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Original Article

Biomechanical Study: Resistance Comparison of Posterior Antiglide Plate and Lateral Plate on Synthetic Bone Models Simulating Danis-Weber B Malleolar Fractures

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ABSTRACT

Objective: The purpose of this study was to compare different positions of plates in lateral malleolar Danis-Weber B fractures on synthetic bone: a lateral plate and a posterior antiglide plate. *Methods*: Short oblique fractures of distal fibula at the level of the syndesmosys were simulated with a fibular osteotomy in sixteen synthetic fibula bones (Synbone®). Eight fractures were fixed with lateral plating associated with an independent lag screw, and the other eight were fixed with posterior antiglide plating with a lag screw through the plate. A strain gage was installed at the center of each plate at the osteotomy site. Supination and external rotation forces were applied to each of the two groups at the bend. *Results*: The lateral position plate group suffered more deformity in response to supination forces compared to the group with the posterior antiglide plate, but this result was not statistically significant. In the tests with external rotation forces, the posterior antiglide plating group had significantly higher resistance ($p < 0.05$). *Conclusion*: When subjected to external rotation forces, osteosynthesis with posterior antiglide plate models simulating type B fractures of the lateral malleolus of the ankle is more resistant than that of the neutralization plate.

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Introduction

The incidence of ankle fractures is increasing, and studies have shown that fracture incidence among the elderly has doubled over the last 40 years.[1] Among athletes, both professional and amateur, the incidence has also increased. Due to its position and characteristics, the ankle is subject to numerous traumas, and its fracture is the most frequent among the load-bearing joints.[2] Risk factors for ankle fracture were elucidated by performing a complementary analysis of multiple cases.[3-5] Most of the cases consisted of isolated malleolar fractures, representing two thirds of total ankle fractures. One fourth of the patients presented fractures in the two malleoli, and 7% of the patients presented bimalleolar fractures with the third posterior fragment. Open fractures are rare and represent only 2% of all ankle fractures.[6]

In various studies, the importance of anatomic reduction and rigid fixation of these fractures to achieve complete functional restitution has been highlighted.[2,7-9] Danis-Weber type-B fractures, adopted by the AO group, are quite frequent.[10,11] In the literature, several ways to stabilize this type of fracture have been suggested: a single interfragmentary lag screw, associated interfragmentary screws, tension bands, intramedullary wire or nails, and intramedullary screw or support plates and screws.[10,12-14]

Within this last option, there are several ways to install the synthesis material. The most common method involves two platings. A one-third tubular neutralization plate is placed laterally and associated with an independent interfragmentary lag screw outside the plate and a posterolateral antiglide plate can be attached with an interfragmentary lag screw through the plate.[15]

Several researchers have conducted trials to compare these two techniques with the use of plates and screws. Some of them use case series and group them into the techniques employed.[12,16] Other researchers have conducted biomechanical studies with cadaveric bones.[9,14] There are many advantages to posterior plating over lateral plating. With lateral orientation, there is the possibility of intra-articular positioning of the distal screws.[17,18] There is also greater incidence of surgical wound dehiscence using the lateral technique.[16] Greater resistance has been observed with posterior plating[17], and a greater number of patients report satisfactory results regarding the positioning of the plate in the posterior position.[19]

There are several arguments in favor of posteriorly placing the plate with ankle fractures, and these arguments have motivated us to attempt to prove these supposed advantages. Our study provides a quantitative analysis concerning the difference in mechanical efficiency obtained with the different dispositions in the osteosynthesis of the lateral malleolus of the ankle.

Objective

This study aims to simluate Danis-Weber type-B fractures and assess the mechanical resistance of osteosynthesis with interfragmentary lag screw and lateral and posterior plates, which are subject to supination stress and external rotation.

Material and Methods

The present study used anatomical models of synthetic fibula bones that simulate the shape and bone characteristics of human fibulas (Synbone®).[20] Sixteen fibulas of the same size and density were used and subjected to a simulated Danis-Weber type-B fracture. Oblique cuts from the anterior cortical bone to the posterior bone were made by using an oscillatory saw with a 1-mm thick blade at the height of the tibiotalar joint of each model (Fig. 1).

The fibulas were divided into two groups. In Group 1, the failure was attached with an interfragmentary lag screw associated with a one-third tubular plate that containing six holes (for 3.5 mm screws) with six cortical screws, which is used for neutralization, on the lateral surface of the fibula (lateral plate; Fig. 2A). In Group 2, the failure was attached with an interfragmentary screw through a one-third tubular plate containing four holes (for 3.5 mm screws) with three more cortical screws in the posterior surface of the fibula (antiglide posterior plate; Fig. 2B).

After the fixation of the two groups, a strain gauge was installed in the center of each plate (Fig. 2C). This device was able to measure slight variations in tension, and it also measured the deformity in the center of the plate to assess the deforming forces.

The first experimental trial was performed with the fibulas of Group 1 (lateral plates). Each fibula was positioned in a stabilization device, together with the tibia, which was also synthetic. These fibulas were subject to bending strengths (simulating supination efforts) from 5 to 60 kgf, progressively increasing the load every 5 kgf. Data were collected by the ADS 500 conditioner by Lynx Tecnologia, and data analysis was performed by the Linx AqDados© and Linx AqDAnalysis© software. The same trial was conducted with Group 2 fibulas (posterior plate; Figs. 3A and 3B).

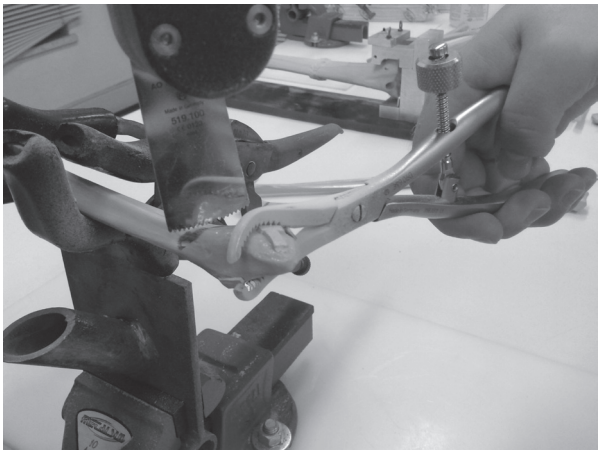

Fig. 1 - A right synthetic fibula was subjected to a simulation of a fracture using a 1-mm thick saw.