

The Use of the Mandibular Ramus for Alveolar Reconstruction in Oral Implantology

Uso de Rama Mandibular para Reconstrucción Alveolar en Implantología Oral

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PARRA, M.; HAIDAR, Z. S.; VALDIVIA, O. J.; ARANEDA, N. & OLATE, S. The use of the mandibular ramus for alveolar reconstruction in oral implantology. *Int. J. Odontostomat.*, 11(2):236-242, 2017.

ABSTRACT: Bone grafts are widely used in alveolar ridge augmentations to allow correct implant installations. Intraoral donor sites, such as the maxillary tuberosity, symphysis and mandibular ramus have presented good characteristics and outcomes; however, the mandibular ramus has comparative advantages that promote its increased use. The aim of this work is to describe the current results of the mandibular ramus as a donor site for obtaining bone grafts to be used in alveolar bone augmentations in oral implantology and to determine the survival rate of the implants installed in the grafted sites. A systematic search of the scientific literature between December 2000 and March 2017 was carried out on the MEDLINE, EMBASE, LILACS and SciELO databases, analyzing each article according to the method of diagnosis and planning, bone resorption at the receptor site, presence of postoperative complications and implant survival rate. Eleven works were included in this study with an average of 43 patients; the follow-up times varied between 6 and 120 months, considering in addition an average success rate of 98.7 % in the implants installed in sites reconstructed with mandibular ramus bone; low morbidity in the site mainly linked to temporary neurosensory alterations was identified. It may be concluded that the need for a second surgical site to obtain graft material and the longer time the treatment requires until implant rehabilitation continue to be disadvantages; nevertheless, the mandibular ramus donor site presents low morbidity, high versatility in its use and predictable results for the dental implant installation.

KEY WORDS: mandibular ramus, bone graft, dental implants.

INTRODUCTION

Bone grafts are widely used to increase atrophic alveolar ridges so dental implants can be correctly installed, and they have evolved considerably in the last decade. Nowadays there is a wide variety of materials (Deluiz *et al.*, 2017); however, the “gold standard” in bone grafts continues to be autogenous bone due to its osteogenic, osteoinductive and osteoconductive properties (Diez *et al.*, 2014). Previous studies have described bone remodeling of the graft, revascularization and new bone formation at the graft site, which provide suitable conditions to support the occlusal forces of an implant-supported prosthesis.

The use of autogenous donor sites continues to be a technique used, and although the iliac crest and calvaria have shown good results, obtaining bone from these areas has major clinical time and cost implications, in addition to being sites of greater morbidity (Restoy-Lozano *et al.*, 2015).

Intraoral donor sites, such as maxillary tuberosity, symphysis and mandibular ramus, however, have recognized advantages in terms of stability, functionality and prognosis in dentoalveolar reconstructions (Reininger *et al.*, 2016). In this sense,

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mandibular donor sites mostly present cortical bone and limited loss of volume (Lee & Kim, 2015), observing new bone formation at the donor site 6 months after bone removal (Lee & Kim); on the other hand, this donor site, when found in the same operative field, also allows for speed and rationalization of the use of the anesthesia.

The most frequently used mandibular sites are the chin and mandibular ramus; the ramus has certain advantages over the symphysis, such as minimal concern on the part of the patient for alteration of their facial contour, lower incidence of suture dehiscence and fewer postoperative complications (Reininger).

The aim of this work is to conduct a contemporary analysis of autogenous bone grafts extracted from the mandibular ramus for use in alveolar bone augmentations in oral implantology and also to determine the survival rate of the implants installed in these grafted sites.

MATERIAL AND METHODS

Search strategy. A systematic search was made of the scientific literature between December 2000 and March 2017 in the MEDLINE, EMBASE, LILACS and SciELO databases. MeSH terms and free terms were used and then the Boolean terms "OR" and "AND" were applied. The search algorithm used for the search in MEDLINE was: (((("Bone Transplantation"[Mesh] OR autologous bone graft)) AND (((("Mandible"[Mesh] OR mandibular ramus) OR mandibular donor site)) AND "Dental Implants"[Mesh]). The search was complemented by a manual review of the references from the articles included.

