Assessment of the fixation of mandibular symphysis fractures using conical cannulated screws: mechanical and photoelastic tests

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Objective. The aim of this study was to use mechanical and photoelastic tests to compare the performance of cannulated screws with other fixation methods in mandibular symphysis fractures.
Study Design. Ten polyurethane mandibles were allocated to each group and fixed as follows: group PRP, 2 perpendicular miniplates; group PLL, 1 miniplate and 1 plate, parallel; and group CS, 2 cannulated screws. Vertical linear loading tests were performed. The differences between mean values were analyzed with the Tukey test. The photoelastic test was carried out using a polariscope.
Results. The results revealed differences between the CS and PRP groups at 1, 3, 5, and 10 millimeters of displacement. The photoelastic test confirmed higher stress concentration in all groups close to the mandibular base, whereas the CS group showed it throughout the region assessed.
Conclusions. Conical cannulated screws performed well in mechanical and photoelastic tests. (Oral Surg Oral Med Oral Pathol Oral Radiol 2014;118:174-180)

Mandible fractures are one of the most common facial injuries. This high prevalence affects both urban and rural dwellers.[1] The high prevalence of this type of fracture affects children and adolescents[2] as well as adults.[3] In addition, the prevalence of mandibular fractures is similar in developing countries such as India[4] and Turkey[5] and in developed countries such as Japan.[6] The symphysis is a mandibular area that exhibits a variation in fracture prevalence that ranges from 13.8%[7] to 49.5%.[4] Surgical treatment of mandibular symphysis fractures involves the restoration of dental occlusion through intermaxillary fixation, anatomic reduction, and osteosynthesis of fractured stumps. This leads to an immediate or rapid return to normal shape and function in the fractured area. The most commonly used fixation techniques are miniplates and screws, plates and screws, and the lag screw method.[8] In an attempt to assess the performance of these fixation techniques, clinical[9,10] and mechanical[11,12] studies have been performed. Photoelastic tests can also be used to assess the mechanical behavior of fixation systems in relation to facial fractures and orthognathic surgery. This type of assessment is conducted through a visualization of the isochromatic fringes in the areas where tension is distributed.[13-16]

Assessments of the clinical performance of the fixation of mandibular symphysis fractures using lag screws, miniplates, and plates have found good results. The installation of lag screws involves a greater surgical difficulty than the use of miniplates. On the other hand, lag screws have been associated with the lowest index of complications.[9] Lag screws have also been found to be more resistant to compression than plates in mechanical tests.[11,12]

Cannulated screws differ from conventional screws in that they have a longitudinal orifice from the base to the apex, which enables the insertion of a Kirschner wire to assist in their insertion during surgery.[17-19] They were originally used to perform arthrodesis of finger joints[20,21] and percutaneous fixation of fractures of the bones of the fingers and hands.[18,22] In the maxillofacial region, cannulated screws have been used to fix intracapsular fractures of the mandibular condyle. The use of this type of screw in these cases has been aided by a Kirschner wire, which enables the fixation of these fractures through a limited preauricular access.[17,19]

According to the literature consulted, there is no evidence that cannulated screws have been used in cases of mandibular symphysis fractures. The application technique of the cannulated screw seems to be

Statement of Clinical Relevance

Cannulated screws are not currently used in mandibular symphysis fracture. The present study suggests that this fixation method might be a viable alternative for fixation of mandibular symphysis fractures.

