Review Article

Success rate of implants placed in autogenous bone blocks versus allogenic bone blocks: A systematic literature review

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ABSTRACT

The aim of this study is to review and compare survival/success rate of dental implants inserted in autogenous and allogenic bone blocks (ALBs). A PubMed search was performed from January 1990 to June 2014 limited to English language and human studies. Studies that reported treatment outcome of implants inserted in augmented alveolar ridges with autogenous or ALBs were included. Primary search identified 470 studies. For autogenous bone block (ABB) 36 articles and for ALB 23 articles met the inclusion criteria. Evidence on implant survival/success rate of both techniques was limited to observational studies with relatively small sample sizes. Study design, treatment methods, follow-ups, defect location, and morphology varied among studies. The range of implant survival and success rates in ABB was from 73.8% to 100% and 72.8% to 100%, respectively. The corresponding numbers for ALB were 95.3–100% and 93.7–100%, respectively. A definite conclusion could not be reached. Future studies with long-term follow-ups are required to further elucidate this issue.

Keywords: Allografts, alveolar bone grafting, alveolar bone loss, alveolar ridge augmentation, dental implantation

INTRODUCTION

Dental implants are an alternative treatment for replacement of missing teeth. To achieve optimum treatment outcome with dental implants, sufficient bone should be available to support and stabilize them.[1,2] Alveolar bone defects occur due to periodontitis, trauma, tumors, or resorption following tooth extraction and need augmentation before placement of dental implants.[3,4] Augmentation of atrophic jaws can be performed using autogenous[5] or tissue engineered bone grafts[6,7] or guided bone regeneration.[8] Autogenous block used as onlay bone graft is considered as the "gold standard" for reconstruction of atrophic ridges.[9,10] Autogenous grafts can be harvested from intraoral or extraoral donor sites. Intraoral donor sites such as symphysis, lateral ramus, and tuberosity are associated with less morbidity and resorption[11] when compared to extraoral donor sites.[12,13] However, the larger the defect of the jaw, the greater the need for an extraoral donor site such as the iliac crest, calvarium, and tibia. Autogenous donor site morbidities and limitations[14] such as transient paresthesia, costs, and hospitalization[15,16] prompted the need for allogenic human bone. Allogenic blocks are categorized based on their preparation process. The preparation process along with sterilization of allografts is performed to reduce immune

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response and inhibit disease transmission.[17] Fresh frozen bone allografts (FFBAs) induce a stronger immune response compared to freeze-dried bone allografts (FDBA).[18,19] However, freeze drying decreases the mechanical properties of the bone block.[17,20] Clinical application of these materials has been reported in some case series.[17,18] However, successful integration and remodeling of these bone substitutes have been an issue of debate.[21]

Although the use of allogenic bone block (ALB) is tempting, treatment outcome in comparison with autogenous bone block (ABB) has never been reviewed to provide scientific evidence for clinical application. Herein, we review survival and success rates of dental implants inserted in ALB and ABB.

MATERIALS AND METHODS

Study design

In the current review, studies that reported treatment outcome of implants (survival/success rates) inserted in augmented alveolar ridges with ABB or ALB in humans were included. Inlay bone grafting was excluded and only onlay use of bone blocks was evaluated. In addition, studies which used growth factors or stem cells in conjugation with bone grafts were excluded. Studies that used various augmentative techniques and did not report implant survival/success rates of onlay bone blocks separately were also excluded. The study design was not a criterion of inclusion for this attentive review and any clinical research was included. Studies on cases with the primary cause of alveolar defect being neoplasm, osteoradionecrosis, or congenital malformations were also excluded.

Search strategy

An electronic search of the literature in PubMed was carried out from January 1990 to June 2014 limited to English language and human studies. The following search terms were used based on PICO model:

Patient: Human.

Intervention: AND ("onlay graft*" OR "onlay bone graft*" OR "iliac crest" OR "ilium" OR "allograft bone*" OR "autograft bone*" OR "bone transplant*" OR "block graft*" OR "block bone*" OR "block autograft*" OR "block allograft*" OR "fresh frozen bone*" OR "freeze dried bone*" AND (implant OR implants).

Control: No term was used for the control group to include studies which reported only the results of on technique.

Outcome: AND (survival OR complication* OR failure* OR success*).

Primary selection including screening titles and abstracts was based on the inclusion criteria and full texts of all eligible studies were obtained. The authors reviewed full texts. Searching and screening process was performed by two reviewers independently and any disagreement was discussed by a third reviewer. Among different reports of one experiment, only the latest report, which revealed the most relevant information with respect to the measurements of this review, was included.

Data extraction included implant survival/success rate, treatment complications, and histological evaluations.

Quality assessment

During data extraction, the quality assessment of the included articles was undertaken by the authors according to the following parameters:[22] Proper randomization (yes/no); presence of both control and test groups (yes/no); surgeon blinded to treatment (yes/no/unclear); blindness to outcome (yes/no/unclear); follow-up completion (yes [withdrawal or dropout explanation]/no). Similar to the search process, quality assessment was also done by two reviewers independently and any disagreement was discussed by a third reviewer.

The experiments were then grouped as either low risk of bias (bias unlikely to influence the outcomes) if all criteria were met; medium risk of bias if three or four criteria were met; or high risk of bias (bias that might weakens confidence in results) if three or more criteria were not met.

