*Int. J. Oral Maxillofac. Surg. 2016; 45: 517–525*
http://dx.doi.org/10.1016/j.ijom.2015.07.012, available online at http://www.sciencedirect.com

International Journal of Oral & Maxillofacial Surgery

Systematic Review Paper
Pre-Implant Surgery

# Effects of platelet-rich plasma in association with bone grafts in maxillary sinus augmentation: a systematic review and meta-analysis

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*C.A.A. Lemos, C.C. Mello, D.M. dos Santos, F.R. Verri, M.C. Goiato, E.P. Pellizzer: Effects of platelet-rich plasma in association with bone grafts in maxillary sinus augmentation: a systematic review and meta-analysis. Int. J. Oral Maxillofac. Surg. 2016; 45: 517–525.* 

*Abstract.* This systematic review evaluated the effect on bone formation and implant survival of combining platelet-rich plasma (PRP) with bone grafts in maxillary augmentation. A comprehensive review of articles listed in the PubMed/MEDLINE, Embase, and Cochrane Library databases covering the period January 2000 to January 2015 was performed. The meta-analysis was based on bone formation for which the mean difference (MD, in millimetres) was calculated. Implant survival was assessed as a dichotomous outcome and evaluated using the risk ratio (RR) with 95% confidence interval (CI). The search identified 3303 references. After inclusion and exclusion criteria were applied, 17 studies were selected for qualitative analysis and 13 for quantitative analysis. A total of 369 patients (mean age 51.67 years) and 621 maxillary sinus augmentations were evaluated. After the data analysis, additional analyses were performed of the implant stability quotient, marginal bone loss, and alveolar bone height measured by MD. The results showed no significant difference in implant stability ($P = 0.32$, MD 1.00, 95% CI −0.98 to 2.98), marginal bone loss ($P = 0.31$, MD 0.06, 95% CI −0.05 to 0.16), alveolar bone height ($P = 0.10$, MD −0.72, 95% CI −1.59 to 0.14), implant survival ($P = 0.22$, RR 1.95, 95% CI 0.67–5.69), or bone formation ($P = 0.81$, MD −0.63, 95% CI −5.91 to 4.65). In conclusion, the meta-analysis indicates no influence of PRP with bone graft on bone formation and implant survival in maxillary sinus augmentation.

Key words: platelet-rich plasma; dental implants; sinus floor augmentation; meta-analysis.

Accepted for publication 15 July 2015
Available online 6 January 2016

 

The amount and quality of bone tissue are considered crucial factors when planning implant-supported rehabilitations.[1] The posterior maxilla is not considered the most favourable site for implant placement due to the low bone quality and the fact that pneumatization of the sinus limits the installation of implants or decreases their long-term success rate, increasing the difficulty of rehabilitation.[2,3] An alternative to counter these problems is the achievement of a sinus lift associated with a graft, thereby increasing the volume of bone to a level sufficient for implant placement,[4] since longer implants show higher success rates, particularly in this area of poor bone density.[5]

Regenerative treatment using platelet-rich plasma (PRP) may be indicated in association with grafting, since this combination may improve the healing process of bone tissue; this is due to the high quantity of blood-associated growth factors that are found in PRP.[6–8] Furthermore, the use of PRP improves graft handling, stimulates soft tissue healing, and reduces patient discomfort.[9] Some studies seeking to prove the efficacy of platelet concentrations in association with grafting have published favourable results.[10–13] On the other hand, other studies have reported no benefit of PRP in relation to bone formation.[8,14,15]

Thus, there is no consensus regarding the benefits of the use of PRP in association with grafting after a maxillary sinus lift. It is therefore necessary to perform a careful analysis of clinical studies through a systematic review and meta-analysis to assess bone formation in patients. The null hypotheses of this study were: (1) The use of PRP in association with grafting has no effect on bone formation; (2) The use of PRP in association with grafting has no effect on implant survival rates.

## Materials and methods

### Registry protocol

This systematic review was structured following the PRISMA checklist[16] and was performed in accordance with models proposed in the literature.[1,17,18] Moreover, the methods used in this systematic review were registered with PROSPERO, an international prospective register of systematic reviews (CRD42014015648).

