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Correlation Between Visual Inspection and Ultrasonography to Identify the Distal Branches of the Superficial Peroneal Nerve: A Cadaveric Study

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ABSTRACT

The anatomy of the superficial peroneal nerve (SPN) and, more precisely, of the distal branches of the SPN at the ankle has attracted interest owing to the possibility of injury when performing ankle arthroscopy. The anterolateral portal is one of the most commonly used portals in ankle arthroscopy, and the intermediate dorsal cutaneous nerve can easily be injured during portal placement. The purpose of the present study was to assess whether visual inspection and palpation of the cutaneous nerves at the ankle differed from examination with ultrasonography and whether the 2 examination techniques correlated with the anatomic location of the SPN, which was verified by cadaver dissection. First, visual examination and palpation was performed to identify the SPN, after which 12 cadaver legs from separate specimens were examined with ultrasonography to mark the course of the SPN. We then measured the distance between the nerve as identified with gross visualization/palpation and ultrasound examination, and compared these with the precise location determined by anatomic dissection. The use of ultrasonography to determine the course of the SPN was good or excellent in 11 of the 12 legs (91.7%) studied. In contrast, gross visualization/palpation was good or excellent in 4 legs (33.3%). Excellent agreement was observed between the ultrasound markings and the anatomic dissection results. However, the visual examination poorly identified the course and the anatomic variations of the nerve branches evidenced in the anatomic dissection. From these findings in cadaver specimens, ultrasound identification of the SPN and its branches is likely preferable to gross visualization/palpation before placement of the anterolateral arthroscopic portal to the ankle.

Arthroscopy is a routine procedure for exploration and treatment of the ankle, although injuries involving the superficial peroneal nerve (SPN) and its branches are one of the main risks associated with anterolateral portal placement (1–5). The anterolateral portal is one of the most commonly used portals in anterior ankle arthroscopy. This portal is placed just lateral to the peroneus tertius tendon at, or slightly proximal to, the joint line. The intermediate dorsal cutaneous nerve, which is a lateral branch of the SPN, can easily be injured during portal placement. Most of the complications described in association with ankle arthroscopy have involved this nerve (6). Ferkel et al (7) reported an overall incidence of complications of 9%, of which iatrogenic SPN damage accounted for 27%. The high risk of SPN injury results from a combination of 2 factors: the anatomic proximity of the SPN branch to the anterolateral portal and the anatomic variation of the nerve (4). A third factor is the relative change in the position of the SPN during ankle movement from plantarflexion to dorsiflexion (8).

The increasing presence and use of ultrasonography in operating theaters and the experience gathered in performing ultrasound-guided peripheral nerve blocks have led us to use ultrasonography to localize, identify, and mark the anatomic structures at risk in the operative field (9). In particular, ultrasonography has enabled us to clearly identify the entire course of the SPN (10).

The aim of the present cadaveric study was to determine whether visual inspection and palpation and the use of ultrasonography to mark the course of the SPN branches would correlate with the anatomy found during dissection in a cadaveric study.

Materials and Methods

Twelve legs from entirely separate, fresh-frozen cadavers were examined. Six of the legs were from the right and 6 from the left lower extremity, and 7 (58.3%) were from

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females and 5 (41.7%) from males. The mean age at death was 71 (range 52 to 84) years. None of the anatomic specimens showed external signs of previous surgery. The study was performed in the anatomy and embryology dissecting room at the anatomy laboratory of the University of Barcelona Faculty of Medicine. The study was divided into 3 examination stages: visual/palpation, ultrasonography, and dissection.

Stage 1: Gross Visualization and Palpation Examination

Two different investigators (D.P., J.A.), both surgeons specializing in foot and ankle surgery, performed the examinations of the 12 cadaver specimens. Using gross visualization of the surface of the skin and palpation, they determined, by consensus, whether the nerve could be seen and/or felt at any point along its trajectory across the ankle. Inversion and supination of the foot and ankle were used to enhance the identification of the cutaneous nerve and/or its branches. When the nerve was identified, its course was marked using an indelible marker.

Stage 2: Ultrasound Examination

The same 12 cadaver legs were then examined using ultrasonography. A trained examiner (A.M.L.) with experience in ultrasound-guided peripheral nerve blocks performed the ultrasound examination. The SPN was localized in the anterolateral aspect of the distal leg, approximately 15 cm proximal to the lateral malleolus, to better follow the course and branches of the SPN. A 6- to 13-MHz linear probe (M-Turbo; Sonosite, Bothell, WA) was used, and the course of the nerve marked with needle tacks. The ankle joint was maintained in the neutral position during the ultrasound examination.

Both the visually and ultrasound-identified nerves were marked, using a marking pen in the gross visualization stage and needle tacks in the ultrasound examination stage. The results were recorded, and nerve identification was classified as excellent when the whole course of the nerve was completely identified, good when most of its course was identified, fair when discerning the nerve around the portal zone was possible but the course difficult to follow, and poor when discerning the nerve around the portal zone was difficult. Furthermore, in each of the stages, the course of the SPN and its terminal branches were marked on the skin using an indelible marker and hypodermic needles at 3 key points: the point at which the nerve pierces the superficial fascia to become subcutaneous, the division of the terminal branches, and its position at the level of the joint line.