Eligibility criteria. The inclusion criteria were as follows: 1) articles published in Spanish, English and Portuguese, 2) studies conducted on humans, 3) articles in which autogenous bone was extracted from the mandibular ramus, and 4) articles in which bone reconstructions were done for dental implant installation. Animal studies, secondary studies and those where bone reconstructions were done for purposes other than the dental implant installation were excluded.

Study variables and data analysis. The variables analyzed in this review were: method of diagnosis and

surgical planning, bone resorption in the receptor site, postoperative complications and implant survival rate. The data were extracted according to the requirements, with data being presented as tables for their study; no data meta-analysis was done.

RESULTS

Study selection. Once the combined search was complete, there were 546 titles. After eliminating duplicates and reviewing abstracts, 53 articles were obtained for a full text analysis; subsequent to this analysis, the inclusion and exclusion criteria were applied and a total of 11 articles was selected and used in this review (Table I).

With respect to excluded articles, these were mainly studies conducted on animals, secondary studies and studies in which bone reconstructions were performed for purposes other than dental implant installation.

Characteristics of the studies . The average number of patients was 43 and varied from 1 to 109 patients. Of the 11 articles analyzed, 9 were prospective and 2 were retrospective. In all the studies, implant installation was delayed; i.e., healing time was expected after graft placement, which was 3 to 5 months in the study by Soehardi *et al.* (2009), 4 months in the works by Happe (2007), Cordaro *et al.* (2011) and Streckbein *et al.* (2014), 4 to 5 months in the studies by Restoy-Lozano *et al.* (2015) and Sakkas *et al.* (2016); 5 months in the work by Singh *et al.* (2013), and 4 to 6 months in the study by Voss *et al.* (2016). On the other hand, in the works by Prousaeffs *et al.* (2002) and Greenberg *et al.* (2012), the expected time was 6 months, whereas in the work by Peñarrocha-Oltra *et al.* (2014) it was 7 months.

Diagnosis methods and planning. With respect to the evaluation method, 6 studies were conducted using orthopantomography (Happe, Soehardi *et al.*, Cordaro *et al.*, Streckbein *et al.*, Sakkas *et al.* and Voss *et al.*), two studies used tomography (Greenberg *et al.* and Peñarrocha-Oltra *et al.*), Singh *et al.* performed their analysis with retroalveolar x-rays, and Restoy-Lozano *et al.* used panoramic x-rays and computed tomography. Prousaeffs *et al.* conducted their study using retroalveolar and panoramic x-rays and histological and histomorphometric studies when the implants were installed.

Table I. Analysis of the studies included in this research related to patients, follow-up and survival of the graft and the implants.

Author, year	Design	N	Male	Female	Time for implant surgery	Follow-up	Method for diagnosis and follow-up	Bone graft resorption	Dental implant survival
Prousaeffs <i>et al.</i> , 2002	Prospective	8	2	6	6 mo	6 mo	Panoramic x-ray, periapical x-ray and histological	16.3 %	100 %
Happe, 2007	Prospective	40	12	28	4 mo	6 mo	Panoramic x-ray	N/R	100 %
Soehardi <i>et al.</i> , 2009	Prospective	32	12	20	3 a 5 mo	51 m mo	Panoramic x-ray	N/R	99 %
Cordaro <i>et al.</i> , 2011	Prospective	78	36	42	4 mo	12 to 42 mo	Panoramic x-ray	N/R	98,6 %
Greenberg <i>et al.</i> , 2012	Retrospective	14	9	5	6 mo	N/R	CBCT	N/R	100 %
Singh <i>et al.</i> , 2013	Prospective	1	1	0	5 mo	18 mo	Periapical x-ray	N/R	100 %
Peñarrocha-Oltra <i>et al.</i> , 2014	Prospective	37	12	25	7 mo	12 mo	CT	0.7 mm	91.1 %
Streckbein <i>et al.</i> , 2014	Prospective	25	9	16	4 mo	27 mo	Panoramic x-ray	N/R	100 %
Restoy-Lozano <i>et al.</i> , 2015	Prospective	43	6	37	4 to 5 mo	32 mo	Panoramic x-ray and CBCT	0.9 mm	100 %
Sakkas <i>et al.</i> , 2016	Prospective	86	77	9	4 to 5 mo	24 mo	Panoramic x-ray	N/R	100 %
Voss <i>et al.</i> , 2016	Retrospective	109	41	68	4 a 6 mo	Up to 120 mo	Panoramic x-ray	1.1 mm	98 %

