Int. J. Oral Maxillofac. Surg. 2014; 43: 559–563
http://dx.doi.org/10.1016/j.ijom.2013.10.002, available online at http://www.sciencedirect.com

International Journal of Oral & Maxillofacial Surgery

Trauma, Research Paper

In vitro evaluation of the resistance of a 2.0-mm titanium fixation system in the sectioned angle without continuity of the inferior border of the mandible

P. F. B. Trivellato, A. O. Pepato, M. C. Ribeiro, C. E. Sverzut, A. E. Trivellato
Department of Oral and Maxillofacial Surgery and Periodontology, School of Dentistry of Ribeirão Preto, University of São Paulo, Ribeirão Preto, São Paulo, Brazil

P. F. B. Trivellato, A. O. Pepato, M. C. Ribeiro, C. E. Sverzut, A. E. Trivellato: In vitro evaluation of the resistance of a 2.0-mm titanium fixation system in the sectioned angle without continuity of the inferior border of the mandible. Int. J. Oral Maxillofac. Surg. 2014; 43: 559–563.

Abstract. The aim of this *in vitro* study was to evaluate the mechanical resistance of a 2.0-mm titanium system applied to the mandibular angle, either with or without continuity of the inferior border of the mandible. Polyurethane mandibles were used as substrates and divided into two groups: unfavourable and favourable to treatment. A single cut was made through the retromolar region, simulating an angle fracture either unfavourable or favourable to treatment. In addition, a small fragment of the inferior border of the mandible was removed in some of the mandibles, creating a discontinuity. The fragments were stabilized in accordance with the technique of Champy et al. The substrates were adapted to a universal mechanical testing machine and submitted to a constant load applied at three different points; load values were obtained at three different moments of displacement: 1 mm, 2 mm, and fixation failure. The value of the tip dislocation at final displacement was obtained. When the load was applied at the first molars, regardless of the side, no statistically significant difference was observed between the groups. When the load was applied at the central incisors, a statistically significant difference was observed at fixation failure in the unfavourable to treatment group, with better results in the subgroup with continuity of the inferior border of the mandible compared to the subgroup without continuity. Discontinuity of the inferior border of the mandible did not decrease the mechanical resistance of the fixation.

Keywords: resistance; mandibular angle fracture; titanium; plate; biomechanical analysis.

Accepted for publication 3 October 2013
Available online 9 November 2013

The mandibular angle fracture is a frequent injury to the maxillofacial skeleton,[1] representing 23–42% of all mandibular fractures.[1,2] Biomechanical and anatomical factors contribute to this proneness to fracture, such as the thinner cross-sectional area than in the tooth-bearing area, the presence of the third molars, the abrupt change in shape from horizontal mandibular body to the vertical ramus, and the masticatory muscle insertions and forces.[1]

The treatment of angle fractures still represents an important clinical challenge and is one of the most discussed topics in maxillofacial traumatology.[3]

With the introduction and popularity of plate and screw fixation, a number of fixation methods have been advocated for fractures occurring through the angle of the mandible. Michelet et al.[4] reported on the treatment of mandibular fractures using small, easily bendable non-compression plates, placed transorally, attached with monocortical screws. Champy et al.[5] observed that bite points resulted in bending moments on the fractured side, which produce an inter-fragmentary tension zone on the alveolar ridge and a compression zone on the inferior border of the mandible. Therefore, the integrity of the inferior border of the mandible appears to play an important role in this modality of treatment.

Some mandibular angle fractures present a fragment at the inferior border of the mandible that can be lost, consequently creating an anatomical discontinuity at this site. Although the loss of this fragment does not usually compromise the external facial contour, the influence of this occurrence on the resistance of the fixation system is uncertain. To the best of our knowledge, there has been no *in vitro* study reported in the indexed scientific literature evaluating the influence of the discontinuity of the inferior border of the mandible on the resistance of the fixation system device.

The purpose of this study was to evaluate the 2.0-mm titanium fixation system applied according to the technique of Champy et al.[5] on the angle sectioned in a manner either favourable or unfavourable to treatment, with or without continuity of the inferior border of the mandible, using mechanical *in vitro* testing.

Materials and methods

The 2.0-mm titanium system consisted of straight four-hole plates ($n = 84$) with 6.0-mm long self-tapping screws ($n = 336$) (NeoOrtho, Curitiba, PR, Brazil). The plates were made of commercial pure titanium and were 1.0 mm thick and 23.5 mm long, with 4.5 mm between the centres of the holes.