RESULTS

Electronic search of the literature yielded a total of 635 articles, of which 57 were included [Figure 1]. Thirty-six out of 57 were related to ABB and 23 to ALB. Two studies compared both techniques.[23,24] Due to the lack of randomized clinical trials and a wide range of study designs, data reporting, recipient site and morphology, defect diameter, graft type, etc., a quantitative outcome measurement could not perform.

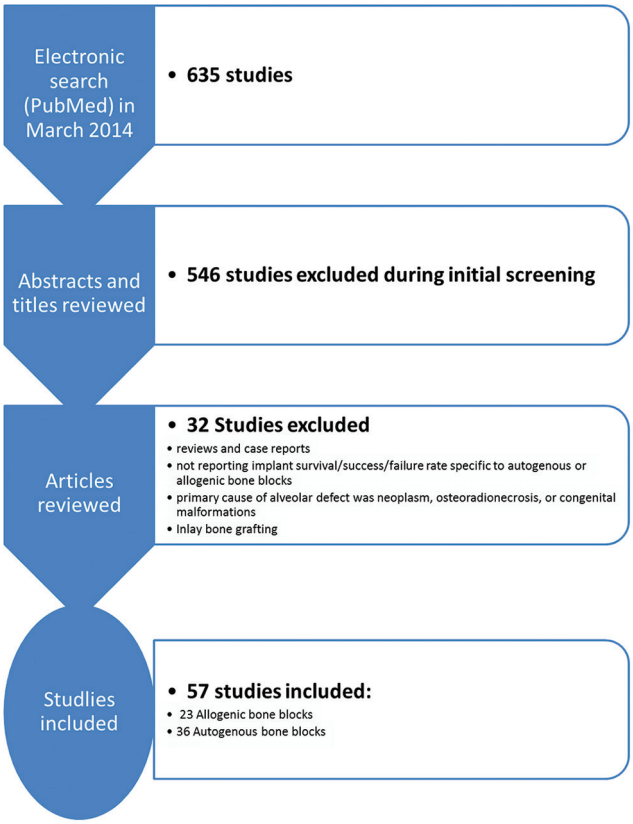

Figure 1: Literature search strategy

The results of the literature review (patients and methods, implant survival rate, complication, and histologic evaluation) are presented separately for each type of the bone block.

AUTOGENOUS BONE BLOCK

Patients and methods

Thirty-six studies that fit this category are displayed in Table 1. Assessing quality of the reviewed publications demonstrated that most of the articles were retrospective studies. Overall, 872 patients who needed alveolar ridge augmentation before implant placement were treated with ABB. Among the studies that reported the type of edentulism, 247 cases were partially edentulous and 205 patients were totally edentulous.

Graft-recipient site was exclusively in the maxilla in 16 studies including 343 patients[12,23,25-38] and exclusively in the mandible in nine studies including 145 patients.[15,39-46] In three studies (36 patients), only the posterior mandible was reconstructed[15,41,42] and in four studies (64 patients) the defects were located in anterior maxillary area.[25-28] Defects were augmented mostly vertically (height range: 3–10 cm)[28,39-41,15,44,46,47,55] and horizontal augmentation was performed in fewer patients (width range: 2–6).[23,25,29,42,48,49] In ten studies, both horizontal and vertical augmentation had been performed.[12,26,31,32,34-36,51,53,55]

Intraoral sites (mental symphysis, mandibular body/ramus, and maxillary tuberosity) were the primary source of autogenous bone (362 patients) followed by Iliac crest in 295 patients. The calvarium was the graft source in three studies;[31,43,54] however, the number of used calvarial grafts was not reported. The harvested bone was used alone as a block bone graft in 419 patients (48% of the cases). Particulate bone (autogenous, allogenic, or synthetic) was used in combination with block graft in 399 patients. Collagen membrane and titanium mesh were used in 169 and 50 patients, respectively.

Outcome

Implant success and survival rates

The included studies involved insertion of 2,647 implants; of which, 968 were inserted simultaneously with grafts. Survival rates ranging from 73.8% to 100% over 12–192 months were reported in 19 studies.[12,16,24,25,27-33,37-39,41,42,43,44,46-48,51-53,55] Success rates of 72.8–100% were reported in 12 studies.[23,26,29,34-36,40,41,15,43,45,47-50,52,54] Criteria for implant success rate were based on Albrektsson *et al*.'s criteria[56] in nine[29,15,43,47,49,50,52,54] and Buser *et al*.'s[57] criteria in two of them.[41,48] Among studies that only treated maxillary defects, survival and success rates of implants ranged from 73.8% to 100%[12,25,27-33,37,38] and 72.8% to 100%,[23,26,29,34-36] respectively. In studies on the mandible, the corresponding numbers ranged from 90% to 100%[39,41,42,43,44,46,47] and 88.2% to 93.3%,[40,41,15,43,45] respectively. Survival and success rates of implants inserted in the anterior zone of the maxilla were from 75% to 100%[25,27,28] and 81.2%,[26] respectively. In the posterior mandible, the corresponding numbers were 95.6–100%[41,42] and 89.5–91.1%,[15,41] respectively. Studies that harvested bone grafts from intraoral sites reported 94.1% to 100%[16,24,25,28,29,41,42,47,48,52,53,55] and 81.2% to 100%[26,29,41,15,47-49,52] implant survival and success rates, respectively. The corresponding ranges for extraoral donor sites were 73.8–100%[12,27,30,31,33,37-39,43,44,46] and 72.8–96.1%,[23,34-36,40,43,45,54] respectively.

