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Review article

Bone augmentation using autogenous bone versus biomaterial in the posterior region of atrophic mandibles: A systematic review and meta-analysis

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ABSTRACT

Objectives: This systematic review and meta-analysis aimed to answer the PICO question: "Do patients who have received bone grafts with bone substitute (biomaterials) present bone gain (before implant installation), complications, and implant survival rates similar to autogenous grafts when used in the posterior mandible region?".
Data: This review followed the PRISMA statement and has been registered at PROSPERO (CRD42016048471). Studies published in English, randomized controlled and/or prospective clinical trials with at least 10 patients, and studies that compared grafts with bone substitutes to autogenous bone grafts (split-mouth design) were included.
Sources: An electronic search and a manual search were conducted in PubMed/MEDLINE, Scopus, and Cochrane databases up to April 2018.
Study selection: Our initial search yielded 640 articles; we selected four articles that met the inclusion criteria. All selected studies used a split-mouth design.
Results: Our analysis revealed no significant difference between the biomaterial and autogenous groups in terms of bone gain (P = 0.11; mean difference [MD]: 0.59; 95% confidence interval [CI]: -0.13–1.31) or complication rate (P = 0.72; risk ratio [RR]: 1.25; 95% CI: 0.37–4.23). Sixty-six implants were installed in the biomaterial group and 63 in the autogenous group; these showed no significant difference in implant survival rate (P = 0.50; RR: 1.57; 95% CI: 0.43–5.81).
Conclusion: We conclude that biomaterials or autogenous bone are indicated for the reconstruction of the posterior mandibular atrophic region, without lowering implant survival.

1. Introduction

Resorption of the maxillary and mandibular bones is a physiological event that occurs over time after tooth loss, and leads to a state of partial or total edentulous alveolar ridge atrophy [1]. Oral rehabilitation through oral implants is a suitable method to restore oral aesthetics and function with predictable results [2,3]. However, a prerequisite for obtaining a successful outcome with implants is minimum bone width and height of the receiving site, which allows for implant installation in the appropriate place and ensures a functional and aesthetic restoration [4–6].

In cases of alveolar ridges with insufficient bone height and volume, additional surgical procedures for reconstruction and enlargement of the deficient regions are needed. Several techniques have been developed to reconstruct deficient mandibular alveolar ridges for implant placement. These include a one-stage simultaneous approach and a two-stage approach [6,7]. These procedures involve the use of bone grafts composed of different types of materials (e.g., autogenous, xenogenous, or other bone substitutes) and can be executed by guided bone regeneration alone or in combination with graft procedures.

Autogenous bone is considered the gold standard in graft surgeries because of its biocompatibility and its osteoinductive, osteoconductive, and osteogenic properties [8,9]. However, the limited availability of intraoral donor sites and the high morbidity associated with the use of extraoral donor sites have made the use of autogenous bone for rehabilitation difficult [10,11]. In view of these difficulties, several

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materials have been used to replace autogenous bone, especially bovine organic bone, which has fundamental characteristics of biocompatibility and osteoconductivity and provides an ideal framework for new bone formation [12,13]. Bovine organic bone is being widely used for vertical/horizontal bone augmentation [14,15] and maxillary sinus lift [16].

Several techniques for bone defect reconstruction in the posterior mandibular region have been developed to achieve adequate bone volume for implant installation [17,18]. This region is considered critical because it is in close contact with the inferior alveolar nerve and is subject to rapid bone resorption with aging, especially after the loss of dental elements [17,19]. In addition, biological factors such as bone width of the recipient area and amount of bone wall affect bone graft stability. These characteristics may affect blood supply during bone graft repair, thereby affecting its ability to heal. This may also lead to greater bone resorption of the grafted bone or even graft loss. Therefore, the posterior mandibular region is an extremely critical region for bone augmentation procedures in oral rehabilitation [17].

The purpose of this systematic review and meta-analysis was to evaluate and compare the clinical outcomes of bone augmentation using autogenous bone and biomaterial in the posterior mandibular atrophic region prior to implant installation. In addition, this study evaluated the survival of implants installed in these grafted regions on the basis of the following hypotheses: 1) There is no difference between the use of biomaterials and autogenous bone graft with respect to bone gain. 2) The complication and survival rates of the implants are not influenced by the type of bone graft.

2. Materials and methods

2.1. Protocol and registration

This systematic review was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist structure [20] and was conducted in accordance with models proposed in published reports [6,7,21]. Moreover, this study was registered on the international prospective register of systematic reviews (PROSPERO: CRD42016048471).

