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Systematic Review

Trauma

Three-dimensional strut plate for the treatment of mandibular fractures: a systematic review

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Abstract. The treatment of mandibular fractures by open reduction and internal fixation is very variable. Thus, there are many controversies about the best fixation system in terms of stability, functional recovery, and postoperative complications. This systematic review sought scientific evidence regarding the best indication for the use of three-dimensional (3D) plates in the treatment of mandibular fractures. A systematic search of the PubMed/MEDLINE, Elsevier/Scopus, and Cochrane Library databases was conducted to include articles published up until November 2016. Following the application of the inclusion criteria, 25 scientific articles were selected for detailed analysis. These studies included a total of 1036 patients (mean age 29 years), with a higher prevalence of males. The anatomical location most involved was the mandibular angle. The success rate of 3D plates was high at this location compared to other methods of fixation. In conclusion, the use of 3D plates for the treatment of mandibular fractures is recommended, since they result in little or no displacement between bone fragments.

Key words: mandible fracture; miniplate osteosynthesis; grid plate; 3D miniplate; internal rigid fixation; standard miniplate.

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Mandibular fractures are frequent in facial trauma and represent between 35.54%[1] and 44.2%[2] of all facial fractures. This high incidence is a result of the mandibular anatomy and characteristics. The mandibular bone includes fragile areas due to the presence of third molars in the mandibular angle and bone narrowing in the subcondylar region. It constitutes the lower third of the face, and possesses certain mobility due to the presence of the temporomandibular joints. These fractures result in functional problems (speech, chewing, and swallowing), as well as social problems due to aesthetic discrepancies[3]. The ideal treatment for mandibular fractures should aim at a perfect anatomical reduction, stable fixation, and satisfactory future function of the mandible with the least possible repercussions for the joints[4].

Rigid internal fixation (RIF) was initially used in the oral and maxillofacial area in the late 1970s[5], and since the work of Michelet et al.[6] and Champy et al.[7], osteosynthesis using miniplates has become an indispensable method of fixation in maxillofacial surgery[5]. Techniques of open reduction for mandibular fractures have changed and diversified greatly in recent decades[3,8], however there is still no consensus regarding the best method of treatment[9,10]. These methods include the use of lag screws[11], reconstruction Plates[12], dynamic compression Plates[13], miniplates[14,15], locking Plates[14], and three-dimensional (3D) Plates[16,17].

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Issues related to the stability provided by the various fixation systems, especially in mandibular angle fractures, have become a key point of debate among surgeons[4]. Therefore, it is prudent to consider the factors that may justify the use of one type of fixation over another, such as the patient's age, the location and level of the fracture line, degree of displacement, severity of mandibular involvement, degree of alteration in occlusion, and the experience of the surgeon, as well as to inform the patients about the possible advantages and disadvantages of the treatment alternatives[18].

Among the fixation systems and techniques, the use of 3D plates for the treatment of mandibular fractures is relatively new, introduced by Farmand in 1992[3,5,19,20]. The basic concept of the 3D system is the use of a geometrically closed quadrangular or rectangular plate fixed with screws to provide stability in the three dimensions[10,21]. The principle of this fixation is supported by the idea that the devices are not positioned in the trajectory lines of compression and tension forces, but in the weaker structure lines[21,22].

The objective of this study was to perform a systematic review of the literature on the treatment of mandibular fractures with 3D plates, in order to answer the following question: What is the scientific evidence regarding the indication for this technique?

Materials and methods

This systematic review was performed according to the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)[23] and the *Cochrane Handbook for Systematic Reviews of Interventions*[24].

Search strategy and selection criteria

The initial bibliographic research was performed in the MEDLINE (via PubMed), Elsevier (via Scopus), and Cochrane Library databases, using four lines of search elements: (1) ''grid plate'' AND ''mandibular fracture''; (2) ''3d plate'' AND ''mandibular fracture''; (3) ''3 dimensional plate'' AND ''mandibular fracture''; (4) ''strut plate'' AND ''mandibular fracture''.