Complications

Most of the studies did not report complications or stated no major complications. Other studies reported few occurrences of minor complications including peri-implantitis,[37,39] exposure of the membrane,[55] exposure of the graft,[12,15,41,43,47-49] infection,[31,38,47] soft tissue dehiscence,[31,38,40,41,43,45,48] hematoma,[27,33] discomfort,[37,38] and graft loss.[26,33,35]

Neurosensory disturbance as a major complication was mostly associated with intraoral donor sites.[40,41,45,48] McGrath *et al*.[40] and van der Meij *et al*.[45] reported mental nerve damage in 11.1% and 14.7% of patients, respectively. In a study by Isaksson *et al*.,[37] one patient had neurological disturbances following bone harvesting from the iliac crest.

Histological evaluation

Bone graft integration was histologically evaluated in two studies both using mandibular lateral ramus bone blocks.[24,29] The nonvital bone was 57.75%[29] and 55.9%[24] of total tissue volume; 27.6% vital bone and 16.4% connective tissue formation were reported by Spin-Neto *et al*.[24]

ALLOGENIC BONE BLOCK

Patients and methods

Twenty-three studies that fit this category are displayed in Table 2. Assessment of the quality of the reviewed publications demonstrated that most of the articles were case series. Overall, 532 patients who needed alveolar ridge augmentation prior to implant placement were treated by means of ALB. Among the studies reported, the type of edentulism in 209 cases was partially edentulous and only 15 patients were totally edentulous.

The recipient site was exclusively the maxilla in 11 studies (212 patients)[23,58-67] and exclusively the mandible in two studies (45 patients).[68,69] In one study (24 patients), only the posterior mandible[68] was reconstructed and in two studies (51 patients) the defects were located only in the anterior maxilla.[58,59] Most defects underwent horizontal augmentation (width range: 2–5 cm)[23,24,60-62,64,66,67,72,73,76-78] and vertical augmentation was performed in fewer patients (height range: 3–4 cm).[64,68,73] In nine studies, both horizontal and vertical augmentations were performed.[58,59,63,66,68,72,73]

Different kinds of allograft bone blocks were used. FFBA was the most common type (254 patients) followed by FDBA (94 patients). The block bone was used alone in 210 patients (39.5% of the cases). Particulate bone (allogenic and xenogenic) was applied in combination with block graft in 81 patients. Resorbable/nonresorbable membranes (272 patients), platelet-rich plasma (three patients),[71] or bone marrow aspirate (five patients)[66] was also used.

Outcome

Implant success and survival rates

The included studies involved insertion of 1395 implants; of which, 48 were inserted simultaneously with the graft. Survival rates ranging from 95.3% to 100% over 12–60 months were reported in 19 studies.[24,58,60-63,65-78] Success rates of 94.7–100%

Table 1: Summary of autogenous bone block studies

Authors	Study	Donor site	Defect type	Number of patients	Patients health condition	Type of edentulism	Site	Defect's height (mm)	Defect's width (mm)	Augmentation material	Number of Implants	Implant insertion	Follow-ups (months)	Implant outcome	Complications
Jemt and Lekholm 2003[25]	PS	Symphysis	H	10	All healthy, nonsmokers	PE	AMx	-	-	Particulate bone	10	6 months	24	cSVR: 100%	No complications
Balaji 2002[26]	CS	Symphysis	V and H	10	No significant medical contraindications	PE	AMx	-	-	-	11	3 months	24-36	SCR: 81.2%	1 graft loss
Astrand *et al*. 1996[27]	CS	Iliac	-	17	NM	-	AMx	-	-	Particulate autogenous bone	92	Sim	12-36	SVR: 75%	Few hematoma in the palate
Raghoebar *et al*., 1996[28]	RS	Symphysis, retromolar, tuberosity	V	27	NM	PE	AMx	>10	<2	Particulate bone	31	3 months	24-68	SVR: 100%	No major complications
Acocella *et al*., 2010[29]	PS	Ramus	H	15	All healthy, 4 smokers	PE	Mx A-P	-	3.13	Particulate autogenous bone	30	3-9 months	12	SVR: 100% SCR: 100% (Albrektsson)	No major complications
Barone and Covani 2007[12]	RS	Iliac	V and H	56	Healthy, health permitting GA	18 PE 38 TE	Mx A-P	-	2-3	Porcine bone particle + CM	162	4-5 months	6	SVR: 95%	3 early graft exposure
Molly *et al*., 2006[30]	RS	Iliac	-	18	NM	TE and PE	Mx A-P	-	-	-	85	8 months	168-192	cSVR: 77.2-86.7%	-
Keller *et al*. 1999[31]	RS	Cranium, iliac	V and H	32	NM	4 PE edentulous 28 TE	Mx A-P	-		Titanium miniplates/lag screws	204	4-6 months	144	SVR: 86.3% (Smith and Zarb)	8 fistula formation 8 soft tissue penetration
Lekholm *et al*., 1999[32]	RS	-	V and H	47	NM		Mx A-P	-	-	-	206	Sim	36	SVR: 77%	-
Dahlin and Johansson 2011[23]	RS	Iliac	H	13	NM	-	Mx	-	-	-	-	6 months	60	SCR: 96.1% (Albrektsson)	-
Clayman 2006[33]	CS	iliac	-	8	NM	TE	Mx	<4	-	The per-alveolar retention wires	41	6 months	90.5	SVR: 83%	2 partial graft loss 1 hematoma
Nystrom *et al*., 2004[34]	RS	Iliac	V and H	30	Health permitting GA	-	Mx	<7	<4	-	177	Sim	120	SCR: 72.8%	-
Widmark *et al*., 2001[35]	CT	Iliac	V and H	16	NM	TE and PE	Mx	-	-	-	101	68: Sim/ 33: delayed	36-60	cSCR: 74%	Loss of grafts and implants
van Steenberghe *et al*., 1997[36]	CS	Iliac	V and H	13	NM	TE	Mx	-	-	-	72	Sim	12-120	cSCR: 85%	No major complications
Isaksson and Alberius 1992[37]	RS	Iliac	-	8	All healthy, two had duodenal ulcers, All but 1 were heavy smokers	PE	Mx	-	-	-	46	Sim	32-64	SVR: 86%	1 early peri-implant infection Postoperative pain from the iliac bone 1 neurological disturbance

