CHAPTER **45**

COMPARISON OF FIBULAR FIXATION: Preliminary Results

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The importance of anatomic reduction of lateral malleolar fractures has been reiterated in several studies. Open reduction and internal fixation of short oblique fractures of the distal fibula have been a mainstay of treatment. Methods of fixation have included the use of interfragmentary lag screws with or without plating, posterior antiglide plates, cerclage wire, intramedullary screw or pin fixation, and more recently biodegradable fixation methods.

Few studies have attempted to biomechanically investigate the stability of fibular fixation methods. Some investigators have compared lateral plate fixation to non-plate fixation. Eckerwall and Persson compared staples and cerclage wire to a lateral plate and lag screw fixation. Bankston et al. evaluated an intramedullary screw to a lateral buttress plate. Both studies concluded that there was no significant difference between either form of fixation. The former study controlled bone density by utilizing bilateral matched pairs, however, the latter study did not mention controlling bone density.

Koval et al. utilized eight pair of densitometrically proven osteopenic fibulas to investigate the biomechanical strength of two fixation methods. The fibulas were cleaned of soft tissue and a transverse osteotomy was made in the fibula, 3 cm from the distal fibula tip. Fibulas were then fixated with either a contoured 6 hole plate and screws, or two 1.6 mm diameter intramedullary Kirschner wires (K-wires) followed by similar lateral plate and screw application. The specimens were then tested nondestructively in bending by applying a 20N load 2 cm distal to the fracture. Torsional load to failure was performed by applying an external torsional load at a rate of 10 degrees/minute. The authors reported that the fibulas augmented with the K-wires had an 81% greater resistance to bending than the fibulas fixated with the plate alone. The K-wire group had twice the resistance to motion in torsional testing, 0.10 Nm / degree versus 0.05 Nm / degree. They concluded that the results support the use of K-wires to augment plate fixation in individuals with osteopenic fibula fractures.

Schaffer and Manoli compared the posterior antiglide plate to the lateral neutralization plate in mechanically produced short oblique fractures of the lateral malleolus. An external rotatory torque and 147 N axial load was placed upon the two fixation methods, and measurements of torque at fixation failure were recorded. The antiglide plate with screws inserted proximal to the fracture site was noted to fail at 36.4 Nm. The posterior plate was then reattached to the fibula through new screw holes proximal and an interfragmentary lag screw was added through the plate distal to the fracture line. This new system failed at 35.9 Nm. The lateral neutralization plate alone failed at 30.2 Nm. An interfragmentary screw was not used with the lateral plate, due to fibular destruction while mechanically producing the short oblique fracture. The authors concluded that the antiglide plate was advantageous for use in fibula fracture patients. The posterior plate was especially useful in osteoporotic bone, and the use of an interfragmentary screw was recommended to help obtain anatomical reduction.

The authors intend to compare the stability of two forms of fibular fixation. The lateral or posterior plate, each with an interfragmentary lag screw, will be compared while controlling for bone density.

Lateral and posterior plate fibular applications are well-documented standards of short oblique fracture fixation. Several advantages and disadvantages have been attributed to each type of plate. In addition to fixating normal fibular bone stock, the posterior antiglide plate has been advocated in reducing osteoporotic fractures. Lateral plate application does not interfere with peroneal tendon function (as may the posterior plate). However, the lateral plate and screws often become painfully prominent, necessitating removal. Unlike the posterior plate, there is a risk of entering the ankle joint with the distal screws of the lateral plate.

STUDY DESIGN

Thirteen bilateral matched cadaveric fibular pair were dissected free of soft tissue. The anterior-medial border of each fibula was marked one centimeter proximal to the superior aspect of the talar articulating surface. A fifty-degree angle was measured from the long axis of the fibula, and a line was drawn posterior and superior from this anterior-medial mark. The same investigator marked and lined each fibula.

A .045 axis guide K-wire was inserted at the midpoint of this line. Each fibular K-wire was inserted by the same investigator, and the wire was perpendicular to all three planes of the fibula as confirmed by the measurements of two investigators. One investigator made all fibular osteotomies utilizing a sagittal saw with the K-wire axis guide as reference.

Each pair was randomized for either a six-hole lateral plate with an anterior to posterior interfragmentary screw, or a five-hole posterior plate with an interfragmentary screw inserted through the plate. New Synthes (Paoli, PA) plates and screws were exclusively used, as well as instrumentation from the Synthes small fragment set. Left sided fibulas had seven lateral and six posterior plates applied. Right sided fibulas were fixated with six lateral and seven posterior plates.

Fractures treated with a lateral plate were first reduced with a 4.0 partially-threaded interfragmentary screw. Each plate was attached by using 3.5-mm fully threaded cortical screws proximal to the fracture and 4.0-mm fully threaded cancellous screws distal to the fracture. In applying the posterior plate, the first distal screw inserted was a 4.0-mm fully threaded cancellous interfragmentary screw.

The fixated fibulas were then potted in bone cement. Care was taken to prevent cement from contacting fixation hardware. A potting jig was used to ensure that each fibula was potted perpendicular. The fibulas were then placed in the Instron 4201 device. A 7 kg axial load was first applied to each potted fibula then the crosshead torque speed was set at 500 mm/min. The distal aspect of left-sided fibulas were rotated counter-clockwise, while the distal aspect of right-sided fibulas were rotated clockwise. The proximal potted end was held stationary. Failure was defined as either bone fracture or fixation pull-out. Several failure types were encountered and each was documented.

DISCUSSION/SUMMARY

This randomized double-blind study compared two types of cadaveric fibular fixation, i.e., the posterior and lateral plate each with an interfragmentary screw. Several variables were controlled by the investigators:

1. Bone density was controlled by using bilateral matched fibular specimens.
2. Each fibular pair was randomly assigned a lateral or posterior plate.
3. One investigator performed particular tasks, e.g., measuring fibular angles, cutting of fibulas, fixating fibulas.
4. Each fibular fracture was created identically so the type of fixation would be better compared. This osteotomy represents the typical supination-external rotation fibular fracture orientation, and is similar to the mechanically-produced fractures as described by Schaffer and Manoli.
5. New Synthes screws and the same standardized instrumentation were used on all specimens.
6. A potting jig was used so the fibulas would be perpendicular to the pots. This insured that all axial and torsional forces were retained within the long axis of the bone.
7. The torque rate and axial load was controlled for each fibula. The weight-bearing load of the fibula has been estimated in several reports to be between 6.5% and 17% of body weight. The 7kg axial load was determined by setting the weight-bearing status of the fibula to 10% of a hypothetical 70 kg individual.

This study was designed to compare the resistance to injury by two forms of fibular fixation.

Specifically, the forces applied to the fixated fibulas simulated a supination-external rotation injury. Indeed, an intact control fibula was potted and subjected to the same load and it developed a long spiral fracture consistent with a Weber Type B fracture. Ultimately, this study evaluated the stability of fixated fibular fractures when subjected to another injury producing force.

In all fibulas tested, axial load was applied prior to distal torque, and no failure was recorded with axial load alone. Failure resulted only with the application of torque. At this writing, the statistics are still being calculated, however, early results indicate that both forms of fixation were equally stable.

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