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Meta-Analysis
Pre-Implant Surgery

A systematic review and meta-analysis of long-term studies (five or more years) assessing maxillary sinus floor augmentation

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Abstract. The objective was to test the hypothesis of no difference in long-term (≥5 years) implant treatment outcomes after maxillary sinus floor augmentation (MSFA) with autogenous bone graft compared to a mixture of autogenous bone graft and bone substitutes or bone substitutes alone. A MEDLINE (PubMed), Embase, and Cochrane Library search in combination with a hand-search of relevant journals was conducted. Human studies published in English between January 1, 1990 and October 1, 2016 were included. Nine studies fulfilled the inclusion criteria. The survival of suprastructures has never been compared within the same study. The 5-year implant survival after MSFA with autogenous bone graft was 97%, compared to 95% for Bio-Oss; the reduction in vertical height of the augmented sinus was equivalent with the two treatment modalities. Non-comparative studies demonstrated high survival rates for suprastructures and implants regardless of the grafting material used. Meta-analysis revealed an overall estimated patient-based implant survival of 95% (confidence interval 0.92–0.96). High implant stability quotient values, high patient satisfaction, and limited peri-implant marginal bone loss were revealed in non-comparative studies. No long-term randomized controlled trial comparing the different treatment modalities was identified. Hence, the conclusions drawn from the results of this systematic review should be interpreted with caution.

Key words: alveolar ridge augmentation; dental implants; oral surgical procedures; review; sinus floor augmentation.

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Maxillary sinus floor augmentation (MSFA) using the lateral window technique was originally developed by Tatum in the mid-seventies and was later described by Boyne and James in 1980[1,2]. This surgical intervention is still the most frequently used method to enhance the alveolar bone height of the posterior part of the maxilla before or in conjunction with implant placement, and treatment outcomes have been reported in several systematic reviews[3–9].

Autogenous bone is generally considered the preferred graft material[10], and oral implants inserted in sinuses augmented with autogenous bone grafts have demonstrated high implant survival rates, as documented in several reviews[3,4,7,9,11,12]. However, the use of autogenous bone grafts is associated with the risk of donor site morbidity and unpredictable graft resorption[12–19]. Hence, various bone substitutes are used increasingly to simplify the surgical procedure by diminishing the need for bone harvesting. The majority of bone substitutes display solely osteoconductive properties, and the capability of the graft material to promote graft maturation and provide optimal long-term support to endosseous implants is one of the critical factors for a high implant success rate.

Previously published systematic reviews have reported high short-term survival rates of suprastructures and implants after MSFA with different mixtures of autogenous bone graft and bone substitutes or bone substitutes alone[8,9,12]. However, very recently published systematic reviews assessing histomorphometric variables concluded that autogenous bone grafts result in the highest amount of newly formed bone in comparison with various bone substitutes, although allografts, alloplastic materials, and xenografts appear to be good alternatives to autogenous bone for MSFA[20,21]. Consequently, the optimal grafting material for MSFA with regard to the long-term survival of suprastructures and implants is not presently clear.

From a clinical and patient perspective, it would be an advantage if bone substitutes alone or in combination with a limited amount of autogenous bone could be used in place of autogenous bone as the graft material for MSFA. However, long-term studies assessing MSFA are limited, and the long-term implant treatment outcomes after MSFA with particulated autogenous bone graft compared to MSFA with a mixture of particulated autogenous bone graft and bone substitutes or bone substitutes alone, has not yet been assessed specifically in a systematic review.

Therefore, the objective of the present systematic review was to test the hypothesis of no difference in long-term (≥5 years) implant treatment outcomes after MSFA with particulated autogenous bone graft compared to MSFA with a mixture of particulated autogenous bone graft and bone substitutes or bone substitutes alone.

Materials and methods

This systematic review was conducted in accordance with the PRISMA statement for reporting systematic reviews (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)[22].

Eligibility criteria for study selection

Randomized clinical trials, prospective cohort studies, and retrospective human studies comparing the long-term (≥5 years) implant treatment outcomes after MSFA with particulated autogenous bone graft to those of MSFA with a mixture of particulated autogenous bone graft and bone substitutes or bone substitutes alone, were considered. Moreover, human studies solely assessing MSFA with particulated autogenous bone graft alone, a mixture of particulated autogenous bone graft and bone substitutes, or bone substitutes alone, were also included as non-comparative studies.

Outcome measures

The primary outcome measures are the most important measures for evaluating the long-term implant treatment outcome. Secondary outcome measures were also included in this systematic review as surrogate measures. The outcome measures assessed are outlined in Table 1.

Search strategy for the identification of studies

A MEDLINE (PubMed), Embase, and Cochrane Library search was conducted. Human studies published in English between January 1, 1990 and October 1, 2016 were included. The search strategy utilized a combination of medical subject heading (MeSH) terms and free text terms:

1. sinus floor augmentation/ (517)
2. (sinus* adj3 (augment* or lift*)).mp. (1848)
3. 1 or 2 (1848)
4. limit 3 to yr = ‘‘1990-Current’’ (1824)

The search was supplemented by a thorough hand-search page by page of relevant journals (Table 2). The manual search also included the bibliographies of all articles selected for full-text screening, as well as previously published reviews relevant to the present systematic review. The search was performed by two reviewers (TSJ and HA). In the event of disagreement between the reviewers, another reviewer was consulted (AM).

Study selection

The PRISMA flow diagram in Fig. 1 presents an overview of the selection process. The titles of identified reports were initially screened. The abstract was assessed when the title indicated that the study fulfilled the inclusion criteria. A full-text analysis was performed when the abstract was unavailable or when the abstract indicated that the inclusion criteria were fulfilled. The references of the identified papers were cross-checked for unidentified articles. The study selection was performed by two reviewers (TSJ and HA). In

Table 1. Outcome measures.

Primary outcome measures:
• Survival of suprastructures: loss of a suprastructure was defined as a total loss due to a mechanical and/or biological complication
• Survival of implants: loss of an implant was defined as mobility of a previously clinically osseointegrated implant, or removal of a non-mobile implant due to progressive peri-implant marginal bone loss or infection
Secondary outcome measures:
• Implant stability quotient (ISQ): estimated by resonance frequency analysis
• Peri-implant marginal bone loss: evaluated by radiographic measurements
• Bone regeneration: evaluated by radiographic or histological measurements
• Patient-reported outcome measures
• Complications

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