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Table 1: Contd...

Authors	Study	Donor site	Defect type	Number of patients	Patients health condition	Type of edentulism	Site	Defect's height (mm)	Defect's width (mm)	Augmentation material	Number of Implants	Implant insertion	Follow-ups (months)	Implant outcome	Complications
Adell *et al.*, 1990[38]	RS	Iliac	-	23	NM	TE	Mx	-	-	Particulate autogenous bone	124	Sim	50.4	SVR: 73.8%	1 fistula 9 minor sequestra, and/or minor dehiscences 5 fistulae and dehiscences 1 persistent facial pain 1 exposed marginal fixture threads
Verhoeven *et al.*, 1997[39]	PS	Iliac	V	13	NM	TE	AMn	7.3-8.9	-	-	30	Sim	30	SVR: 100%	7 peri-implantitis
McGrath *et al.*, 1996[40]	RS	Iliac	V	18	NM	-	AMn	-	-	Particulate bone + hydroxyapatite	36	Sim	12-32	SCR: 91.6%	11.1% damage to the mental nerve Early dehiscence in some patients
Peñarrocha-Oltra *et al.*, 2014[41]	RS	Symphysis, ramus	V	20	No contraindication to IT	PE	PMn	7-8 (above inferior alveolar nerve)	-	Particulate autogenous bone + βTCP + CM	45	6-8 months	12	SVR: 95.6% SCR: 91.1% (Buser *et al.*)	3 temporary hypoesthesia 3 wound dehiscence with graft exposure 1 exposure of the osteosynthesis screw without bone graft exposure
Ozkan *et al.*, 2007[42]	CT	Chin	H	8	All healthy, nonsmoker	-	PMn	-	3.2±0.3	Particulate autogenous bone	17	4 months	12	SVR: 100%	_
Chiapasco *et al.*, 2007[15]	PS	Ramus	V	8	health permitting GA	PE	PMn	-		Particulate bone	19	4-5 months	24-48	SCR: 89.5% (Albrektsson)	1 graft exposure
Chiapasco *et al.*, 2008[43]	RS	Cranium, iliac	-	16	No systematically compromised health	PE	Mn A-P	-	-	-	60	4-7 months	94	cSVR: 96.7% cSCR: 93.3% (Albrektsson)	1 fracture of titanium plate 1 dehiscence of the flap, with partial graft exposure
Bell *et al.*, 2002[44]	RS	Iliac	V	14	NM	TE	Mn A-P	9 in the mandibular midline and 5 in the body region	-	-	70	4-6 months	24-48	SVR: 100%	-
van der Meij *et al.*, 2005[45]	RS	Iliac	-	17	NM	-	Mn	-	-	Particulate bone	34	Sim	52	SCR: 88.2%	2 minor wound dehiscences 2 major wound dehiscences 14.7% damage of the mental nerve

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Table 1: Contd...