N= number of patients, x-ray= radiography, mo=months, CBCT= cone beam computed tomography, CT= computed tomography, N/R= no registered

Histological analyses. Prousaeffs *et al.* conducted histological and histomorphometric analyses on bone samples 2 mm in diameter obtained from the grafted sites when the dental implants were installed; these samples were fixed in 10 % formalin, dehydrated with alcohol, and embedded in resin (“Technovit 7200 VLC, Kulzer, Wehrheim”, Germany), cut in thicknesses from 40 to 50 mm and then dyed with Stevenel’s blue and Van Gieson’s stains for light microscopy. The results of the histological analysis showed a solid core, composed mainly of cortical bone, with obvious signs of bone remodeling activity. The histomorphometric analysis revealed that approximately 45 % corresponded to newly formed bone and almost 30 % to fibrous tissue.

Bone resorption at the receptor site. Some of the studies included in this review report lower rates of bone resorption at the receptor site in the first year of follow-up. Peñarrocha-Oltra *et al.* reported an average of 0.7 mm; Restoy-Lozano *et al.*, 0.9 mm and Voss *et al.* 1.075 mm; Happe, Soehardi *et al.*, Cordaro *et al.*, Greenberg *et al.*, Singh *et al.*, Streckbein *et al.* and Sakkas *et al.* did not report on bone resorption rates at the receptor site.

Postoperative Complications. An average of postoperative complications at the donor site was estimated to be 6.51 % among the studies. The study by Prousaeffs *et al.* reported 1 case of slight pain (12.5 %); Happe reported 1 case of dehiscence, 1 case of infection with suppuration and 1 case of alteration of lower lip sensitivity representing 7.5 % of the total cases; in the study by Soehardi *et al.*, 22 % of the cases presented some type of postoperative complication, being mainly a slight paresthesia in the symphyseal area; Cordaro *et al.* reported that 6.4 % of their cases presented some type of postoperative complication, mainly alterations in sensitivity; Streckbein *et al.* indicated the presence of 1 case of dysesthesia; Restoy-Lozano *et al.*, from a total of 43 subjects, reported 3 cases of edema and one case of infection, while

Sakkas *et al.* described 3 cases of donor site infection, corresponding to 3.4 % of the subjects. Greenberg *et al.*, Singh *et al.* and Peñarrocha-Oltra *et al.* indicated that no postoperative complications were observed. In the study by Voss *et al.*, the presence or absence of postoperative complications at the donor site was not reported. The postoperative complications are detailed in Table II.

Dental implant survival rate. With respect to the survival rate of the implants installed in grafted sites, an average of 98.7 % was estimated among the studies. This was 91.1 % in the study by Peñarrocha-Oltra *et al.*, 98 % in the work by Voss *et al.*, 98.6 % in the study by Cordaro *et al.*, 99 % in the case of Soehardi *et al.* and 100 % in the works by Prousaeffs *et al.*, Happe, Greenberg *et al.*, Singh *et al.*, Streckbein *et al.*, Restoy Lozano *et al.* and Sakkas *et al.*

DISCUSSION

Autogenous block grafts, used in alveolar bone reconstructions, have made it possible to achieve high success rates with implants. With respect to where these grafts are obtained, the mandibular ramus has been shown to be a reliable donor site, as it can rationalize the use of time and presents lower morbidity and postoperative complications, being better accepted by patients than other mandibular donor sites, like the symphysis (Reininger *et al.*).

Analysis of the studies included reveal that most of them conducted their planning using 2D or 3D images, but few studies conducted a histological analysis of the newly formed tissue to determine the characteristics of the new bone structure.

Table II: Complications related to the donor site reported in the studies included in this research.