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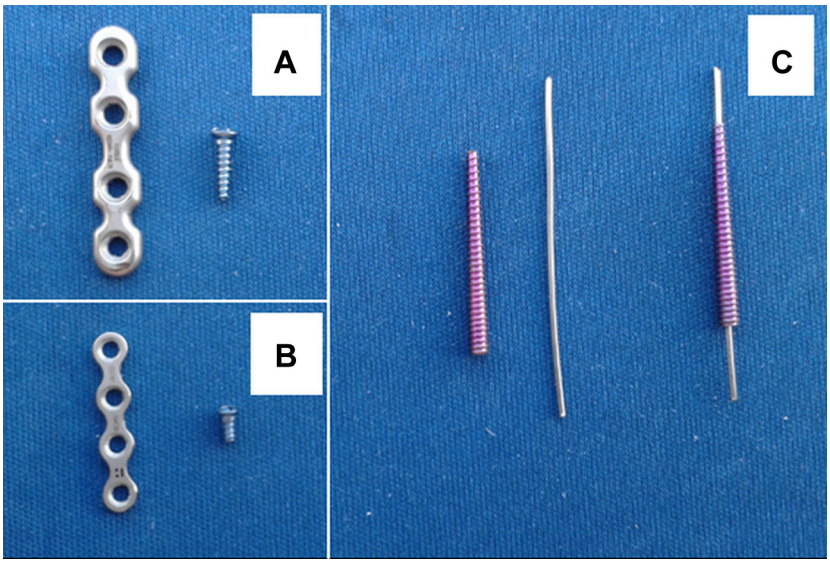

Fig. 1. Fixation materials. A, Straight plate with 4 holes and bicortical screw (system 2.4). B, Straight miniplate with 4 holes and monocortical screw (system 2.0). C, conical cannulated screws (system 2.8), note screws with or without wire insertion indicating that the screw is cannulated.

simpler than the application of lag screws, which are currently used to fix mandibular symphysis fractures. The aim of the present study was to assess the performance of cannulated screws in the fixation of mandibular symphysis fractures through photoelastic and mechanical tests, as well as to compare their performance with that of other fixation methods.

MATERIALS AND METHODS

This study did not require ethics committee approval, because it was an in vitro study without involvement of human participants or animals.

In the present study, 30 identical polyurethane mandibles per the ASTM F 1839 standard (Nacional Ossos, Jaú, São Paulo, Brazil) and 3 birefringent photoelastic mandibles (Araldite GY 279 and Aradur HY 2963; Nacional Ossos) were used. The fixation materials included the following: 10 straight plates with 4 holes (system 2.4); 40 bicortical screws (system 2.4) 11 mm in length (Figure 1, A); 30 straight miniplates (system 2.0) with 4 holes; 120 monocortical screws (system 2.0) 5 mm in length (see Figure 1, B); and 20 conical cannulated screws (system 2.8) 28 mm in length (see Figure 1, C) (Tóride, Mogi-Mirim, São Paulo, Brazil).

Sample preparation

For the mechanical test, the 30 polyurethane mandibles were divided into 3 fixation groups as follows: the perpendicular miniplates group (PRP) with 10 mandibles, each of which was fixed perpendicularly with 2 straight miniplates with 4 holes and 8 screws (system 2.0) 5.0 mm in length (Figure 2, A); the parallel plates group (PLL) with 10 mandibles, each of which was fixed in a parallel pattern with 1 straight miniplate with 4 holes and 4 screws (system 2.0) 5.0 mm in length and 1 straight plate with 4 holes and 4 screws (system 2.4) 11.0 mm in length (see Figure 2, B); and the cannulated screws group (CS) with 10 mandibles, each of which was fixed with 2 conical cannulated screws (system 2.8) 28 mm in length perpendicular to the fracture line and parallel to one another (see Figure 2, C). For the photoelastic test, each of the 3 photoelastic resin mandibles was fixed exactly as described previously in the fixation groups (PRP, PLL, and CS).

A guide of colorless acrylic resin (Artigos Odontológicos Clássico Ltda, Campo Limpo Paulista, São Paulo, Brazil) was built to standardize the location of the fixation of the osteosynthesis material and the location of the cut to simulate the mandibular symphysis fracture. A polyurethane mandible that was not used in the tests was used to build this guide. First, a partial cut was made on the polyurethane mandible with a 22-mm diamond disk (KG; Sorensen, Cotia, São Paulo, Brazil) mounted on a mandrel and adapted into a handpiece. This cut began in the area of the lower central incisors and finished in the area of the genial tubercle (Figure 3, A, B). After this partial cut had been made, the miniplates and the plates were modeled and fixed in the mandible, using the positions in which they would be fixed in each study group. Next, the perforations, where the cannulated screws would be inserted, were created. The acrylic resin was then adapted in the area of the mandibular symphysis on the osteosynthesis material, to design the guide. After the resin had set, the guide was removed from the mandible and drilled in the