Authors	Study	Donor site	Defect type	Number of patients	Patients health condition	Type of edentulism	Site	Defect's height (mm)	Defect's width (mm)	Augmentation material	Number of Implants	Implant insertion	Follow-ups (months)	Implant outcome	Complications
Vermeeren *et al*., 1996[46]	RS	Iliac	V	31	NM	TE	Mn	≤8	-	-	78	Sim	60	SVR: 90%	-
Kim *et al*., 2013[47]	RS	Ramus	V	28	Physically healthy	TE and PE	Mx-Mn A-P	-	-	Particulate autogenous bone	61	6.2 months	85.2	cSVR: 94.1% cSCR: 90.2% (Albrektsson)	2 early graft resorption 1 infection 4 graft exposure 1 of mobility of grafts after screw removal
Peñarrocha-Diago *et al*., 2013[48]	RS	Intra oral sites	H	42	No contraindication to IT	TE and PE	Mx-Mn A-P	-	≤4	Particulate autogenous bone + βTCP + CM	71	38: Sim/33: 6.8 months	12	SVR: 98.5% SCR: 92.9% (Buser *et al*.)	Temporary paresthesia, wound dehiscence with bone graft exposure, and exposure of osteosynthesis screw occurred in 9 patients
Boronat 2010[49]	RS	Chin, retromolar, tuberosity	H	37	No contraindication to IT	TE and PE	Mx-Mn A-P	-	≤4	Particulate bone + CM	73	Sim	12	SCR: 95.9% (Albrektsson)	8 graft exposure
Elo *et al*., 2009[50]	RS	Iliac crest, tibia, chin, retromolar	-	65	NM	_	Mx-Mn A-P	-	-	-	184	-	36	SCR : 97% (Albrektsson)	-
Sbordone *et al*., 2009[51]	RS	Chin, iliac	V and H	40	NM	3 TE 37PE	Mx-Mn A-P	<7	<6	Particulate autogenous bone/lag screw	109	3-5 months	36	SVR: 100% cSVR: 99.1%	-
Levin *et al*., 2007[16]	RS	Symphysis, retromolar, ramus	V or H	50	NM	-	Mx-Mn A-P	-	-	-	129	5.2 months	24.3	SVR: 96.9%	-
Cordaro *et al*., 2002[52]	RS	Ramus, symphysis	V or H	15	NM	PE	Mx-Mn A-P	-		-	40	6 months	12	SVR: 100% SCR: 100% (Albrektsson)	No major complications
Sethi and Kaus 2001[53]	PS	Symphysis, ramus	V , H or both	60	NM	PE	Mx-Mn A-P	-	-	-	118	3-6 months	22	SVR: 98.3%	Infection of the graft, Sensory disturbances in the buccal mucosa adjacent to the molar teeth, gingival recession, dehiscence of the wound
Chiapasco *et al*., 1999[54]	CT	Cranium, iliac	H	15	Good health	PE	Mx-Mn A-P	≤4	-	Particulate bone	44	6-8 months	22.4	SCR: 90.9% (Albrektsson)	No major complications

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Table 1: Contd...

Authors	Study	Donor site	Defect type	Number of patients	Patients health condition	Type of edentulism	Site	Defect's height (mm)	Defect's width (mm)	Augmentation material	Number of Implants	Implant insertion	Follow-ups (months)	Implant outcome	Complications
Spin-Neto *et al*., 2014[24]	CS	Ramus	H	14	No systemic diseases affecting bone turnover, or interfere with treatment	-	Mx-Mn	-	<4	CM	-	6 months	NM	SVR: 100%	No major complications
Roccuzzo *et al*., 2004[55]	PS	Ramus, symphysis	V or V and H	18	All healthy, nonsmoker	PE	Mx-Mn	4.9		Particulate bone/titanium micro-mesh	37	4-6 months	NM	SVR: 100%	4 exposure of the Ti-mesh

CS=Case series; CT=Clinical trial; RS=Retrospective study; PS=Prospective study; V=Vertical; H=Horizontal; TE=Total edentulous; PE=Partial edentulous; Mx=Maxilla; Mn=Mandible; CM=Collagen membrane; NM=Not mentioned; SVR=Survival rate; SCR=Success rate; cSVR=Cumulative survival rate; cSCR=Cumulative success rate; Sim=Simultaneous Insertion; IT=Implant therapy; GA=General anesthesia

were reported in four of the studies.[23,59,63,64] Criteria for implant success rate were based on Albrektsson *et al*.'s criteria[56] in three of them[23,63,64] while other studies did not mention the success criteria. Among studies that only treated maxillary defects, survival and success rates of implants ranged from 98.3% to 100%[58,60-63,65-67] and 94.7% to 100%,[23,59,63,64] respectively. In studies on the mandible, the implant survival rate ranged from 95.3% to 100%.[24,68-78] No study reported implant success rate in the mandible. Survival of implants inserted in the anterior zone of the maxilla was between 98.8%[58] and 100%.[60] In the posterior mandible, implant survival rate was 95.3%.[68]

Complications

Most of the studies did not report complications and no major complications were recorded. Other studies reported few occurrences of minor complications including graft exposure,[24,61,64,65,72] graft loss,[24,72,75] soft tissue dehiscence,[59,70,75] and infection.[70,75,78]

Histological evaluation

Bone graft integration was histologically evaluated in 11 studies,[24,58,60,61,65,66,68,71,75,76,78] mostly revealing incorporation and remodeling of block allograft with no inflammatory response. However, Acocella *et al*.[60] reported poor cellular activity and poor amounts of newly formed bone with no signs of rapid revascularization of the recipient site. In the cited article, osteoclasts were rarely detected and a mixture of fibrous and new bone formation was observed at the graft recipient site interface in some cases. The presence of a large number of osteocytes trapped within the mineralized matrix, angiogenesis, and few osteonic structures was reported by Orsini *et al*.[61]

The amount of nonvital bone, vital bone, and soft tissue ranged from 26% to 61.96%, 8.4% to 44%, and 27% to 48.4%, respectively.[24,58,60,61,66,68] The new bone presented features of mainly woven and lamellar bone with large marrow spaces.[60,75]

QUALITY ASSESSMENT

Estimated risk of bias for each study is reported in Table 3 that shows that almost all included studies had a high risk of bias.