For the initial selection, three independent reviewers (JCSO, JSDM, and LBM) reviewed the title and/or abstract of the articles against established inclusion criteria: studies performed in human beings; specific studies on the use of 3D plates for the treatment of mandibular fractures; published in the English language; type of study: case series and retrospective and prospective clinical trials. There was no restriction on date of publication.

After the initial selection, the three examiners reviewed the full texts of the selected articles and identified those for inclusion in the final review using the same eligibility criteria.

Data extraction

The examiners independently extracted the data from the articles included in the final review. The data extracted were the type of study, number of patients and fractures, location and displacement of the fracture, surgical approach, type of 3D plate used, complications, and success rate (%). In order to standardize the success rate of the studies, the cases in which re-operation was required for the removal of fixation material, there was bad union or non-union, fixation failure, or an unsatisfactory postoperative condition, such as inadequate occlusion, as well as those in which there was a need for maxillomandibular fixation (MMF) or there was occlusal wear, were considered as failures. Discrepancies in data extraction between the reviewers were resolved by further discussion. Data were analyzed using descriptive statistics.

Quality assessment

The evaluation of methodological quality was performed using the PRISMA statement criteria[23], in order to verify the strength of the available scientific evidence in the current literature for use in clinical decision-making. The classification of potential risk of bias in each study followed pre-established criteria used in previous reviews[25]: random selection in the population (sample); definition of inclusion/exclusion criteria; report of patient loss to follow-up; validated measurements; statistical analysis.

Studies that presented all of the above criteria were classified as having a low risk of bias, those that lacked one criterion were classified as having a moderate risk of bias, and those that lacked two or more criteria were classified as having a high risk of bias.

Results

The electronic search was conducted in November 2016 and identified 281 articles. Eighty-two were determined to be relevant after reading the title and/or abstract. After removing duplicates, the complete texts of 27 articles were evaluated against the previously established criteria. Two of these articles did not meet the inclusion criteria and were excluded from the study. The final review included 25 articles. The year of publication of the articles selected ranged from 2005 to 2016. Figure 1shows the flowchart of the article selection process.

Among the articles selected for the final review, 16 reported prospective studies[3–5,9,10,18,21,22,26–33], seven reported retrospective studies[8,17,34–38], and two reported

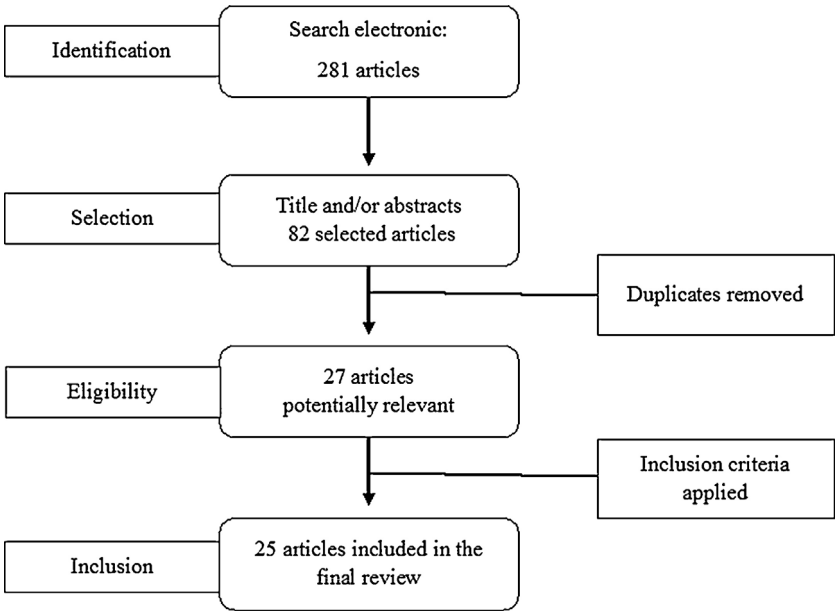

Fig. 1. Flowchart of the systematic review process.