Author, year	Pos-operative complications in the donor site	Description of complications in the donor site	% of complications
Prousaeffs <i>et al.</i> , 2002	Yes	Low pain (1 case)	12.5 %
Happe , 2007	Yes	Lost of suture (1 case), infection (1 case), sensitivity dysfunction in the lower lip (1 case)	7.5 %
Soehardi <i>et al.</i> , 2009	Yes	Mild paraesthesia in the chin (6 cases), infection (1 case)	22 %
Cordaro <i>et al.</i> , 2011	Yes	Hypoesthesia (4 cases), paraesthesia (1 case), mild pain (1 case)	6.4 %
Greenberg <i>et al.</i> , 2012	No		0 %
Singh <i>et al.</i> , 2013	No		0 %
Peñarrocha-Oltra <i>et al.</i> , 2014	No		0 %
Streckbein <i>et al.</i> , 2014	Yes	Dysesthesia (1 case)	4 %
Restoy Lozano <i>et al.</i> , 2015	Yes	Infection (1 case), edema (3 cases)	9.3 %
Sakkas <i>et al.</i> , 2016	Yes	Infection (3 cases)	3.4 %
Voss <i>et al.</i> , 2016	N/R	N/R	N/R

N/R= no reported

In relation to the postoperative complications of the mandibular ramus as a donor site, there were 7 studies that reported complications (Prousaeffs *et al.*; Happe; Soehardi *et al.*; Cordaro *et al.*; Streckbein *et al.*; Restoy-Lozano *et al.*, Sakkas *et al.*), presenting an estimated average of postoperative complications of 6.51 %, with the most frequently observed being surgical wound infections and slight alterations in sensitivity in the donor area and lower lip of the corresponding hemiarch. The cases of infection, treated with antibiotics, limited the local infectious processes and in the case of the sensory alterations, these disappeared in a period of not more than 1 year. Analyzing the bone harvesting from the mandibular symphysis, the review done by Nkenke & Neukam (2014) demonstrated 29 % with sensory alterations, with endodontic treatment being needed in some teeth of the anteroinferior sector.

Noia *et al.* (2011) found almost 30 % neurosensory alterations in bone extractions from the mandibular symphysis, whereas Velázquez *et al.* (2017) indicated that the limited amount of cortical bone in the mandibular symphysis and the proximity to the apical dental region could be one of the causes of the major neurosensory complications in the zone. Rocha *et al.* (2010) indicated that the position of the ramus and the possibility of extension when removing the bone through the oblique line could reduce the neurosensory complications, where the use of ultrasonic systems also has a positive impact on reducing surgical site morbidity (Olate *et al.*, 2013).

Other studies have demonstrated sufficient cortical bone from this anatomical zone, close to 3 mm in the lateral region, to allow efficient installation of an osteosynthesis screw with good stability to ensure integration of the block (De Oliveira *et al.*, 2012). Therefore, selection of the type of osteosynthesis may be a relevant aspect in the block installation technique (Netto *et al.*, 2013b) since the type of screw, its shape, size and the material with which it is made present different mechanisms in the graft integration; in addition, the block graft can be incorporated into the receptor bed either by putting the cancellous bone or the cortical bone directly in contact with the receptor bed, which gives the bone extracted from the mandibular ramus greater versatility, considering the sometimes complex morphologies in the receptor bed (Netto *et al.*, 2013a).

Considering that autogenous bone continues to be the “gold standard” (Kluppel *et al.*, 2013), with

contemporary applications in both large maxillofacial reconstructions (Fariña *et al.*, 2016) and in smaller reconstructions (Netto *et al.*, 2016), other alternatives for the autogenous block graft extracted from the mandibular ramus have preferentially used homogenous or heterogeneous bone blocks with controversial results. Deluiz *et al.* (2016) studied postoperative complications in 58 patients who required implant-assisted rehabilitation and augmented volume with a block allograft. After 4 to 6 months of healing, the corresponding implants were installed: a total of 268 implants. In a 12-month follow-up period, the complications found were: infection (10.3%), surgical wound dehiscence (8.62 %), mucosal perforation (12.07 %), partial graft loss (6.9 %) and total graft loss (5.17 %). In addition, 16 (5.97 %) of the 268 implants failed. Although the use of an alloplastic graft for block reconstructions reduces morbidity when a donor site is not needed to obtain the bone graft, the study by Deluiz *et al.* described other types of postoperative complications associated with alloplastic grafts, such as partial or total graft loss. Chiapasco *et al.* (2015) reported 19 subjects with atrophic maxillae with human allogenic block grafts, of which 4 completely lost the reconstruction due to exposure of the previous graft to the implant installation, and 9 patients presented exposure and partial graft loss after the installation, concluding that such material is significantly associated with wound exposure and a high risk of implant failure.

