Journal of Cranio-Maxillo-Facial Surgery 44 (2016) 1607–1617

Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

Dental implants combined with sinus augmentation: What is the merit of bone grafting? A systematic review

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ARTICLE INFO

Article history:
Paper received 27 January 2016
Accepted 27 June 2016
Available online 2 July 2016

Keywords:
Dental implant
Sinus floor augmentation
Bone grafting
Systematic review
Meta-analysis

ABSTRACT

Purpose: The aim of the present study was to systematically assess the current evidence on the effect of nongrafted compared to graft-assisted maxillary sinus floor elevation on implant survival/failure, endosinus bone gain, crestal bone loss, and bone density around dental implants.
Materials and methods: MEDLINE-PubMed, Cochrane-CENTRAL, and EMBASE databases were searched up to November 2015 for randomized controlled trials (RCTs) and controlled clinical trials-(CCTs), evaluating dental implants placed in combination with maxillary sinus elevation without and with bone grafting. Implant survival/failure served as the primary outcome, whereas endosinus bone gain, crestal bone loss, and bone density around dental implants were secondary outcomes. To assess possible bias, the Cochrane risk of bias tool was used. Data were extracted and a meta-analysis performed where appropriate.
Results: Independent screening of 3180 papers resulted in six eligible experiments. Heterogeneity was observed among experiments. One experiment showed low, three unclear, and two a high risk of bias. The assessed outcomes showed no significant long-term differences between groups.
Conclusion: Within the limit of the current systematic review, nongrafted maxillary sinus floor elevation seems to be characterized by new bone formation and high implant survival rate comparable to bone-graft-assisted maxillary sinus floor augmentation. Further long-term studies are needed before definitive conclusions can be made.
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1. Introduction

Endosseous dental implant placement is a fundamental treatment modality for prosthetic reconstruction of partially or completely edentulous patients. For osseointegration and subsequent functional load bearing, sufficient alveolar bone volume and quality are required as major predictors for clinical rehabilitation outcomes and foreseeable long-term results. The edentulous posterior maxillary region has attracted explicit interest, due to the frequent maxillary sinus pneumatization and the resultant absence of sufficient bone volume and quality in vertical and/or horizontal dimensions (Thor et al., 2007b), making dental implant placement clinically challenging.

An array of bone grafting materials have been used for maxillary sinus augmentation, comprising autogenous bone obtained from the iliac crest (Block and Kent, 1997), chin (Wood and Moore, 1988), mandibular ramus (Clavero and Lundgren, 2003), bone substitutes alone (Hising et al., 2001; Hallman et al., 2002), or in combination with autogenous bone and biological agents (Hallman et al., 2002; Lee et al., 2007). Even if new bone/bone-like structure can be observed in the maxillary sinus after bone graft placement, it seems that grafting is not an absolute prerequisite for bone formation.

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http://dx.doi.org/10.1016/j.jcms.2016.06.022
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Various human and animal studies have supported the concept of space provision between the antral bone and the sinus membrane for new bone formation around dental implants in the maxillary sinus, even in the absence of bone grafting materials, both radiographically and histologically (Riben and Thor, 2012; Pinchasov and Juodzbalys, 2014). The space creation obtained through a stabilized sinus membrane elevation, establishing a void space for a stable blood clot, may solely regenerate new bone, using the osteogenic potential of the sinus membrane (Riben and Thor, 2012; Pinchasov and Juodzbalys, 2014), according to the biological principles of guided bone regeneration (GBR) (Dahlin et al., 1989).

Currently, controversy exists regarding the merit of grafting material application during maxillary sinus elevation approaches combined with dental implant insertion. The goal of the present study was to systematically assess the current evidence on the effect of nongrafted compared to bone-graft-assisted maxillary sinus floor elevation on dental implant survival/failure, endosinus bone gain, crestal bone loss, and bone density around dental implants.

2. Material and methods

This systematic review was conducted in accordance with the Cochrane handbook for systematic reviews of interventions (Higgins and Green, 2009) and the guidelines of the Transparent Reporting of Systematic Reviews and Meta-analyses (PRISMA) statement (Moher et al., 2009). The protocol for this systematic review was established a priori.