2.2. Eligibility criteria

The studies selected for this analysis followed the criteria established by the PICO index, defining the following question: “Do bone grafts with bone substitute (biomaterials) present bone gain similar to autogenous grafts when used in the posterior mandible region?”. Studies included patients requiring a bone graft in the posterior mandibular region for implant installation. Patients who received grafts with bone substitutes were compared with those who received autogenous bone grafts in the posterior mandibular region for implant installation, with respect to the following outcomes: bone gain before implant installation (primary outcome), the complication rates, and survival of implants installed in the grafted region (secondary outcomes).

The inclusion criteria were as follows: studies published in the English language, randomized controlled and/or prospective clinical trials with at least 10 patients, and studies that compared patients who received grafts with bone substitutes with those who received autogenous bone grafts (split-mouth design). The exclusion criteria were as follows: animal studies and in vitro studies, studies with patients who underwent bone graft surgery without the use of autogenous bone and/or biomaterials, and studies with patients who underwent graft surgery in the maxillary region.

2.3. Information sources and search strategy

The search for the studies was independently performed by two previously calibrated reviewers (C.A.S. and C.A.A.L.). The authors conducted an electronic search of the PubMed/MEDLINE, Scopus, and Cochrane databases for articles published up to April 2018. All studies identified by the inclusion criteria were analyzed, and the corresponding authors of these studies were contacted to identify possible additional information. The search was performed using the following search terms: “bone graft AND vertical bone augmentation OR bone graft AND posterior mandible.” The search strategy was as follows: (“bone transplantation”[MeSH Terms] OR (“bone”[All Fields] AND “transplantation”[All Fields]) OR “bone transplantation”[All Fields] OR (“bone”[All Fields] AND “graft”[All Fields]) OR “bone graft”[All Fields]) AND (vertical[All Fields] AND (“bone and bones”[MeSH Terms] OR (“bone”[All Fields] AND “bones”[All Fields]) OR “bone and bones”[All Fields] OR “bone”[All Fields]) AND augmentation[All Fields]) OR (“bone transplantation”[MeSH Terms] OR (“bone”[All Fields] AND “transplantation”[All Fields]) OR “bone transplantation”[All Fields] OR (“bone”[All Fields] AND “graft”[All Fields]) OR “bone graft”[All Fields]) AND (posterior[All Fields] AND (“mandible”[MeSH Terms] OR “mandible”[All Fields])).

The same researchers also manually searched for articles published in the journals *Clinical Implant Dentistry and Related Research, Clinical Oral Implant Research, Implant Dentistry, International Journal of Oral and Maxillofacial Surgery, Journal of Clinical Periodontology, Journal of Dental Research, Journal of Dentistry, Journal of Maxillofacial and Oral Surgery, Journal of Oral Implantology, Journal of Periodontology, and International Journal of Oral and Maxillofacial Implants.* All discrepancies related to the search in the databases and manual searching were analyzed and resolved by the third reviewer (J.F.S.J.) in a consensus meeting.

2.4. Data collection process

One of the authors (C.A.S.) collected relevant information from the articles and a second author (L.P.F.) reviewed all the collected information. The variables collected from the articles were as follows: author/year, type of study, number of patients, number of implants, characteristics of the implants, mean age, graft donor site, biomaterials, stabilizations of the bone graft, complications of the graft, number of implants survived, and bone gain.

2.5. Risk of bias

The risk of bias in the studies included was assessed independently by two authors (C.A.S. and C.A.A.L.). The Cochrane Collaboration’s tool for assessing the risk of bias was used to assess the quality of the studies included in this review. This tool addressed six specific domains, namely, random sequence generation, allocation concealment, blind outcome assessment, incomplete outcome data, selective outcome reporting, and other biases. The classification was based on judgment related to the risk of bias and was defined as low, unclear, or high risk.

2.6. Summary measures

The influence of different bone grafts on bone gain was evaluated on the basis of a continuous outcome through the mean difference, while the survival rate of the implants was evaluated using a dichotomous outcome through the risk ratio (RR), both with a 95% confidence interval (CI). Analyses were performed using the software program Review Manager 5.3 (The Cochrane Library). P values < 0.05 were considered to indicate statistical significance.

The fixed-effects model was used in situations with a low heterogeneity index, and the random-effects model was utilized in situations with a high heterogeneity index between the trials. The heterogeneity was evaluated using the Q (x^2) method and the I^2 value was measured. The statistical value of I^2 was used to analyze variations in heterogeneity, and $I^2 > 75\%$ (range, 0–100%) was considered to indicate relevant heterogeneity [22,23].