Block Allograft for Reconstruction of Alveolar Bone Ridge in Implantology: A Systematic Review

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Purpose: *The aim of this study was to evaluate the literature regarding clinical efficacy and predictability of block allograft for restoration of vertical and/or horizontal bone defects.*

Materials and Methods: *A literature search was conducted in PubMed/MEDLINE and Cochrane databases about studies reporting the use of block allografts. The review included studies published in English from 1960 to 2011 and excluded single-case reports and articles that did not use block allograft stabilized by fixation screws.*

Results: *The search revealed 567 articles, but only 14 were included, which were conducted in humans with a total of 194 patients treated with block allografts, totalizing 253 blocks.*

Conclusions: *Although a high success rate has been reported for the bone allograft survival, this systematic review demonstrated low level of scientific evidence articles with short follow-up time and diversified methodology with difficult possibilities to compare their results. (Implant Dent 2013;22:304–308)*

Key Words: allograft, alveolar bone graft, dental implant

Bone volume is an important requirement for proper positioning of implants and for osseointegration.[1,2] The correct positioning of implants enhances esthetics and better hygiene, whereas limited bone volume dictates the need for reconstruction of the alveolar ridge to improve the 3-dimensional implants insertion.[3–5]

Several surgical techniques have been presented in the literature usually associated to bone grafts and substitutes.[5–10] Autogenous bone is a reported approach and has been used in the form of block or particulate.[4,6] However, its clinical application remains limited by donor tissue volume and morbidity secondary to graft harvesting.[6]

Allografts are presented as an alternative to autogenous bone and have been used for vertical and horizontal augmentation of the alveolar ridge, despite the lack of scientific support for the bone thickness mainly when block allografts are used.[6] As this type of graft allows the selection of blocks with predetermined configuration and cortical-cancellous composition, large areas can be reconstructed with low patient morbidity.[11]

The use of allografts includes frozen, lyophilized, and demineralized-lyophilized fresh bone as well as cryopreserved grafts. All the tissues are collected from cadavers, successively treated, and stored in different ways. The rules for processing of the bone tissue, donors selection, collection criteria, storage, and records are important for the safety of this approach.[4,11–13] Most of the blocks used for alveolar reconstruction were fresh-frozen allografts. Histological and immunological evaluation did not demonstrate signs of antigenic reaction.[14] The aim of this study was to conduct a systematic review regarding the clinical efficacy and predictability of block allografts for reconstruction of vertical and/or horizontal bone defects.

MATERIALS AND METHODS

The search was conducted in the PubMed/MEDLINE and Cochrane databases including studies published in English from 1960 to 2011. The articles should accomplish block allografts stabilized by screws to increase the height and/or thickness of the alveolar bone ridge and could be associated, or not, with particulate bone- or platelet-rich plasma. The search was limited to studies conducted in humans and included the keywords "allograft block augmentation" and "allograft alveolar bone."

The following periodicals were included in the literature review: *Journal of Oral and Maxillofacial Surgery*,

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Table 1. Distribution of Publications Selected for This Review Showing Number and Use of the Bone Blocks

Reference	Year	Study Type	Patients	Blocks	Characteristics of the Bone Block
Lyford et al[24]	2003	Case series	3	5	Cortical-cancellous
Leonetti and Koup[35]	2003	Case series	4	4	Cortical-cancellous
Holmquist et al[20]	2007	Case series	6	6	Cortical-cancellous
Gomes et al[11]	2008	Prospective longitudinal	28*	15	No information
Pendarvis and Sandifer[23]	2008	Case series	9	16	Cortical
Barone et al[14]	2009	Prospective longitudinal	13	24	Cortical-cancellous
Peleg et al[21]	2010	Prospective longitudinal	41	57	Cortical
Wallace and Gellin[15]	2010	Prospective longitudinal	12	16	Cortical-cancellous
Kim et al[22]	2010	Case series	3	3	Cortical-cancellous
Maiorana et al[19]	2011	Prospective longitudinal	12	12	Cortical-cancellous
Spin-Neto et al[4]	2011	Case series	12	12†	Cortical
Contar et al[17]	2011	Prospective longitudinal	18	39	Cortical-cancellous
Macedo et al[16]	2011	Case series	9	16	Cortical-cancellous
Nissan et al[18]	2011	Prospective longitudinal	24	34	Cortical-cancellous

*Twenty-eight patients (8 with block graft, 7 with block graft and particulate bone, and 13 with particulate bone for maxillary sinus augmentation).
†Six autogenous and 6 allogeneic blocks.