DISCUSSION

Autogenous onlay grafts are considered the gold standard treatment for alveolar defects. Systematic reviews on survival rates for dental implants in ABB augmented alveolar ridges showed various study designs.[79,80] Due to limitations of ABB, onlay grafting with allogenic blocks has been recently evaluated. However, reviews on ALB reported a lack of evidence for the establishment of its treatment efficacy.[81,82] The current review compared implant treatment outcomes between ABB and ALB. Most biocompatible substitutes can be integrated into the host bone due to minimal inflammatory response, but only the remodeled tissue can be named a successful bone graft. The normal remodeling process of the jaw usually takes more than 12 months.[4]

Table 2: Summary of allogenic bone block studies

Authors	Study	Type of graft	Defect type	Number of patients	Patients health condition	Type of edentulism	Site	Defect's height (mm)	Defect's width (mm)	Augmentation material	Number of implants	Implant insertion	Follow-ups (months)	Implant outcome	Complications
Nissan *et al*., 2012[58]	RS	Cancellous FDBA	H and V	40	NM	-	AMx	≥3	≤3	CM	83	6 months	14-83	SVR: 98.8%	-
Nissan *et al*., 2008[59]	RS	Cancellous FDBA	H and V	11	Good health, nonsmoker	PE	AMx	≤4	3≥	CM	12	5 months	18	SCR : 100%	1 minor soft tissue dehiscene
Acocella *et al*., 2012[60]	PS	FFBA	H	16	Good health, no contraindication to RBS	TE and PE	Mx A-P	-	2-4	-	34	4-9 months	18-30	SVR: 100%	-
Orsini *et al*., 2011[61]	CS	Corticocancellous FFBA	H	10	No contraindication to IT	PE	Mx A-P	-	2.3±0.4	Soft FFB chips	14	5 months	24	SVR: 100%	1 exposure of the graft
Wallace and Gellin 2010[62]	CS	Cancellous FDBA	H	12	No contraindication to IT	PE	Mx A-P	-	≥5	Particulate mineralized cortical allograft + CM	17	5 months	4	SVR: 100%	No complication
Carinci *et al*., 2010[63]	RS	FFBA	H and V	69	NM	TE and PE	Mx A-P	-	-	-	287	4-6 months	26	SVR: 98.3% cSCR: 96% in the first year (Albrektsson)	-
Barone *et al*., 2009[64]	PS	Corticocancellous DFBA	5 block for V augmentation and 19 for H augmentation	13	No contraindication to RBS	PE	Mx A-P	-	-	Additional cancellous chips	38	5 months	-	SCR: 94.7% (Albrektsson)	2 early exposure of graft
Contar *et al*., 2009[65]	PS	FFBA	-	15	No systemic medical conditions	TE	Mx A-P	-	-	-	51	9 months	24-35	SVR: 100%	1 early exposure of graft
Soltan *et al*., 2007[66]	CS	Corticocancellous BA	H or H and V	5	NM	PE	Mx A-P	-	-	Particulate allograft/ bone marrow aspirate	23	4-8 months	NM	SVR: 100%	-
Dahlin and Johansson 2011[23]	RS	DFDB	H	13	NM	-	Mx	-	-	CM	-	6 months	60	SCR: 98.7% (Albrektsson)	-
Gomes *et al*., 2008[67]	RS	-	H	8	NM	-	Mx	-	-	-	-	8 months	12-48	SVR: 100%	-
Nissan *et al*., 2011[68]	RS	Cancellous BA	H and/or V	24	NM	-	PMn	≥3	≥3	CM	85	6 months	12-66	SVR: 95.3%	_
Carinci *et al*., 2009[69]	RS	FFBA	-	21	No contraindication to RBS	TE and PE	Mn	-	-	-	63	-	20	SVR: 96.8%	-
Nissan *et al*., 2011[70]	CS	Cancellous FDBA	H and V	12	NM	PE	Mx-Mn A	≤3	≥3	Particulate bovine bone mineral + CM	21	6 months	30	SVR: 95.2%	4 soft tissue breakdown 1 fistula in the marginal gingival
Petrungaro *et al*. 2005[71]	CS	Corticocancellous BA	2 patients H, 1 V and H	3	Nonsmokers	PE	AMx PMn	-	-	PRP + CM	7	Delayed	6 in 1 patient and 18 in other patients	SVR: 100%	-

Contd...

Table 2: Contd...