In a study with 8 to 10 years follow-up, de Moraes *et al.* (2015) confirmed that there are no differences when comparing implant survival in non-grafted and grafted sites with bone from the iliac crest, presenting implant failures below 6 %. Although the iliac crest bone is essentially cancellous and the bone in the mandibular ramus is essentially cortical, the current success rates in this study are over 95 %. Motamedian *et al.* (2016), in a systematic review, analyzed the success rates of autologous block grafts vs. block allografts, finding similar rates; however, they indicated that the ranges are too wide and due to the low number of controlled clinical trials, it is not possible to estimate precise rates. In addition, in their work they indicated that the main concern with autogenous blocks is donor site morbidity, whereas in the case of the allograft, the main concern is the integration of the graft into the receptor site.

The findings of this review indicate that the survival rate of implants installed in reconstructed alveolar ridges with autogenous block grafts from the mandibular ramus is close to 98 %, similar to what has been observed in other studies (Clementini *et al.*, 2011),

and 100 % success was also confirmed in 7 studies (Prousaeffs *et al.*; Happe; Greenberg *et al.*; Singh *et al.*; Streckbein *et al.*; Restoy-Lozano *et al.*; Sakkas *et al.*). In an analysis of implant installation times, we observed that all the studies installed the implants after a delay, with an average time estimated for healing until implant installation of 4.9 months.

Given the articles in the search periods, a data meta-analysis was not performed, so that this narrative review with a systematic search presents conclusions in terms of a high implant success rate in sites reconstructed with mandibular ramus bone and low morbidity in the donor site; the need for a second surgical site to obtain the graft and the longer time from treatment to implant rehabilitation continue to be disadvantages.

PARRA, M.; HAIDAR, Z. S., VALDIVIA, O. J.; ARANEDA, N. & OLATE, S. Uso de rama mandibular para reconstrucción alveolar en implantología oral. *Int. J. Odontostomat.*, 11(2):236-242, 2017.

RESUMEN: Los injertos óseos son ampliamente utilizados en el aumento de rebordes alveolares atróficos para permitir la correcta instalación de implantes. Sitios donantes intraorales, tales como tuberosidad de la maxila, sínfisis y rama mandibular han presentado buenas características y resultados, sin embargo la rama mandibular presenta ventajas comparativas que estimulan el aumento en su uso. El objetivo de éste trabajo es describir los resultados actuales de la rama mandibular como sitio donante en la obtención de injertos óseos para ser utilizados en aumentos óseos alveolares en implantología oral y determinar la tasa de sobrevida de los implantes instalados en los sitios injertados. Se realizó una búsqueda sistemática de la literatura científica entre Diciembre del 2000 y Marzo de 2017 en las bases de datos MEDLINE, EMBASE, LILACS y SciELO, analizando cada artículo según el método de diagnóstico y planificación, la reabsorción ósea en el sitio receptor, presencia de complicaciones postoperatorias y tasa de sobrevida de los implantes dentales instalados. Se incluyeron 11 trabajos en este estudio con un promedio de 43 pacientes; los tiempos de seguimiento de los sujetos fluctuaron entre los 6 y 120 meses, considerando además una tasa de éxito promedio de 98,7 % en los implantes instalados en sitios reconstruidos con hueso de rama mandibular; se identificó una baja morbilidad en el

sitio donante vinculada principalmente a alteraciones neurosensoriales transitorias. Se puede concluir que continúa siendo una desventajas la necesidad del segundo sitio operatorio para la obtención de injerto y el mayor tiempo que alcanza el tratamiento hasta la rehabilitación del implante; aun así, el sitio donante de rama mandibular presenta baja morbilidad, alta versatilidad en su empleo y resultados predecibles para la instalación de implantes dentales.

PALABRAS CLAVE: rama mandibular, injerto óseo, implantes dentales

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Recibido : 04-03-2017
Aceptado: 11-05-2017