Eighty-four human dentate mandible replicas made of rigid polyurethane resin (Nacional Ossos, Jaú, SP, Brazil) were used as the substrate. The replica mandibles were divided into two groups: 'favourable' and 'unfavourable' to treatment. Each group was divided into subgroups according to the condition of the inferior border of the mandible and the site of load application (Table 1). Each subgroup consisted of seven replica mandibles.

Table 1. Distribution according to the group, type of sectioning, the site of load application, and subgroup.

Group	Continuity of the inferior border of the mandible	Site of load application	Subgroup
Unfavourable to treatment	With	First molar, plated side	1
	With	First molar, contralateral side	2
	With	Between central incisors	3
	Without	First molar, plated side	4
	Without	First molar, contralateral side	5
	Without	Between central incisors	6
Favourable to treatment	With	First molar, plated side	7
	With	First molar, contralateral side	8
	With	Between central incisors	9
	Without	First molar, plated side	10
	Without	First molar, contralateral side	11
	Without	Between central incisors	12

The experimental models were uniformly sectioned at the left mandibular angle using a micro-reciprocating saw with a 0.2-mm thick blade (Dentscler, Ribeirão Preto, SP, Brazil). A first point (A) was marked on the alveolar process, 5 mm posterior to the distal face of the second molar (Fig. 1, I). From this point, a line was traced perpendicular to the inferior border of the mandible and a second point (B) was identified in a more inferior aspect of the inferior border of the mandible. Two further points were obtained 10 mm equidistant from point B, one anterior (C) and the other posterior (D). To obtain defects simulating fractures both favourable and unfavourable to treatment, the sectioning was completed from points A to C (favourable; Fig. 1, II) and from points A to D (unfavourable; Fig. 1, III). A discontinuity of the inferior border of the mandible was created using the oblique lines obtained (A–C and A–D) in each respective group. In the favourable to treatment group, point E was obtained along the A–C line 10 mm above point C. Next, point F was obtained 5 mm forward of point C along the inferior border of the mandible. Finally, the triangle created by the points C–E–F (Fig. 1, IV) was

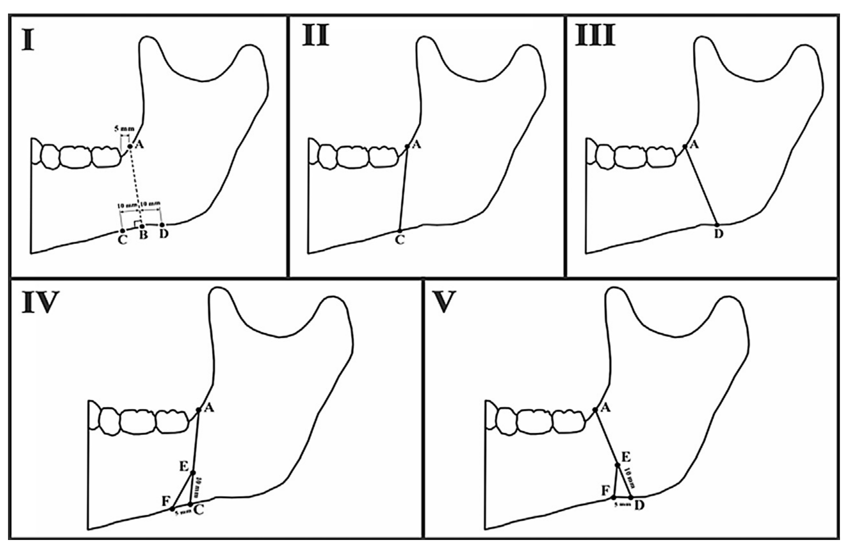

Fig. 1. (I) Point A was marked on the alveolar process, 5 mm posterior to the distal face of the second molar. From this point, a line perpendicular to the inferior border of the mandible was traced (dotted line) and point B was obtained. Points C and D are 10 mm equidistant from point B along the inferior border of the mandible. (II) The trajectory of the sectioning made from point A to point C, simulating a fracture favourable to treatment. (III) The trajectory of the sectioning made from point A to point D, simulating a fracture unfavourable to treatment. (IV) Trajectories of the sectioning involving the points C, E, and F to create the discontinuity in the inferior border of the mandible in the favourable to treatment group. (V) Trajectories of the sectioning involving the points D, E, and F to create the discontinuity in the inferior border of the mandible in the unfavourable to treatment group.