Injury, Int. J. Care Injured 45 (2014) 2051–2054

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Nerve and tendon injury with percutaneous fibular pinning: A cadaveric study

Justin Iorio, Katharine Criner, Saqib Rehman *, Casey Meizinger, Christopher Haydel

Temple University School of Medicine, Department of Orthopaedic Surgery and Sports Medicine, 3401 North Broad Street, Zone B, 6th floor, Philadelphia, PA 19140, United States

ARTICLE INFO

Article history:
Accepted 7 August 2014

Keywords:
Fibula fracture
Intramedullary pinning
Safe zones
Tendon injury
Nerve injury
Cadaver

ABSTRACT

Objective: The purposes of this study were to measure the average distance from a percutaneous pin in each quadrant of the distal fibula to the sural nerve and nearest peroneal tendon, and define the safe zone for percutaneous pin placement as would be used during surgery.
Method: Ten fresh-frozen cadavers underwent percutaneous pin fixation into four quadrants of the distal fibula. The sural nerve and peroneal tendon were identified as they coursed around the lateral ankle. Distances from the K-wire in each quadrant to the anatomic structure of interest were measured.
Results: Average distances (mm) from the K-wire to the sural nerve in the anterolateral, anteromedial, posterolateral, and posteromedial quadrants were 19.1 ± 8.9 (range, 5.1–35.5), 12.8 ± 8.2 (range, 0.3–27.8), 12.6 ± 6.8 (range, 3.0–27.8), and 5.9 ± 5.5 (range, 0.1–19.9), respectively. Average distances from the K-wire to the nearest peroneal tendon in the anterolateral, anteromedial, posterolateral, and posteromedial quadrants were 15.7 ± 4.4 (range, 9.5–23.1), 11.9 ± 5.2 (range, 3.2–21.7), 6.3 ± 3.9 (range, 0.1–14.4), and 1.0 ± 1.6 (range, 0–5.6), respectively.
Conclusions: Percutaneous pinning of distal fibula fractures is a successful treatment option with minimal complications. Our anatomical study found the safe zone of percutaneous pin placement to be in the anterolateral quadrant. The sural nerve can be as close as 5.1 mm and the peroneal tendons as near as 15.7 mm. In contrast, the posteromedial quadrant was associated with the greatest risk of injury to both the sural nerve and peroneal tendons.

Introduction

Distal tibia and fibular fractures are frequently treated with open reduction and internal fixation of the tibia and fibula, with fibular fixation typically consisting of plate and screw fixation [1]. With tibial pilon fractures and some extraarticular distal tibia fracture patterns, the fibular fracture often does not involve the ankle joint, and the surgeon has to decide whether or not fibular fixation is needed [2]. Unfortunately, soft tissue concerns with these injuries may preclude fibular plating, or lead to wound complications when plating is done through usual extensile incisions.

Closed reduction and percutaneous pinning (CRPP) is a surgical treatment option for displaced distal fibular fractures and segmental distal fibular fractures [3–5]. Percutaneous pinning is a successful treatment method for elderly patients and those with multiple medical comorbidities who are prone to wound complications and osteoporotic bone, such as diabetics and chronic steroid users [5–8]. CRPP avoids significant stripping of the soft tissue envelope and provides lateral column stabilization. In the absence of fixation in concomitant distal tibia fractures, there is destabilization of the lateral column depending on fracture configuration and associated ankle injuries. Further, the fibula fracture has the potential to affect tibial length, alignment, and rotation [2,3]. This ultimately affects functional outcome, tibial malunion rate in combined tibia-fibula fracture, and post-traumatic ankle arthrosis [9,10].

The goals of fibular pinning or an intramedullary rod are to improve bending stability of the tibia and fibula fractures, and to some degree, maintain fibular length. Because this is often done as a percutaneous method, the peroneal tendons and sural nerve are at risk for injury. Furthermore, we have noted that the incidence of painful implants is not insignificant in our practice, potentially in part due to irritation of nearby anatomic structures. The proximity

* Corresponding author. Tel.: +1 267 908 1043; fax: +1 215 430 4136.
E-mail address: saqib.rehman@tuhs.temple.edu (S. Rehman).

http://dx.doi.org/10.1016/j.injury.2014.08.025
0020–1383/

of percutaneously-placed fibular pins to the nearby structures, namely the peroneal tendons and sural nerve, has not been described. The purpose of this anatomic study is to measure the distance from percutaneous pins in the distal fibula to these anatomic structures and define the safe zone for pin placement correlated with fluoroscopic images as would be used during surgery.

Materials and methods

Ten fresh-frozen cadaver lower extremities with an average age of 78 years (range, 57–95 years) were dissected after percutaneous pinning of the distal fibulas. All procedures were performed on left fibulas from 6 female and 4 male cadavers in the prone position and ankles in the resting equinus position. Plantar flexion angles were measured with a goniometer for each cadaver and averaged 33.8° (range, 17–51°). No cadavers had evidence of lower extremity bony disease or trauma. Under mini C-arm fluoroscopic guidance, four Kirschner wires (K-wires) (1.1 and 2.0 mm) were inserted with a Small Battery Drive drill (Synthes, West Chester, PA).

One orthopaedic trauma-trained fellow performed all percutaneous pin placements. K-wires were inserted through the skin 1–2 cm distal to the tip of the lateral malleolus and directed towards and parallel to the intramedullary canal as in standard approach for fibular intramedullary fixation. One K-wire was placed into each of four different quadrants of the distal fibula and verified by anteroposterior and lateral fluoroscopic imaging. The four quadrants as viewed from the axial plane were defined as anteromedial, anterolateral, posteromedial, and posterolateral (Fig. 1). A chief-level orthopaedic surgery resident dissected the lateral ankle after all 4 pins were inserted. The dissection and percutaneous pinning was supervised by one orthopaedic trauma fellowship-trained attending.