Journal of Craniofacial Surgery, *Journal of Periodontology*, *The International Journal of Oral & Maxillofacial Implants*, *Journal of Oral Implantology*, *Dental Implants*, *International Journal of Periodontics and Restorative Dentistry*, *Clinical Implant Dentistry and Related Research*, *Implant Dentistry*, and *The International Journal of Oral and Maxillofacial Surgery*.

This study aimed to clarify the predictability of block allografts stabilized by screws for vertical and/or horizontal augmentation of alveolar ridge for implants insertion. Thus, scientific evidence was searched regarding its incorporation, efficacy of reconstruction, and implant survival.

The exclusion criteria were single-case report, grafts for maxillary sinus augmentation, animal studies, and association with bone morphogenetic proteins. The studies reported the block allograft associated or not to particulate bone.

RESULTS

The keywords generated 567 studies at PubMed/MEDLINE and Cochrane databases. The initial selection

Table 2. Distribution of Publications Selected for This Review, Emphasizing Augmentation Dimensions and Anatomical Considerations

Reference	Year	Anatomical Location	Augmentation Dimension	Associated Techniques
Lyford et al[24]	2003	Maxilla and mandible	Horizontal	Collagen membrane or nonabsorbable barrier + particulate autogenous bone
Leonetti and Koup[35]	2003	Maxilla and mandible	Horizontal and vertical	Collagen membrane + particulate allogeneic bone
Holmquist et al[20]	2007	Maxilla	Horizontal	No
Gomes et al[11]	2008	Maxilla and mandible	Horizontal and vertical	Particulate allogeneic bone
Pendarvis and Sandifer[23]	2008	Maxilla and mandible	Horizontal	Collagen membrane + particulate allogeneic bone + PRP
Barone et al[14]	2009	Maxilla	Horizontal and vertical	No
Peleg et al[21]	2010	Maxilla and mandible	32 horizontal and 25 vertical	Collagen membrane + dura mater membrane
Wallace and Gellin[15]	2010	Anterior maxilla	Horizontal	Collagen membrane + particulate allogeneic bone + PRP
Kim et al[22]	2010	Maxilla and mandible	Horizontal and vertical	Collagen membrane + particulate allogeneic bone (in 2 cases)
Maiorana et al[19]	2011	Maxilla	Horizontal	Collagen membrane + bovine bone
Spin-Neto et al[4]	2011	Maxilla	Horizontal	No
Contar et al[17]	2011	Maxilla	Horizontal	No
Macedo et al[16]	2011	Maxilla	Vertical	No
Nissan et al[18]	2011	Mandible	Vertical and horizontal	Collagen membrane + particulate bone

The use of different biomaterial types is also shown in the table. PRP indicated platelet-rich plasma.

Table 3. Follow-up Time According to Each Author

Reference	Follow-up	Complications	Evaluation
Lyford et al[24]	6 mo	No	Clinical
Leonetti and Koup[35]	1 y after	No	Histological of 1 case and clinical
Holmquist et al[20]	12 mo	Yes	Histological, Radiographic, and Clinical
Gomes et al[11]	1–6 y after	No	Radiographic
Pendarvis and Sandifer[23]	6 mo	No	Histological and clinical
Barone et al[14]	12 mo	Yes	Clinical
Peleg et al[21]	26 mo	No	Radiographic and clinical
Wallace and Gellin[15]	5 mo	No	Radiographic and clinical
Kim et al[22]	4.5 mo	No	Histological, radiographic, and clinical
Maiorana et al[19]	3 mo	No	Histomorphometric and histological
Spin-Neto et al[4]	7 mo	No	Histological
Contar et al[17]	11 mo	No	Histological, radiographic, and clinical
Macedo et al[16]	7 mo	Yes	Clinical and tomographic
Nissan et al[18]	43 ± 19 mo	No	Histological and histomorphometric

