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In vitro biomechanical evaluation of sagittal split osteotomy fixation with a specifically designed miniplate

V. A. Pereira Filho, H. Y. Iamashita, M. S. Monnazzi, M. F. R. Gabrielli, L. G. Vaz, L. A. Passeri
Dental School of Araraquara, Department of Diagnosis and Oral and Maxillofacial Surgery, Universidade Estadual Paulista, Unesp, Rua Humaita, 1680, 2° andar, Araraquara, São Paulo, Cep 14801-903, Brazil

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Abstract. Recent studies have evaluated many methods of internal fixation for sagittal split ramus osteotomy (SSRO), aiming to increase stability of the bone segments while minimizing condylar displacement. The purpose of this study was to evaluate, through biomechanical testing, the stability of the fixation comparing a specially designed bone plate to other two commonly used methods. Thirty hemimandibles were separated into three equal groups. All specimens received SSRO. In Group I the osteotomies were fixed with three 15 mm bicortical positional screws in an inverted-L pattern with an insertion angle of 90°. In Group II, fixation was carried out with a four-hole straight plate and four 6 mm monocortical screws. In Group III, fixation was performed with an adjustable sagittal plate and eight 6 mm monocortical screws. Hemimandibles were submitted to vertical compressive loads, by a mechanical testing unit. Averages and standard deviations were submitted to analysis of variance using the Tukey test with a 5% level of significance. Bicortical screws presented the greatest values of loading resistance. The adjustable miniplate demonstrated 60% lower resistance compared to bicortical screws. Group II presented on average 40% less resistant to the axial loading.

Key words: biomechanical evaluation; sagittal split ramus osteotomy; rigid internal fixation.

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Improvements in surgical techniques and internal fixation devices have helped to increase the predictability and stability of results in orthognathic surgery.[1] Stable internal fixation has reduced or eliminated the need for intermaxillary fixation, diminishing the risks of postoperative aspiration and facilitating masticatory function recovery, thereby improving oral hygiene and quality of life for patients in the immediate postoperative period.[2]

Sagittal split ramus osteotomy (SSRO) is the most common mandibular orthognathic surgery performed and because of its design results in a broad area of overlapping bone which facilitates the application of internal fixation devices.[3] The SSRO is stabilized by different fixation methods, including bicortical screws,[2,4] miniplates with monocortical screws,[5–7] and hybrid techniques.[8] There has been increasing interest in investigating the different types of osteosynthesis, to determine which is the most stable and causes least morbidity or complications.

Condylar position changes to some extent after surgical repositioning of the mandible by SSRO. Condylar positioning devices do not warrant that the preoperative position is maintained. Condylar sag or torque may induce exaggerated remodelling, malocclusion, temporomandibular joint dysfunction or even condylar resorption. Special plates have been developed, aiming to allow some degree of passive muscular seating of the condyles after fixation, in order to decrease articular complications. For that task, the concept of a less rigid fixation construct has been proposed, as well as adjustable less rigid Plates 9.

Previous studies have used alloplastic hemimandibles to perform biomechanical evaluations,[10–13] varying the method of osteosynthesis or mixing the application of different fixation devices. This article evaluates the resistance of the fixation of the sagittal split osteotomy with a specifically designed adjustable plate and compares it with two commonly used internal fixation methods.

Fig. 1. Alloplastic hemimandibles with sagittal osteotomy. External view of the distal segment (left); external view of the proximal segment (right).

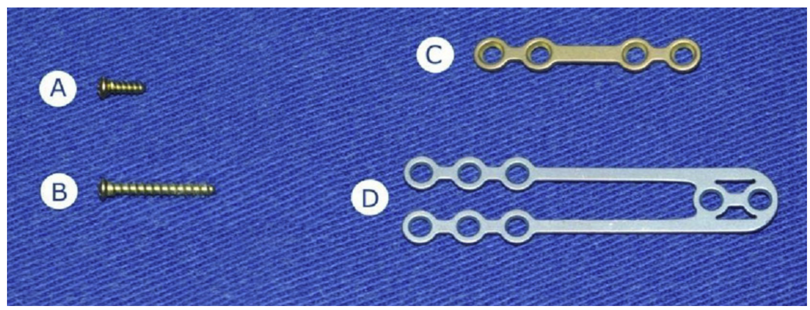

Fig. 2. Metallic internal rigid fixation devices used: (A) monocortical 6 mm screw; (B) bicortical 15 mm screw; (C) straight miniplate 4 holes and (D) sagittal adjustable miniplate 8 holes.

Materials and methods

Thirty polyurethane hemimandibles (Nacional, Jaú, SP, Brazil) fabricated in the same lot, with sagittal split osteotomies previously done by the manufacturer, were used as substrate for mechanical testing in this study (Fig. 1). They were separated into three groups of 10 hemimandibles each, according to the type of fixation employed to stabilize the sagittal osteotomy (Fig. 2). The sample size calculation considered the mean and variance values as described by Özden et al.,[14] establishing the significance level of 5% and power of 80% which results in a sample of 10 hemimandibles for each group.

This mechanical testing was based on a biomechanical cantilever bending model that simulates the masticatory forces on replica hemimandibles. This method was described in previous studies that evaluated *in vitro* mandibular advancement and setback surgery with other types of rigid internal fixation devices.[8,11] To allow load testing, a custom-fabricated support apparatus was produced according to a previous description,[11] in which the proximal segment was rigidly stabilized in the condylar and coronoid areas, allowing free movement of the distal segment (Fig. 3).

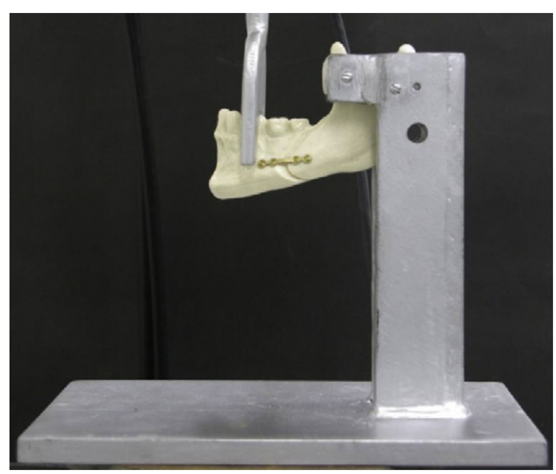

Fig. 3. Custom fabricated support apparatus with the hemimandible in place ready for starting the loading tests.

The hemimandibles were randomly assigned to each of the three groups, corresponding to the 10 repetitions for each experimental condition (Fig. 4). In Group I the SSRO hemimandibles were stabilized by three 15 mm (Modus® 2.0, Medartis AG, code M-5140.15, Basel, Switzerland) bicortical screws inserted at a 90° angle, at a distance of 10 mm from each other, following an inverted L pattern. In Group II the SSRO hemimandibles were stabilized by one 4-hole straight miniplate using four 6 mm monocortical screws (Modus® 2.0, Medartis AG, code M-4320, Basel, Switzerland). In Group III the SSRO hemimandibles were stabilized by one sagittal miniplate 2.0 system using eight 6 mm monocortical screws (Modus® OSS 2.0, Medartis AG, code M-4774, Basel, Switzerland).

The standardization of the amount of advancement (5 mm), proper position of the segments and adequate configuration of screws was ensured by the use of a transparent acrylic jig for all specimens.