Authors	Study	Type of graft	Defect type	Number of patients	Patients health condition	Type of edentulism	Site	Defect's height (mm)	Defect's width (mm)	Augmentation material	Number of implants	Implant insertion	Follow-ups (months)	Implant outcome	Complications
Novell *et al.*, 2012[72]	RS	FDBA	15 patient just H, 5 patient H and V	16	NM	TE and PE	Mx-Mn A-P	-	-	CM	46	Delayed	12-60	SVR: 100%	33 × posure of graft 1 graft fracture
Peleg *et al*. 2010[73]	RS	Corticocancellous BA	H and/or V	41	Good health, nonsmokers	PE	Mx-Mn A-P	-	-	Freeze-dried dura mater membrane	84	3-4 months	26	SVR: 99%	No complication
Viscioni *et al.*, 2010[74]	RS	FFBA	-	81	No contraindication to IT	TE and PE	Mx-Mn A-P	-	-	-	350	48: Sim/302: Delayed	32	SVR: 93.7% in Sim and 98.6% in delayed	-
Keith *et al.*, 2006[75]	PS	Corticocancellous BA	-	73	2 smokers	PE	Mx-Mn A-P	-	-	CM	97	4-6 months	25-36	SVR: %99	7 block allografts failed as improper contouring, prosthesis impingement, and/or infection 7 soft tissue dehiscence
Leonetti and Koup 2003[76]	CS	Corticocancellous BA	H	4	No contraindication to IT	PE	Mx-Mn A-P	-	3 reported in only 1 patient	Particulate allograft + CM	4	5-7 months	12	SVR: 100%	-
Lyford *et al.*, 2003[77]	CS	Cancellous FDBA	H	3	Good health, nonsmoker	PE	Mx-Mn A-P	-	4	Resobable or nonresorbable membrane/ particulate allograft	4	Delayed	NM	SVR: 100%	-
Spin-Neto *et al.*, 2014[24]	CS	Corticocancellous FFBA	H	20	No systemic diseases affecting bone turnover, or interfere with treatment	-	Mx - Mn	-	<4	CM	-	6 months	NM	SVR: 100%	4 graft loss 1 early graft exposure
Deluiz *et al.*, 2015[78]	PS	Corticocancellous FFBA	H	22	No systemic diseases, nonsmokers	PE	NM	-	-	Freeze dried allograft particles	75	4, 6 or 8 months	NM	cSVR: 98.67%	1 infection

CS=Case series; PS=Prospective study; RS=Retrospective study; FFBA=Fresh frozen block allograft; BA=Block allograft; FDBA=Freeze dried block allograft; DFBA=Deep frozen block allograft; DFDBA=Demineralized freeze-dried block allograft; H=Horizontal; V=Vertical; Sim=SIMULTANEOUS Insertion; TE=Total edentulous; PE=Partial edentulous; Mx=Maxilla; Mn=Mandible; A=Anterior; P=Posterior; NM=Not mentioned; SVR=Survival rate; SCR=Success rate; cSCR=Cumulative success rate; CM=Collagen membrane; CM=Collagen membrane; PRP=Platelet rich plasma; IT=Implant therapy; RBS=Reconstructive bone surgery

Table 3: Quality assessment

Authors	Assessment criteria					Estimated risk of bias
	Randomization	Control	Surgeon blinded to treatment	Blindness to outcome	Follow-up	
Jemt and Lekholm 2003[25]	No	No	No	No	Yes	High
Balaji *et al*., 2002[26]	No	No	No	No	Yes	High
Astrand *et al*., 1996[27]	No	No	No	No	Yes	High
Raghoebar *et al*., 1996[28]	No	No	No	No	Yes	High
Acocella *et al*., 2010[29]	No	No	No	No	Yes	High
Barone and Covani 2007[12]	No	No	No	No	Yes	High
Molly *et al*., 2006[30]	No	No	No	No	Yes	High
Keller *et al*., 1999[31]	No	No	No	No	Yes	High
Lekholm *et al*., 1999[32]	No	No	No	No	Yes	High
Dahlin and Johansson 2011[23]	No	Yes	No	No	Yes	High
Clayman 2006[33]	No	No	No	No	Yes	High
Nystrom *et al*., 2004[34]	No	No	No	No	Yes	High
Widmark *et al*., 2001[35]	No	Yes	No	No	Yes	High
van Steenberghe *et al*., 1997[36]	No	No	No	No	Yes	High
Isaksson and Alberius 1992[37]	No	No	No	No	Yes	High
Adell *et al*., 1990[38]	No	No	No	No	Yes	High
Verhoeven *et al*., 1997[39]	No	No	No	No	Yes	High
McGrath *et al*., 1996[40]	No	No	No	No	Yes	High
Peñarrocha-Oltra *et al*., 2014[41]	No	Yes	No	No	Yes	High
Ozkan *et al*., 2007[42]	No	No	No	No	Yes	High
Chiapasco *et al*., 2007[15]	Yes	Yes	No	No	Yes	Medium
Chiapasco *et al*., 2008[43]	No	No	No	No	Yes	High
Bell *et al*., 2002[44]	No	No	No	No	Yes	High
van der Meij *et al*., 2005[45]	No	No	No	No	Yes	High
Vermeeren *et al*., 1996[46]	No	No	No	No	Yes	High
Kim *et al*., 2013[47]	No	Yes	No	No	Yes	High
Peñarrocha-Diago *et al*., 2013[48]	No	No	No	No	Yes	High
Boronat 2010[49]	No	No	No	No	Yes	High
Elo *et al*., 2009[50]	No	No	No	No	Yes	High
Sbordone *et al*., 2009[51]	No	No	No	No	Yes	High
Levin *et al*., 2007[16]	No	No	No	No	Yes	High
Cordaro *et al*., 2002[52]	No	No	No	No	Yes	High
Sethi and Kaus 2001[53]	No	No	No	No	Yes	High
Chiapasco *et al*., 1999[54]	No	Yes	No	No	Yes	High
Spin-Neto *et al*., 2014[24]	No	Yes	No	No	Yes	High
Roccuzzo *et al*., 2004[55]	No	No	No	No	NM	High
Nissan *et al*., 2012[58]	No	No	No	No	Yes	High
Nissan *et al*., 2008[59]	No	No	No	No	Yes	High
Acocella *et al*., 2012[60]	No	No	No	No	Yes	High
Orsini *et al*., 2011[61]	No	No	No	No	Yes	High
Wallace and Gellin 2010[62]	No	No	No	No	Yes	High
Carinci *et al*., 2010[63]	No	No	No	No	NM	High
Barone *et al*., 2009[64]	No	No	No	No	NM	High
Contar etal. 2009[65]	No	No	No	No	Yes	High
Soltan *et al*., 2007[66]	No	No	No	No	NM	High
Gomes *et al*., 2008[67]	No	No	No	No	Yes	High
Nissan *et al*., 2011[68]	No	No	No	No	Yes	High
Carinci *et al*., 2009[69]	No	No	No	No	Yes	High
Nissan *et al*., 2011[70]	No	No	No	No	Yes	High
Petrungaro *et al*., 2005[71]	No	No	No	No	Yes	High
Novell *et al*., 2012[72]	No	Yes	No	No	Yes	High
Peleg *et al*., 2010[73]	No	No	No	No	Yes	High
Viscioni *et al*., 2010[74]	No	No	No	No	Yes	High
Keith *et al*., 2006[75]	No	No	No	No	Yes	High
Leonetti and Koup 2003[76]	No	No	No	No	Yes	High
Lyford *et al*., 2003[77]	No	No	No	No	NM	High
Deluiz *et al*., 2015[78]	Yes	No	No	No	NM	High