2.1. Focused PICOS question

The Focused PICOS question (Copanitsanou and Valkeapaa, 2014) was as follows: Based on randomized controlled clinical trials (RCTs) or controlled clinical trials (CCTs), in patients with residual bone height ≤6 mm, what is the effect of non-graft-assisted compared to bone-graft-assisted maxillary sinus floor elevation on implant survival/failure, endosinus bone gain, crestal bone loss and bone density around dental implants?

2.2. Search strategy

Three internet sources were used to search for appropriate papers for the study purpose. These sources included the National Library of Medicine, Washington, DC (MEDLINE-PubMed), the Cochrane Central Register of Controlled Trials (CENTRAL), and EMBASE (Excerpta Medica Database, Elsevier). All three databases were searched for eligible studies up to November 2015. Unpublished (grey) literature was searched via www.opengrey.eu. The structured search strategy was designed to include any relevant published paper that evaluated the effect of sinus floor elevation without and with bone grafts on dental implants placed in the posterior maxillary region. For details regarding the search terms used, see Table 1.

2.3. Screening and selection

Two reviewers (S.N. and S.B.) independently screened the titles and abstracts for eligible papers. If eligibility aspects were present in the title, the paper was selected for further reading. If none of the eligibility aspects were mentioned in the title, the abstract was read in detail and screened for suitability. After selection, full-text papers were read in detail (S.N. and K.F.E.). Any disagreement between the two reviewers was resolved after additional discussion. If a disagreement persisted, judgment by a third reviewer (D.E.S.) was decisive. Papers that fulfilled all selection criteria were processed for data extraction. All reference lists of the selected studies were hand-searched (S.N. and S.B.) for additional published work that could meet the eligibility criteria of the study. Unpublished work was not sought.

The eligibility criteria were as follows:

- RCTs or CCTs
- Papers in English language.
- Studies in human subjects.
  - ≥18 years old
  - In good general health
  - Single/multiple missing units in maxillary posterior area.
  - Enlarged maxillary sinuses or atrophic maxilla.
  - Mean residual bone height ≤6 mm (Fenner et al., 2009; Nedir et al., 2013).
- Intervention (test): Maxillary sinus floor elevation without bone grafts.
- Comparison (control): Maxillary sinus floor elevation with bone grafts.
- Outcome: Evaluation with one or more of the following clinical evaluation parameters: implant survival (absence of clinically detectable implant mobility, absence of pain and subjective discomfort, absence of peri-implant infection, and absence of continuous radiolucency around the implant); implant failure (implant fracture or severe peri-implant infection as deep peri-implant pockets (>5 mm) with bleeding or pus on probing) as primary outcome; endosinus bone gain (measured as a high dense image between a reference coronal implant thread and the most apical implant–bone contact of each implant in the sinus cavity); crestal (marginal) bone loss around the implant (a distance parallel to the implant axis measured between the most coronal bone–implant contact and the most apical implant thread); and bone density (density measurements in HU around the peri-implant bone area in the protruded implant area on the maxillary sinus in vivo) as secondary outcomes.
- Minimum evaluation period of ≥6 months after implant placement (Albrektsson et al., 1986).

Exclusion criteria were studies that depended on histological assessment without quantification.

2.4. Assessment of heterogeneity

Heterogeneity of the primary outcome parameter across studies was detailed according to the following factors:

- Study design, research groups, evaluation period
- Primary and secondary outcomes
- Subject characteristics and smoking habits
- Sinus lifting techniques, setting, and procedures
- Time of implant placement
- Prosthetic phase
- Complications

2.5. Quality assessment

Two reviewers (S. and K.F.E.) scored the methodological qualities of the included studies according to the Cochrane Risk of Bias Tool for RCTs (Higgins and Green, 2009). The study was classified as having low risk of bias if it met the following criteria: no selection bias regarding random allocation, allocation concealment, and baseline characteristics; no performance bias regarding masking of participants and personnel; no detection bias regarding masking of examiners; no reporting bias regarding being free of selective reporting; no attrition bias regarding complete outcome data and

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