

Systematic Review Trauma

Three-dimensional versus standard miniplate fixation in the management of mandibular angle fractures: a systematic review and meta-analysis

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Abstract. The aim of the present study was to test whether there is a significant difference in the clinical outcomes between standard and three-dimensional (3D) miniplate fixation in the management of mandibular angle fractures (MAFs). An electronic search without date and language restrictions was performed in October 2013. Inclusion criteria were studies in humans including randomized controlled trials, controlled clinical trials, and retrospective studies, with the aim of comparing the two techniques. Six studies were included. The meta-analyses revealed statistically significant differences for the incidence of hardware failure and postoperative trismus. There were no significant differences in the incidence of postoperative infection, malocclusion, wound dehiscence, non-union/malunion, or paresthesia. The cumulative odds ratio was 0.42, meaning that the use of 3D miniplates in the fixation of MAFs decreases the risk of the event (postoperative complication) by 58%. The results of this meta-analysis showed lower postoperative complication rates with the use of 3D miniplate fixation in comparison with the use of standard miniplate fixation in the management of MAFs.

Key words: mandibular angle fracture; surgical treatment; rigid fixation; conventional miniplate; 3D miniplate; complications.

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Approximately 19–40% of all facial fractures are fractures of the mandible, and 12–30% of all mandibular fractures (MFs) are fractures of the mandibular angle.^{1–5} Among MFs, the angle is the first most frequent region for fractures caused by sports activities, the second most frequent

region for fractures caused by violence, and the third most fractured region in cases of traffic accidents involving automobiles.⁵ Although there is widespread agreement regarding the need for surgical reduction and fixation of a mandibular angle fracture (MAF), a variety of differ-

ent treatment modalities have been described.^{6,7}

The so-called ‘Champy technique’ has probably been the most commonly used method of fixation to date. The biomechanical studies of Champy et al.⁸ resulted in the concept of an ideal line of osteosynthesis.

They used blocks made of a photoelastic resin to represent the mandible. A plate was then secured to the lateral surface of the blocks along the superior border, and the complex was subjected to simple cantilever loading. The test showed that the pattern of stress distribution created in the plated blocks was similar to the uncut blocks. This study was instrumental in establishing the concept of tension band plating for the treatment of MFs. Taking into account torsional tensile and compressive forces at all points of the mandible, the ideal lines of osteosynthesis were described, and this formed the basis of the internal fixation of MFs with miniplates. In the case of MAFs, results have demonstrated that the best site for plating is the vestibular osseous flat part located in the third molar region, which will counteract the muscular forces that act naturally to distract the fragments. It has also been suggested that an osteosynthesis located lower down, on the outer surface of the mandible, is solid enough to support the strain resulting from the masticatory forces in this region. However, the stability of the single miniplate fixation of MAFs has been challenged in several biomechanical studies.⁷

The use of three-dimensional (3D) strut plates has been one of the methods of fixation to challenge the Champy technique for the fixation of MAFs, with a growing number of clinical studies.⁶ The 3D plates can be considered a two-plate system, with two miniplates joined by interconnecting crossbars.⁹ Their shape is based on the principle of the quadrilateral as a geometrically stable configuration for support.¹⁰ Because the screws are arranged in the configuration of a box on both sides of the fracture, a broad-band platform is created, increasing the resistance to twisting and bending of the long axis of the Plate.¹¹ There is a simultaneous stabilization of the tension and compression zones, making 3D plates a time-saving alternative to conventional miniplates. Moreover, this system is simple to apply because of its malleability, low profile (reduced palpability), and ease of application (requires little or no additional contouring).¹¹

As philosophies on the treatment of maxillofacial trauma alter over time, a periodic review of the different concepts is necessary to refine techniques and eliminate unnecessary procedures. This would form the basis for optimum treatment. Thus, the objective of this study was to address the focused question 'Is there a significant difference in the clinical outcomes between standard and 3D miniplate

fixation in the management of MAFs?' by conducting a systematic review and meta-analysis of prospective studies published in the dental literature up to and including October 2013.

Materials and methods

Data sources and key words

An electronic search without date or language restrictions was performed in the following databases: PubMed, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials (CENTRAL), Embase, Medline, Alt HealthWatch, Health Source: Consumer Edition, Health Source: Nursing/Academic Edition, CINAHL, SPORTDiscus, and Electronic Journal Centre.

The key words and combinations of these used in the search included: 'conventional AND versus AND 3-dimensional AND miniplate AND management AND mandibular angle AND fracture,' 'standard miniplate versus AND 3-dimensional AND fixation AND mandibular angle AND fracture,' 'Champy technique versus 3-dimensional miniplate AND fixation AND mandibular angle AND fracture,' 'mandibular angle,' 'miniplate,' 'three-dimensional,' 'standard or conventional,' 'rigid fixation,' 'osteosynthesis,' 'grid miniplate,' 'matrix miniplate,' '3D strut miniplate,' and 'Champy.'

A manual search of oral and maxillofacial surgery-related journals, including the International Journal of Oral and Maxillofacial Surgery, British Journal of Oral and Maxillofacial Surgery, Journal of Oral and Maxillofacial Surgery, Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology, Journal of Cranio-Maxillofacial Surgery, Journal of Craniofacial Surgery, and Journal of Maxillofacial and Oral Surgery, was also performed.

Relevant reviews on the subject and the reference lists of the studies identified were also scanned for possible additional studies. Moreover, online databases providing information on clinical trials in progress were checked (<http://clinicaltrials.gov>; <http://www.centerwatch.com/clinical-trials>; <http://www.clinicalconnection.com>).

Inclusion and exclusion criteria

Inclusion criteria were studies in humans including randomized or quasi randomized controlled trials (RCTs), controlled clinical trials (CCTs), and retrospective studies with the aim of comparing 3D and standard miniplate fixation techniques

in the management of MAFs, and reporting the incidence of postoperative complications.

Exclusion criteria were: (1) case reports, technical reports, animal studies, *in vitro* studies, and review papers, (2) studies including infected comminuted MAFs, and (3) studies including angle fractures in atrophic edentulous mandibles.

Selection of relevant studies

The four authors independently assessed the eligibility of all studies retrieved from the databases. Disagreements concerning the selected studies were resolved by discussion. The following data were extracted (when available) from the studies included in the final analysis: year of publication, study design, number of patients, patient age range and/or mean age, follow-up period, number of MFs, region of MFs, fixation methods, surgical approach, length of operation, postoperative maxillomandibular fixation (MMF), use of antibiotics and/or chlorhexidine, number of teeth retained and removed, mouth opening, postoperative radiological assessment, and postoperative complications (infection, postoperative occlusion, hardware failure, segmental mobility, malunion, non-union, wound dehiscence, inferior alveolar nerve paresthesia, unstable fracture fragments). Authors were contacted for possible missing data.

Quality assessment

A methodological quality rating was performed by combining the proposed criteria of the MOOSE statement,¹² STROBE statement,¹³ and PRISMA,¹⁴ in order to verify the strength of scientific evidence in clinical decision-making.

The classification of the risk of potential bias for each study was based on the following five criteria: random selection in the population, definition of inclusion/exclusion criteria, report of losses to follow-up, validated measurements, and statistical analysis. A study that included all the criteria mentioned above was classified as having a low risk of bias, a study that did not include one of these criteria was classified as having a moderate risk of bias. When two or more criteria were missing, the study was considered to have a high risk of bias.

Meta-analysis

Meta-analyses were conducted only if there were studies of similar comparisons

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