The follow-up time correlates evaluation types and complications according to each author.

of the periodicals was conducted by the keyword allograft alveolar bone, which revealed 523 studies, but only 3 of them fulfilled the inclusion criteria, eliminating the remaining 520 articles. The keyword allograft block augmentation generated 44 studies including 11 articles within the inclusion criteria and 33 articles that were excluded. Fourteen studies evaluated the bone reconstruction with block allografts stabilized by screws including 7 series of case reports and 7 prospective longitudinal studies (Tables 1 and 2).

All studies reported fixation of the block allografts with screws after perforation of the receptor area for better vascularization of the graft. A total of 194 patients were treated with block allografts, corresponding to about 253 blocks. The association with particulate bone (autogenous, homogenous, or xenogenous source) was reported in some studies. Platelet-rich plasma was also used in two studies, totalizing 21 patients. Eight articles reported the use of absorbable collagen membrane, including 1 with dura mater membrane, 1 with particulate allogeneic bone, and 5 with no mechanical barrier.

The horizontal bone augmentation was the most frequent for the block allograft, which justifies its main indication. Maxilla and mandible were reconstructed, but a higher number of cases were reported in maxilla.

Considering the evaluation of the bone grafts, only Wallace and Gellin[15] and Macedo et al[16] conducted tomography to assess the quality and quantity of the bone tissue after grafting. Histological analysis was described in 8 studies, and most of the specimens were collected from 3 to 6 months after surgery, revealing adequate bone neoformation. Two studies, Contar et al[17] and Nissan et al,[18] presented longer evaluation periods of 11 months and 12 to 66 months, respectively. Six studies presented radiographic analysis. Nissan et al[18] and Maiorana et al[19] conducted histomorphometry of the grafted area and demonstrated adequate regeneration.

The follow-up periods ranged from 3 to 43 ± 19 months, and 12-month follow-up was the most frequent one (Tables 3 and 4). Barone et al[14] and Holmquist et al[20] revealed that dehiscence with graft exposure was the most frequent complication. Barone et al[14] and Nissan et al[18] revealed a success rate close to 100% for the graft incorporation (99.20% and 100%, respectively) and implant survival (95% and 95.3%, respectively). In addition, Peleg et al[21] reported a success rate of 98.81% for the implants during a 26-month follow-up. Although Contar et al,[17] Kim et al,[22] Pendarvis and Sandifer,[23] and Lyford et al[24] inserted implants in grafted areas, the authors did not evaluate the survival rate of the implants.

Table 4. Follow-up Time According to Each Author

Reference	Number of Implants	Implant Survival (%)	Grafting Success (%)
Lyford et al[24]	4	—	100
Leonetti and Koup[35]	No information	100	100
Holmquist et al[20]	16	100	100
Gomes et al[11]	24	100	100
Pendarvis and Sandifer[23]	16	—	100
Barone et al[14]	38	95	99.20
Peleg et al[21]	84	98.81	100
Wallace and Gellin[15]	—	100	100
Kim et al[22]	4	—	100
Maiorana et al[19]	24	100	100
Spin-Neto et al[4]	40	100	100
Contar et al[17]	58	—	100
Macedo et al[16]	—	—	100
Nissan et al[18]	85	95.3	100

The follow-up time correlates the number of implants, implants survival and grafting success according to each author.

DISCUSSION

Recent systematic reviews concluded that clinical evidences are enough to support the vertical and horizontal bone reconstruction of the alveolar ridge for insertion of dental implants.[7,25] The autogenous grafts are still considered the gold standard for reconstruction, mainly for large defects, and present implant survival rates similar to nongrafted areas.[26–28] However, the volume

limitation and morbidity after graft harvesting reduce its indication and lead to the development of alternative approaches. The allografts do not present such limitations and complications, whereas some histological studies have demonstrated its viability even though particulate allografts have been used in those situations.[29,30] Thus, the present systematic review revealed that the recent clinical evidence about efficacy of block allografts for vertical and horizontal augmentation is still limited.