### Research strategy and information sources

The article selection was performed by two independent reviewers (CAAL and CCM) according to the inclusion and exclusion criteria. Clinical studies that compared the use of PRP with grafting to bone grafting alone were sought. After performing searches in the selected databases, a careful analysis was done to identify any cases of disagreement between the authors. Studies were selected on the basis of their titles and abstracts and assessed according to the inclusion and exclusion criteria. The reviewers analyzed and discussed the articles until consensus was reached; remaining disagreements were resolved by discussion with a third reviewer (EPP).

Searches were performed in the databases PubMed/MEDLINE, Embase, and Cochrane for research studies published in English between January 2000 and 20 January 2015, using the following Keywords: (dental implant) AND (platelet-rich plasma OR platelet concentrate OR PRP and sinus augmentation OR sinus floor augmentation OR maxillary sinus lift) AND [limit to OR clinical trial OR randomized controlled trial OR comparative study OR controlled trial AND humans]. In addition, manual searches of the following journals for articles published between January 2000 and 20 January 2015 were conducted by all three reviewers: *Clinical Implant Dentistry and Related Research*, *Clinical Oral Implants Research*, *International Journal of Oral and Maxillofacial Implants*, *International Journal of Oral and Maxillofacial Surgery*, *Journal of Oral and Maxillofacial Surgery*, *Journal of Clinical Periodontology*, *Journal of Oral Rehabilitation*, *Journal of Periodontology*, and *Periodontology 2000*.

### Criteria for the selection of studies

Article selection in the database search was initially performed by means of an analysis of titles and abstracts. After the first selection step, the full content of the articles was analyzed against the inclusion and exclusion criteria. Thus, the PICO question recommended in the PRISMA statement was delimited: (1) population: patients selected for dental implant surgery; (2) intervention: patients rehabilitated with implants after maxillary sinus lift with bone grafting; (3) comparison: patients rehabilitated with implants after maxillary sinus lift with bone grafting in association with PRP compared to bone grafting alone; (4) outcomes: to analyze the influence of PRP in association with bone grafting when compared with bone grafting alone on bone formation and the implant survival rate. The PICO question was structured as follows: Does PRP improve the properties of the graft in terms of bone formation and the rates of implant survival after maxillary sinus lift?

### Inclusion and exclusion criteria

The inclusion criteria used in this study were the following: randomized controlled trial (RCT) or prospective study; articles published in the English language. The exclusion criteria were the following: in vitro studies, animal studies, reviews, retrospectives studies, and studies evaluating the association of PRP but without a comparison between graft only and graft with PRP.

### Quality assessment

The quality of selected studies was evaluated using the PRISMA criteria by means of 27 questions established by Moher et al.[16] Therefore, these studies were separated into categories of RCTs and prospective studies.

The methodological quality of all studies included was graded using the five-point Jadad scale[19] (Table 1). This widely used scale evaluates the reporting of studies based on criteria related to the method of randomization, adequacy of blinding, and the completeness of follow-up. The minimum and maximum scores for the studies included were 1 and 5, respectively. Articles with a score of 3–5 were classified as high quality, and those with a score of 0–2 were classified as low quality.

An inter-examiner test (kappa) was performed to evaluate the selection of titles and abstracts, with the following final values of concordance for the databases: PubMed/MEDLINE, kappa = 0.81; Embase, kappa = 0.88; Cochrane, kappa = 1.

### Data analysis

The software Reviewer Manager 5.3 (The Nordic Cochrane Centre, Copenhagen, Denmark) was used to perform the meta-analysis; values were considered significant when $P < 0.05$. Bone formation, implant stability, marginal bone loss, and alveolar bone height were assessed as continuous outcome variables by inverse variance (IV) method and recorded as the mean difference (MD) with 95% confidence interval (CI). The implant survival rate was assessed as a dichotomous outcome by Mantel–Haenszel method and recorded as the risk ratio (RR) with 95% CI, with the weight contribution of each study.