Stage 3: Dissection

Gross anatomic dissection was performed after the ultrasound assessment. The skin was removed gradually while measuring the distances to the path of the SPN, its division, and the course of each of the terminal branches. The skin was removed a point approximately 15 cm proximal to the lateral malleolus, extending distally to the submalleolar area. A millimeter caliper was used to measure the distance between the ultrasound-marked position and the actual position observed during gross dissection at the following points: the point at which the nerve pierced (emerged) through the deep fascia and the 2 subdivisions of the terminal branches. We also measured the distance between the visually examined location of the various branches of the SPN at the level of the ankle joint line (Fig. 1).

Statistical Analysis

The correlation between the visual or ultrasound findings and dissection findings was considered correct when the difference between both marks was <1 mm. The results are presented as frequencies and percentages and each measurement's 95% confidence interval (CI). Differences between the visual examination and ultrasound findings were assessed using McNemar's test for paired comparisons. Concordance between the ultrasound examination and dissection findings regarding the identification of anatomic variations was assessed using Cohen's kappa coefficient, and the level of agreement was categorized according to the criteria of Landis and Koch (11). Statistical significance was defined at the 2-tailed 5% ($p \leq .05$) level, and computations were conducted using SPSS, version 20.0 (SPSS, Inc., Chicago, IL).

Results

Stage 1: Gross Visualization and Palpation Examination

In the 12 legs examined, the point at which the SPN pierced the deep fascia could not be identified by direct, gross visual examination or palpation. The examination of the subcutaneous course of the nerve and its division and branches was categorized as poor in 5 cases (41.7%), fair in 3 (25%), and very good or excellent in 4 (33.3%). In 1 of the cases (8.3%), 2 nerve branches could be distinguished. No interobserver disagreement was found in the gross visualization and palpation examination findings.

Stage 2: Ultrasound Examination

The subfascial visualization was good or excellent in 11 of the 12 cases (91.6%). In 1 case (8.3%; specimen 2), we identified a division of the SPN and 2 places where it pierced the fascia. However, we could not visualize the SPN in the first specimen we examined, possibly because of the subcutaneous fluid in that specimen. Visualization of the subcutaneous course of the nerve and the point of division was good or excellent in 11 of the 12 examinations (91.6%). It could not be visualized in the first specimen. Visualization of the branches (medial and intermediate dorsal cutaneous nerves) at the level of the joint line was good in 10 cadaver specimens (83.3%). In only 2 cases (16.6%; specimens 1 and 6) was the division not clearly identified. In 2 specimens (16.6%), multiple branches of the SPN could be distinguished (fan-shaped in 1 case and band-shaped in 1; Fig. 2).

Correlation Among the Dissection, Visual Inspection, and Ultrasound Findings

The correlation between the gross visualization/palpation and ultrasound examination findings and the actual anatomic dissection localization of the nerves is presented in Table 1.

Point at Which the SPN Pierced (Emerged) Through the Deep Fascia

The point at which the SPN pierced the deep fascia could not be evaluated by direct, gross visual inspection and palpation. However, excellent correlation (83%, 95% CI 62% to 100%) was found between

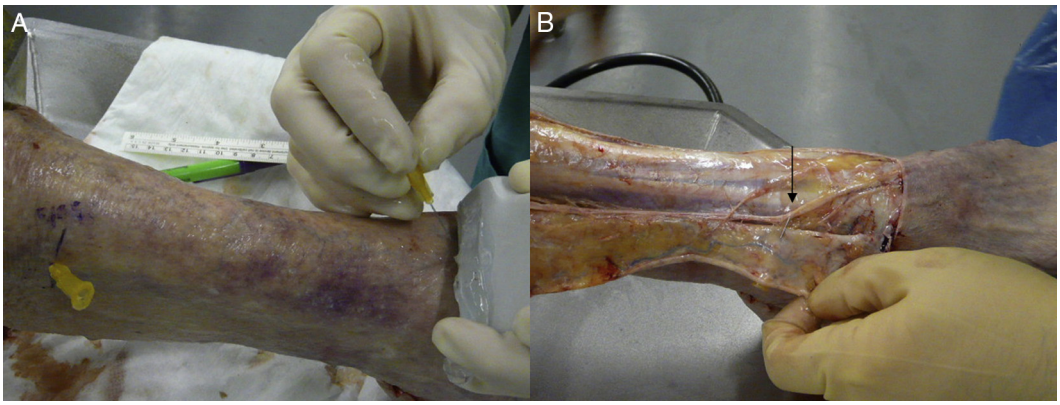

Fig. 1. (*A*) Ultrasound marking of superficial peroneal nerve and (*B*) correlation with dissection findings.