Considering the results of this study, it was observed that most of the articles included single-case reports. However, this category was excluded from the review because it presents weak scientific evidence.[31] Thus, prospective longitudinal studies and multiple-case reports were considered for analysis representing stronger scientific evidence.[32]

One limitation in the present review was the absence of standardization for the evaluation methods of the grafted areas. Contar et al,[17] Kim et al,[22] Pendarvis and Sandifer,[23] and Lyford et al[24] did not evaluate the implant survival rate. These authors only considered the clinical and histological characteristics of the grafts during implant insertion through measurements of the bone tissue and removal of material for microscopic analysis. The histological analysis revealed bone with no signs of acute inflammatory reaction, presence of immature bone, and revascularization at 3 to 11 months. Although these results are similar to autogenous bone grafting,[33] Goldberg and Stevenson[34] stated that such grafts require longer periods for complete revascularization and substitution, which results in longer period for implant insertion.

Success rates with low standard deviation were observed in cases with more than 12 months of follow-up for implants inserted in the grafted areas.[4,11,14–25] Among these articles, only 6 reported a follow-up longer than 1 year.[4,11,17,18,20,21,32,35] Although the first year could be a reasonable evaluation period, the grafts may require longer period for integration and remodeling, which could significantly influence the long-term results. Nissan et al[18] who presented a longer follow-up revealed lower survival rate of the implants around 95.3% success rate during follow-up from 19 to 43 months of implant insertion. Although this result represents a significant loss in comparison to the studies with shorter periods, the rates are within the criteria established by the National Institute of Health.[36] Controlled clinical trials are also important to evaluate the role of grafts on implant survival. However, Woo et al[37] used autogenous grafts and did not consider this modality as a risk factor.

An additional limitation of the present review was the wide variability of the reconstructed areas, although most of the defects corresponded to a small region of 1 or 2 implants. It is important to highlight that thin areas and extensive atrophies may represent poor vascularization for the grafts. Considering that the graft performance is also influenced by different receptor sites, maxilla, which presents more vascularization and less cortical bone, allows faster incorporation of the graft than mandible. Carvalho et al[38] found different results for incorporation and volume maintenance of grafts in cortical areas that were prepared to improve the medullary or endosteal vascularization. Among the 14 studies selected in the present review, mandible was reported in 7 studies. There was not enough information about the specific area of each jaw, success rate of reconstruction, and implant survival.

The criteria for clinical evaluation should be also improved and standardized. As no consensus is established to classify the successful grafting, some aspects are considered as nonexposure of the grafts, postoperative infection, clinical appearance of the grafted area, bleeding after removal of the fixation screws, possibility of implants insertion, and implant survival. There was no report about the clinical examination applied to determine the survival of the grafts and implants.

Considering the characteristics of the bone block, cortical-cancellous bone was the most frequent.[4,14,17–20,22,35] There was also variation for the materials associated to the grafts. Although the collagen membrane was the most common, autogenous and homogenous particulate bone, dura mater membrane, and platelet-rich plasma were also reported.[4,11,15,18,19,21–24,35] However, it would be important to evaluate the influence of such materials on the results, making it difficult the comparison among the studies.

Few studies reported complications of the grafts.[4,14,16,18] Barone et al[14] observed collapse of the soft tissue and graft exposure and associated this factor to the slow revascularization of the allograft, resulting in delayed healing. As onlay autogenous grafts, dehiscence seems to be the most common complication, which may lead to partial or complete loss of the graft, mainly in the mandibular reconstruction.[6] The present review demonstrated that additional studies are necessary to support this modality of bone reconstruction as an adequate alternative to the autogenous graft.

CONCLUSIONS

Although some studies demonstrated high success rate for this treatment approach, the present systematic review revealed that the block allografts stabilized by screws for reconstruction of alveolar ridge in Implantology are supported by only few studies with short follow-up and limited methodology. Thus, additional studies with longer follow-up periods of the grafted areas and implants are necessary as well as controlled clinical trials to provide reliable scientific evidence.

DISCLOSURE

The authors and the institution declare that there are no financial or personal relationships with other people or organizations, actual or potential, that inappropriately could influence this work.

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