Available online at www.sciencedirect.com
ScienceDirect
British Journal of Oral and Maxillofacial Surgery xxx (2016) xxx–xxx
BRITISH Journal of Oral and Maxillofacial Surgery
www.bjoms.com

In vitro evaluation of the resistance of three types of fixation to treat fractures of the mandibular angle☆

D. Maritza Contreras Gonzalez, G. Spagnol, C. Edvard Sverzut, A. Elias Trivellato*

Department of Oral and Maxillofacial Surgery and Periodontology, School of Dentistry of Ribeirão Preto, University of São Paulo, Ribeirão Preto, São Paulo, Brazil

Accepted 20 September 2016

Abstract

The purpose of this study was to compare the mechanical resistance of three different plates used to treat fractures of the mandibular angle: a regular 4-hole plate, a longer 4-hole plate (both positioned using the Champy technique), and a 3-dimensional plate positioned over the oblique line. Three equal groups of replicas of human dentate mandibles made out of polyurethane resin were used (n = 21 in each group). The force was applied perpendicular to the occlusal plane at a rate of 2 mm/minute at three different points: the first molar on the sectioned side; the first molar on the contralateral side; and between the central incisors. This was followed by a resistance-to-load test. The two varying factors (type of plate and site-of-load application) were tested by analysis of variance, and probabilities of less than 0.05 were accepted as significant. There were no significant differences between the subgroups, or between the mean values of the different types of plates (p = 0.925). The three types of plates showed similar mechanical behaviour, which showed that the 3-dimensional plates positioned over the oblique line can produce mechanical scores similar to those of conventional plates.

Keywords: Mandibular Fracture; Bone screws; Bone plates; 3D plate

Introduction

The angle fracture is one of the most common fractures of the mandible, and it poses a challenge as its treatment is difficult and unpredictable because it is biomechanically complex and is associated with high morbidity.[1–3]

The technique developed by Michelet et al.[4] and consolidated by Champy et al.[5] is the one most commonly used for the treatment of isolated fractures of the mandibular angle. It consists of fixing one small bendable plate on to the monocortical bone on the oblique line using an intraoral approach sufficient to withstand the tensile and torsional forces to which the mandibular bone is typically subject.

Three-dimensional miniplates are a viable option. Their geometry increases the resistance to forces of both torsion and flexion, and the tension and compression zones are stabilised.[6–8] Some authors have reported promising results, but their use in the external oblique line is not regarded as the best option when using only one miniplate.

The purpose of the present study was to compare the mechanical resistance of three types of plate recommended for treating fractures of the mandibular angle: the regular 4-hole plate and the longer 4-hole plate, both positioned using the Champy technique, and the 3-dimensisonal plate positioned over the oblique line.

☆ Sources of support: 190475/2012-9 program PEC-PEG/CNPq.
* Corresponding author at: Department of Oral and Maxillofacial Surgery and Periodontology, School of Dentistry of Ribeirão Preto, University of São Paulo, Avenida do café, s/n, Fone (5516) 33154137 CEP 14.040-904, Ribeirão Preto, São Paulo, Brazil.
E-mail address: eliastrivellato@forp.usp.br (A. Elias Trivellato).

http://dx.doi.org/10.1016/j.bjoms.2016.09.017

Please cite this article in press as: Contreras Gonzalez DM, et al. In vitro evaluation of the resistance of three types of fixation to treat fractures of the mandibular angle. *Br J Oral Maxillofac Surg* (2016), http://dx.doi.org/10.1016/j.bjoms.2016.09.017

Fig. 1. 3-dimensional plate.

Fig. 2. Longer 4-hole plate.

Material and methods

The material comprised 63 human dentate mandibular replicas made of polyurethane resin (National Bones Ltda, Jaú, São Paulo, Brazil) divided into three equal groups according to the type of plate - regular 4-hole plate, 3-dimensional plate, and longer 4-hole plate (n = 21 in each) (Figs. 1–3). Each group was further divided into subgroups according to the site-of-load application (n = 7 in each).

The left angle of the mandibular replicas of all groups were sectioned as described by Bregagnolo et al.[9] The sectioning was done with a blade 0.2 mm thick fitted to a microreciprocating saw (Dentscler, Ribeirão Preto, São Paulo, Brazil). Point "A" was obtained 5 mm posterior to the distal face of the second molar, and a line was traced perpendicularly to the mandibular base from this point. At the most inferior point of this line (A), point B was marked. Point C was marked 10 mm posterior to point B. Simulated fractures that were not amenable to treatment were obtained by sectioning the substrates from point A to point C. To standardise the sectioning, one jig was made with acrylic resin and adapted to the lateral surface of all the polyurethane mandibular replicas.

Fig. 3. Regular 4-hole plate.

The 63 × 2.0 mm plates (regular 4-hole plates, longer 4-hole plates and 3-dimensiosnal plates, n = 21 in each group) were made from pure commercial titanium (Tóride, Mogi-Mirim, São Paulo, Brazil). To stabilise the plates, we used 252 self-tapping screws made from titanium-aluminium-vanadium alloy (6.0 mm long) (Tóride, Mogi-Mirim, São Paulo, Brazil).

The plates were adapted and later stabilised passively over the oblique line into each group using the specific instruments included by the manufacturer. A cylindrical drill 1.6 mm in diameter and 6.0 mm deep was used before the screws were inserted. Four screws were used to stabilise each plate. To standardise the position of the plates, another three jigs made from acrylic resin were constructed for each specific group. The plates were supported by jigs that were adapted to the lateral surface of the substrates during the perforation, which allowed the plates in each specific group to be in the same position.

The resistance-to-load test was done using an EMIC DL200 Universal Material Testing Machine (EMIC, São José dos Pinhais, Paraná, Brazil) located at the Integrated Laboratory for Research on the Biocompatibility of Materials at the School of Dentistry of Ribeirão Preto, University of São Paulo. Two steel devices were made and set up on the EMIC machine: one to support and stabilise the models, and the other to apply the vertical loads. Force at a rate of 2 mm/minute was applied perpendicular to the occlusal plane at three different points: the first molar on the sectioned side; the first molar on the contralateral side; and between the central incisors.

The data from the loading applied were recorded in kilogram force at four different times: 1.0 mm, 2.0 mm, and 5.0 mm of tip displacement, and when the fixation failed. All measurements were in mm.

Statistical analysis was made with the aid of the software Winks SDA – Version 6.0.1 (Texasoft Copyright 1991-2007) and we used analysis of variance (ANOVA) to assess the significance of differences between the two variation fac-

Please cite this article in press as: Contreras Gonzalez DM, et al. In vitro evaluation of the resistance of three types of fixation to treat fractures of the mandibular angle. *Br J Oral Maxillofac Surg* (2016), http://dx.doi.org/10.1016/j.bjoms.2016.09.017