Keith *et al*.[75] reported implant survival rate of 99% when only seven out of 82 ALBs failed. Duration of follow-up was not mentioned for three ABB[24,50,55] and five ALB groups.[24,64,66,77,78] Wallace and Gellin[62] had reported 4 months follow-up. Carinci *et al*.[63] showed that cumulative implant success rate decreased from 96% in the 1st year to 40% in 4 years due to crestal bone loss. Follow-ups for ALB were relatively shorter than ABB (12–192 months vs. 12–60 months).

The resorption rate of ALB was three times more than that of ABB at 6 months.[83] Occlusal force or accumulation of microbial

plaque may cause micro-fractures in a nonremodelable bone block and cause weakness in maintaining crestal bone around dental implants.[84] Deluiz *et al*.[78] demonstrated that significantly different resorption rates of allografts occur during 4–8 months of healing.

ABB harvested from intraoral donor sites showed higher implant survival than extraoral donor sites (94.1–100%[16,24,25,28,29,41,42,47,48,52,53,55] vs. 73.8–100%).[12,27,30,31,33,37-39,44,45,47] In this group, implants placed in reconstructed mandibles survived longer than implants in reconstructed maxillae (90–100%[39,41,42,43,44,46,47] vs. 73.8–100%).[12,25,27-33,37,38]

Simultaneous implant placement had a frequency higher than 36% in ABB groups. Survival of simultaneously placed dental implants was higher than those placed in ALB after a healing period (93.7% vs. 98.6%).[74] Peñarrocha-Diago *et al*.[48] reported 98.5% survival rate for both delayed and simultaneously inserted implants in autografts harvested from intraoral sites.

Recipient site analysis and matching is an important variable in the interpretation of results of augmentative techniques. ALB was mostly used for horizontal bone augmentation or defects limited to one or two teeth. No report of ALB could be found in the treatment of posterior mandible in our review; most were found in the anterior maxilla. Graft resorption occurred more in the mandible than in the maxilla.[52] Dimension and location of the recipient site influence treatment outcomes.[85]

Particulate bone with collagen membrane has been used with ALB in comparison to ABB (48% vs. 39.5%). The addition of PRP to ALB resulted in 100% survival of implants.[71]

Two trials compared implant treatment outcomes between ALB and ABB.[23,24] Horizontal augmentation of defects < 4 mm width resulted in 100% implant survival rate for both techniques.[24] Five-year follow-up of the horizontal augmentation of the maxilla revealed 96.1% and 98.7% success rates for implants inserted in ABB and ALB, respectively.[23]

Low incidence of complications related to onlay bone grafting was observed in both techniques. Paresthesia was mostly transient and related to intraoral donor sites.[40,41,45,48] In addition, pain and discomfort were reported in few studies following block harvesting from the iliac crest.[37,38]

Histological evaluation in two articles revealed that more than half of the tissue volume was nonvital graft remnants.[24,29] Acocella *et al*.[29] demonstrated reduction of nonvital bone and final remodeling with time. A wide range of remodeling has been reported (8.4%[24] to 44%[68]). While most studies revealed proper integration of ALB, some studies reported no regenerative and remodeling activity with a high percentage of nonvital bone.[24,60] Formation of fibrous tissue, which was reported in some cases at the graft recipient site interface, could reduce graft survival.[60] Goldberg and Stevenson[86] mentioned delayed vascularization of ALB and longer implant healing periods.

Comparing histological integration of ABB and ALB, Spin-Neto *et al*.[24] reported that larger amounts of both nonvital and vital bone and lesser amounts of soft connective tissue were observed in the ABB group. No difference was observed between the groups in either bone-to-implant contact or the bone area between implant threads.[24]

CONCLUSION

Due to the lack of controlled clinical trials, a definite consensus cannot be reached regarding the success and survival of implants placed in defects reconstructed with autogenic versus ALB. Wide ranges of implant success and survival have been reported for both techniques. The main concern regarding ABB is donor site complications and for ALB is the integration of the graft. Future studies with longer follow-ups are required to further elucidate these issues.

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Conflicts of interest
There are no conflicts of interest.

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