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Original Contribution

The effect of obesity on the anatomical relationship of the popliteal artery and tibial nerve in the proximal and distal popliteal fossa: relevance to popliteal sciatic nerve block and a traceback technique using the popliteal artery☆,☆☆,★

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Abstract
Study Objective: To determine the effect of body mass index (BMI) on the relationship of the popliteal artery to the sciatic and tibial nerves in the popliteal fossa.
Design: Prospective, observational study.
Setting: University medical center.
Subjects: One hundred patients scheduled for magnetic resonance imaging scans of the knee.
Measurements: BMI was recorded and magnetic resonance imaging scans were assessed at 3 different measurement points along the femur for the distance and angle between the popliteal artery and tibial nerve, or sciatic nerve if the sciatic nerve had not bifurcated at the measurement point.
Main Results: At the distal femur, the tibial nerve was a mean of 2.9 mm from the popliteal artery. The nerve was consistently posterior to the artery; however, it was variably located medial or lateral to the artery. At the 5- and 8-cm measurement points, the nerve was 10.0 and 16.1 mm (SD, 4.1 and 5.2 mm), and 31° and 44° (SD, 15° and 16°) lateral to the popliteal artery, respectively. Zero degree was defined as directly posterior to the artery. Increasing BMI was correlated with increasing distance between the nerve and the artery at the 5- and 8-cm measurement points (r= 0.36 P> |t| .000 and .45 P> |t| .002).

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Conclusions: At 5 cm proximal to the distal femoral condyles, the popliteal artery is a reliable sonographic landmark to locate the tibial nerve due to the close proximity and consistent location of the nerve 1 cm posterolateral to the artery, with only a moderate effect of BMI.

1. Introduction

Ultrasound-guided sciatic nerve block in the distal thigh is a common regional anesthetic approach for distal lower extremity surgery [1-3]. Ultrasound is used to identify the sciatic nerve, and local anesthetic is deposited near the nerve to achieve blockade. Even with ultrasound, definitive localization of the sciatic nerve using published techniques is not always readily achievable [4]. In these situations, additional anatomical structures that are easily identified on ultrasound may be used to orient the anesthesia provider and aid in locating the sciatic nerve. One common approach is to first identify the popliteal artery in the distal popliteal fossa and then look for the tibial component of the sciatic nerve lateral and superficial to the artery [4]. A "traceback" technique may then be used to follow the tibial nerve proximally to locate the sciatic nerve where it bifurcates into the tibial and common peroneal nerves [5]. Successful application of this technique assumes a relatively consistent anatomical relationship between the popliteal artery and sciatic nerve in the popliteal fossa. Obesity is a common clinical problem, and adipose tissue can collect in the popliteal fossa. Prior studies have demonstrated the variability of the bifurcation of the sciatic nerve in the posterior knee and thigh, the variability of the popliteal artery and vein in the popliteal fossa, and the affect of obesity on required needle angles to approach the sciatic nerve in the popliteal fossa [6-10]. The anatomical relationship of the popliteal artery as it relates to the tibial and sciatic nerve at 3 different locations in the popliteal fossa was examined. It was hypothesized that in obese patients, excess adipose tissue would be present between the sciatic and tibial nerves, and the popliteal artery, significantly changing their anatomical relationship.

2. Methods

The institutional review board of the hospital approved this prospective observational study and waived patient consent. We recruited consecutive subjects with magnetic resonance imaging (MRI) scans of the knee for any diagnostic purpose recorded in the image archive system after April 1, 2012. Subjects were excluded for age less than 18 years; MRI sections not obtained to 8 cm proximal to the distal femur; prior surgery of the distal thigh, knee, or proximal lower leg; tumor in the distal thigh, knee, or proximal lower leg; or MRI scans in which measurements could not be obtained due to poor image quality. The age and sex of the subject, body mass index (BMI), and side of the body from which the scan was obtained were recorded. Consecutive MRI scans of the knee were included in the study. After exclusions, 100 MRI scans were enrolled and included in data analysis.

All MRI scans were obtained with a Philips 3 T MRI scanner. Coronal cuts were obtained using a coronal proton density turbo spin-echo scan. Axial cuts were obtained using axial fat-suppressed intermediate TE-weighted SPIR scans. All MRI scans were reviewed and measurements obtained using an IMPAX 6.3.1.6506 image archiving system. A coronal cut through the femur containing the most distal aspect of the medial femoral condyle was selected for each subject. The distal condyle was chosen as the point at which the knee hinges and is approximately 1 cm distal to the popliteal skin crease. The relationship between the distal femoral condyles and the popliteal skin crease was confirmed by examining several pilot MRI scans and plain x-rays. The coronal cut was used to identify 3 different points along the distal femur where measurements were recorded; the distal aspect of the medial condyle of the femur, 5 cm proximal to the distal medial condyle, and 8 cm proximal to the distal medial condyle. The 5- and 8-cm (approximately 7 cm from the popliteal skin crease) measurement points were selected because between these distances are common points for both ultrasound and nerve stimulator techniques, to identify the sciatic nerve for popliteal blocks [2,11]. Measurements were recorded from axial cuts corresponding to the locations on the femur. In each of these axial cuts, the popliteal artery and tibial nerve were identified. If the sciatic nerve had not bifurcated in the axial cut as defined by a 1-mm distance between the tibial and common peroneal components of the sciatic nerve, measurements were taken using the sciatic nerve. Otherwise, all measurements were taken using the tibial nerve. A line was drawn through the center of the popliteal artery and through the center of the nerve. The distance along this line from the edge of the popliteal artery to the edge of the nerve was measured and recorded in millimeters.

To obtain a reference point for the amount of rotation of the femur, a line was drawn through the posterior intercondylar line of the femur on an axial cut where the condyles were most prominent (Fig. 1). A line perpendicular to the rotation reference line was drawn through the center of the popliteal artery on each axial cut in which measurements were recorded. This line represented 0° (directly posterior to the artery). The angle in degrees between the 0° line and the line through the center of the popliteal artery and center of the nerve was recorded, with positive numbers indicating that the nerve was medial to the artery and with negative numbers indicating that the