposed was to observe the results obtained with non-autogenous human bone.

In our research, a greater percentage of grafts (76.4%) was placed in women than in men (23.5%). The grafts were placed in the right sector of 7women and 3 men, and in the left of 6 women and 1 man. 77% of bone grafts are performed in the anterior area of the maxilla for esthetic reasons. In a study conducted with a total of 1512 implants, they were placed in 421 males and 371 females[24].

Dental implants were successfully placed in all the patients included in this study with no peri-implantitis or other sequela recorded that would indicate a clinical failure of the restorative treatment. Fig. 1 shows, radiographically, the increase of bone achieved at 7 and 180 days. We observed a variation of 4-8 mm in average values of mm of bone at the beginning, significantly increasing to average values of 14 mm and more at 7 and 180 days after surgery (average percentage of increment 66%). In agreement with our study, Netto et al.2016,using autogenous bone grafts, observed an average increase in bone formation of 38.45 ± 6.64% (less than that observed in our study) without significant variations between the times studied[25].

In conclusion, the use of bone grafts of non-autogenous human origin for the first time in this study showed a highly significant increase in bone formation in a short time and allowed the successful placement of dental implants. This new type of graft broadens the spectrum of restorative dental treatments that can be considered in this type of dental surgery, probably presenting characteristics similar to those of autogenous bone, which until now remains the gold standard.

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Todos los autores declaran que no existen conflictos potenciales de interés con respecto a la autoría y / o publicación de este artículo.

All authors declare no potential conflicts of interest with respect to the authorship and/or publication of this article

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