Each cadaveric dissection was performed without disrupting local anatomy and included identification of the sural nerve and its branches (SN), and the peroneal tendons (PT). Using a single incision, the PT were dissected from approximately 5 cm proximal to the lateral malleolus to an area several centimetres distal to the K-wires along the lateral border of the foot. The shortest distance from the centre of each K-wire to the closest section of the sural nerve, whether a branch or the nerve proper, was measured with a Brown & Sharpe calliper (Dial-Cal Metric Model no. 599-579-14; North Kingstown, RI). Distances to the nearest tenth of a millimetre were recorded. The same procedure was repeated for PT, measuring the shortest distance between each K-wire and the nearest tendon. K-wires that penetrated the sural nerve or peroneal tendons were given a distance of 0 mm and wires that abutted against these structures were recorded as 0.1 mm. All measurements were performed and recorded by three different individuals. Measurements were then averaged and the range, standard deviation, and variance were calculated.

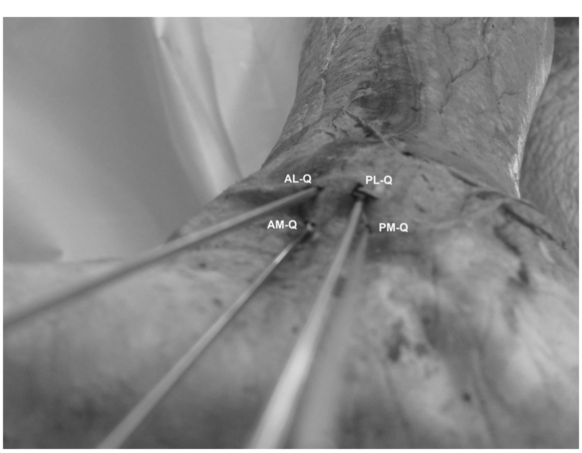

Fig. 1. Axial view of K-wire placement in distal fibula of left cadaver leg. AL-Q, anterolateral quadrant; AM-Q, anteromedial quadrant; PL-Q, posterolateral quadrant; PM-Q, posteromedial quadrant.

Results

The sural nerve and peroneal tendons were identified in all cadavers. The distances of the K-wire to these anatomical structures are summarised in Fig. 2. Two of the 10 K-wires in the posteromedial quadrant (PM-Q) were found to be abutting the sural nerve (Fig. 3). In 4 of the 10 specimens, the PM-Q K-wire was found to be piercing the peroneal tendons (Fig. 4) and in 3 separate specimens abutting the tendons as they curved anteriorly around the distal fibula. The PM-Q K-wire was an average distance of 5.9 mm (range, 0.1 [abutting the nerve] – 19.0 mm; SD 5.52) from the sural nerve and an average of 0.96 mm (range, 0 [piercing the tendon] – 5.6 mm; SD 1.61) from the peroneal tendons.

In 1 of 10 cadavers, the K-wire abutted the peroneal tendons during insertion into the posterolateral quadrant (PL-Q); the average distance between PL-Q K-wire and the tendons was 6.3 mm (range, 0.1–14.4 mm; SD 3.9). In one cadaver, the PL-Q K-wire was only 3 mm from a branch of the sural nerve and the average distance from wire to sural nerve was 12.56 mm (range, 3–27.8; SD 6.82).

No K-wires in the anteromedial quadrant (AM-Q) contacted the nerve or tendons, although in one cadaver the wire was only 0.3 mm from a branch of the sural nerve. The average distance between AM-Q K-wire and nerve was 12.82 mm (range, 0.3–27.8; SD 8.22). K-wires were an average distance of 11.92 mm (range, 3.2–21.7 mm; SD 5.2) from the peroneal tendons.

The anterolateral quadrant (AL-Q) K-wires were the furthest from the sural nerve with an average distance of 19.1 mm (range, 5.1–35.5 mm; SD 8.95). Distances measured in this quadrant exhibited the greatest variability among quadrants. Similarly, no tendons were abutted or pierced when K-wires were inserted in this quadrant (average distance, 15.65 mm; range, 9.5–23.1 mm; SD 4.37).

Discussion

The fundamental advantage of fibula fixation in certain isolated fibula fractures and in combined distal tibia-fibula fractures is well established [10]. Intramedullary fibula fixation is a successful surgical option in patients with potential for poor wound healing,

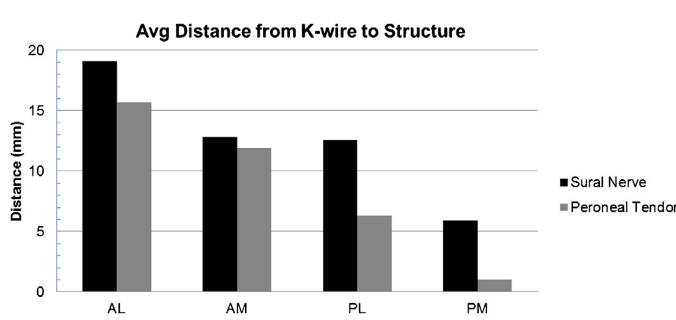

Fig. 2. Average distance from K-wire in each quadrant of distal fibula to sural nerve and nearest peroneal tendon. AL, anterolateral; AM, anteromedial; PL, posterolateral; PM, posteromedial.