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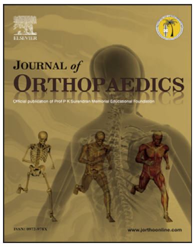

Original Article

Injury to neurovascular structures with insertion of traction pins around the knee

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ABSTRACT

Objective: Identify risk to neurovascular structures around the knee with placement of skeletal traction pins.

Methods: Kirchner wires were inserted into cadaveric limbs followed by layer dissecting of each leg. Correlations between weight, height, BMI, and distance were determined after calculating the average distance with deviation between each anatomic structure and the Kirschner wire.

Conclusion: Insertion of traction pins around the knee did not result in injury to neurovascular structures. Both weight and BMI positively correlated with distance between implants and neurovascular structure. Data collected suggests similar trends for all other anatomic structures.

1. Introduction

Skeletal traction was once used as definitive treatment of long bone fractures, but today is most commonly applied as a temporary method of stabilizing fractures in a damage control setting.[3,11] Contemporary practice uses skeletal traction for temporary stabilization until definitive surgical fixation can be performed.[1–3] Benefits of skeletal traction include maintenance of limb length, pain control, minimizing blood loss, and limiting further soft tissue injury. Clinical examples include: femur fractures, vertically unstable pelvic ring injuries, and acetabular fracture-dislocations.[11]

Bedside insertion of larger Steimann pins or smaller Kirschner wires are connected to 15–20 pounds of weight and attached to an appropriate traction frame. Damage to neurovascular structures, local soft tissue infection, osteomyelitis, thermal injury, and physeal injury are all possible complications of skeletal traction.[1,4] Traction pin insertion techniques are well described and focus on minimizing injury to the surrounding soft tissue (1–5). Historically, distal femoral traction pins have been inserted from a medial to lateral while

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Table 1 – Average distance between neurovascular structure and implant.

	Left avg. (mm)		Right avg. (mm)	Combined R&L (mm)
Left femur		**Right femur**		
Great Saphenous Vein	50.9 ± 24.7 (28–90)	Great saphenous vein	40.1 ± 22.2 (11–80)	45.50
Saphenous nerve	31.6 ± 13.1 (16–51)	Saphenous nerve	29.9 ± 17.0 (8–50)	30.75
Femoral artery	27.6 ± 12.3 (15–45)	Femoral artery	29.9 ± 16.1 (8–50)	28.75
Femoral vein	28.3 ± 11.6 (16–45)	Femoral vein	31.4 ± 17.0 (12–55)	29.85
Left tibia		**Right tibia**		
Super peroneal nerve	30.7 ± 7.7 (20–43)	Super peroneal nerve	33.4 ± 11.5 (21–55)	32.05
Deep peroneal nerve	23.9 ± 7.7 (12–33)	Deep peroneal nerve	20.3 ± 7.5 (7–32)	22.10
Anterior tibial artery	17.9 ± 4.5 (12–25)	Anterior tibial artery	16.6 ± 5.9 (10–26)	17.25
Anterior tibial vein	18.9 ± 4.6 (13–25)	Anterior tibial vein	16.6 ± 4.0 (11–21)	17.75

proximal tibial traction pins have been inserted from lateral to medial. One main concern with application of skeletal traction is iatrogenic damage to surrounding neurovascular structures. To our knowledge, an anatomic study that evaluates the risk to neurovascular structures with insertion of a traction pin into the distal femur through a medial entry or a proximal tibia traction pin placed through a lateral approach has not been previously done. The purpose of this study is to identify the relationship of neurovascular structures around the knee with placement of distal femoral and proximal tibial skeletal traction pins.

2. Methods

Fourteen lightly embalmed cadaveric limbs from seven specimens were used for the insertion of distal femur and proximal tibia Kirschner wires. Distal femoral traction pins were placed with the specimen in a supine position, the knee flexed and supported to 45°, and the patella facing directly anterior. The sharp end of a 1.6 mm (mm) smooth Kirschner wire was used to pierce the skin of the medial distal thigh, at the level of the proximal pole of the patella. The mid-sagittal plane of the femur was determined by palpating the anterior and posterior cortex of the femur with the wire. The wire was advanced parallel to the knee joint from medial to lateral and in bicortical fashion using a power driver (Synthes, Paoli, PA) until the wire fully exited the lateral skin. Without changing position of the leg, a bicortical 1.6 mm smooth Kirschner wire was inserted into the proximal tibia. The entry site utilized was 1 cm (cm) distal and 2 cm posterior to the tibial tubercle. The wire was introduced through the anterior compartment of the lateral tibia, placed down to bone, and the mid-sagittal plane of the tibia was determined by using the wire to palpate the anterior and posterior cortex of the tibial. The wire was then advanced using a power driver in bicortical fashion parallel to the knee joint from lateral to medial until it exited the medial skin. All wires were inserted by a single fellowship trained orthopedic trauma surgeon. Fluoroscopic imaging for wire insertion was not used so as to reproduce clinical practice. This process was repeated on each specimen.

Following insertion of traction pins, each leg underwent layered dissection by an anatomist (R.S.). Superficial and deep neurovascular structures of the distal femur including the great saphenous vein, saphenous nerve, femoral artery, and femoral vein were carefully identified. For the proximal tibia, the superficial peroneal nerve, deep peroneal nerve, anterior tibial artery, and anterior tibial vein were also identified. The distance between each anatomic structure and the Kirschner wire was measured with a digital caliper with a tolerance of 0.1 mm. The average distance with deviation between each anatomic structure and the Kirschner wire was calculated. Differences in distance between left and right extremities were compared using a student's *t* test ($p < 0.05$). Injury to any anatomic structure was documented as present or absent.

3. Results

Fourteen lower extremities in seven lightly embalmed cadavers (2 females and 5 males) were utilized and then dissected. The average age was 78 ± 13 with an average body mass index of 24.5 ± 9.5 (Table 2). No anatomic structures were injured during insertion of either distal femoral or proximal tibia Kirschner wires. Average distances between implant and anatomic structures are listed in Table 1. The average distance between Kirschner wires and neurovascular structures ranged from 17.25 mm, for the anterior tibial artery, to 45.5 mm, for the great saphenous vein. The average distance between the Kirschner wire and individual anatomic structures in the femur are listed in Table 1. The average distance between the Kirschner wire and the great saphenous vein was 45.5 mm, the saphenous nerve was 30.75 mm, the femoral artery 28.75 mm, and the femoral vein was 29.85 mm. In the proximal tibia, the average distance between the Kirschner wire and anatomic structures are listed in Table 1. The average distance between the Kirschner wire and the anterior tibial artery was 17.25 mm, anterior tibial vein was 17.75 mm, the deep peroneal nerve was 22.1 mm, and the superficial peroneal nerve 32.05 mm. All anatomic structures of the distal femur and proximal tibia were noted to rest posterior to the trajectory of the K-wire. Student's *t* test showed no difference between left and right extremities when

Table 2 – Patient demographics.

Specimen	Sex	Height	Weight	BMI
1	M	75″	205	25.6
2	F	62″	78	14.3
3	M	70″	280	40.2
4	F	67″	220	34.5
5	M	69″	125	18.5
6	M	69″	140	20.7
7	M	70″	125	17.9