Anatomy of the Lateral Antebrachial Cutaneous and Superficial Radial Nerves in the Forearm: A Cadaveric and Clinical Study

Steven Beldner, MD, Dan A. Zlotolow, MD, Charles P. Melone Jr, MD, Ann Marie Agnes, MD, Morgan H. Jones, MD, *Bronx, NY*

Purpose: To define the anatomy of the lateral antebrachial cutaneous nerve (LACN) and the superficial radial nerve (SRN) in relation to easily identifiable landmarks in the dorsoradial forearm to minimize the risk to both nerves during surgical approaches to the dorsal radius.

Methods: In this study 37 cadaveric forearms and 20 patients having distal radius external fixation were dissected to identify these nerves in relation to various anatomic landmarks.

Results: Based on these dissections the anatomy was divided into 2 zones that can be identified by easily visible and palpable landmarks. Zone 1 extends from the elbow to the cross-over of the abductor pollicis longus with the extensor carpi radialis brevis and longus. Zone 2 is distal to the cross-over. In zone 1 the 2 nerves can be differentiated through limited incisions based on their depth and anatomic location. Within this zone the SRN is deep to the brachioradialis until 1.8 cm proximal to zone 2 (9 cm proximal to the radial styloid), where it becomes superficial and pierces the fascia of the mobile wad and then remains deep to the subcutaneous fat. In contrast the LACN pierces the fascia between the brachialis and biceps muscles at the level of the elbow. In all specimens the LACN ran parallel to the cephalic vein within the subcutaneous fat. In 31 specimens it ran volar to the vein and in 5 specimens the nerve crossed under the cephalic vein at the elbow and ran dorsal to the vein in the forearm. One specimen had 2 branches with 1 on either side of the vein. Differentiation of these nerves was found to be possible through limited incisions in zone 1 during placement of external fixation pins for distal radius fractures. The LACN always was located in the superficial fat running with the cephalic vein, whereas the SRN was deeper to this nerve either covered by the brachioradialis or closely adherent to it within the investing fascia of the mobile wad. In zone 2 the nerves arborized and ran in the same tissue plane, making differentiation through limited incisions difficult.

Conclusions: Dividing forearm anatomy into zones aids in understanding the complex 3-dimensional anatomy. Recognition of the consistent location of both the LACN and SRN facilitates surgical exposure. This allows localization through limited incisions during nerve repair and hardware placement, thereby enhancing uncomplicated and favorable outcomes. (J Hand Surg 2005;30A:1226–1230. Copyright © 2005 by the American Society for Surgery of the Hand.)

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From the Division of Orthopedic Surgery, Albert Einstein College of Medicine, Bronx, NY.

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Corresponding author: Dan A. Zlotolow, MD, University of Maryland Department of Orthopaedics, 2200 Kernan Drive, Baltimore, MD 21207; e-mail: dzlotolow@yahoo.com.

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Mackinnon and Dellon[1] observed that 77% of their patients with traumatic superficial radial nerve (SRN) lacerations in the forearm also sustained concomitant lateral antebrachial cutaneous nerve (LACN) lacerations at the same level. This led them to suggest that unrecognized injury to the LACN in part may be the cause of the poor clinical results associated with surgical repair of the SRN in the region of the distal forearm.

Despite its significant clinical importance this same nerve largely has been ignored in the distal forearm by the literature and surgeons alike. Iatrogenic injury to this nerve has been reported after minimally invasive procedures such as venipuncture.[2,3] Two cadaveric studies[4,5] noted that the LACN is the closest nerve during percutaneous pin placement for external fixation of distal radius fractures, which prompted the recommendation of open placement of these pins. There has been no detailed description of this complex anatomic region in relation to these specific structures.

The anatomy of the LACN has been well described in the region of the elbow. The nerve is the terminal branch of the musculocutaneous nerve and is composed purely of sensory fibers. It emerges from beneath the biceps muscle on its lateral aspect in the region of the interepicondylar line of the humerus.[6,7]

In this study we define the anatomy of the LACN and the SRN in relation to easily identifiable landmarks to minimize the risk to both nerves during surgical approaches to the dorsal radius. This information should help the surgeon identify both nerves rapidly through limited dorsal incisions for either protection or surgical repair after traumatic laceration.

Materials and Methods

Cadaveric Dissection

Thirty-seven embalmed cadaveric forearms with no history of previous forearm trauma (26 male, 11 female) were dissected to identify the LACN, SRN, and cephalic vein. These structures were traced using ×3.5 loupe magnification from the elbow to their final arborization about the wrist. Great care was taken to note the tissue layers in which the structures were identified and their locations relative to each other.

Clinical Study

Twenty consecutive patients had external fixation for distal radius fractures. A 2-cm incision was made in line with the dorsal edge of the brachioradialis muscle just proximal to the cross-over of the muscle bellies of the extensor pollicis brevis (EPB) and the abductor pollicis longus (APL) with the tendons of the extensor carpi radialis longus (ECRL) and extensor carpi radialis brevis (ECRB). This cross-over is easily palpable in most patients, located approximately 10 cm proximal to the radial styloid. The subcutaneous fat was dissected bluntly to preserve any local neurovascular structures. The forearm fascia was incised in line with the skin incision in the interval between the brachioradialis and ECRL tendons. Blunt dissection then was used to access the radius. The presence and location of the cephalic vein, SRN, and LACN were noted.

Results

Cadaveric Dissection

The LACN, SRN, and cephalic vein were identified in every specimen. The LACN was found consistently in the subcutaneous fat distal to its emergence from the lateral border of the biceps tendon. At the elbow the nerve either continued parallel and volar to the cephalic vein in 31 specimens, crossed deep to the vein to lie dorsal to it in 5 specimens, or split into 2 major trunks in 1 specimen: one branch dorsal and one branch volar to the vein (Fig. 1). In all cases the LACN ran at the same depth as the cephalic vein and never was farther than 1 cm from this vessel proximal to the cross-over of the APL and EPB with the ECRL and ECRB.

The SRN was located deep to the fascia enveloping the ECRB, ECRL, and brachioradialis in the proximal forearm. The SRN pierced the forearm fascia 9.3 cm proximal to the tip of the radial styloid in the male specimens (range, 7.2–12.3 cm) and 8.3 cm in the female specimens (range, 6.7–9.7 cm); on average this was 1.8 cm proximal to the cross-over of the APL and EPB with the ECRL and ECRB. The nerve then continued distally within the subcutaneous fat. The SRN and LACN were in close proximity and often overlapped distal to the cross-over. Neither nerve in any of the specimens crossed underneath the first dorsal compartment.

The cephalic vein was in close proximity to the LACN throughout its course within the subcutaneous fat in all specimens proximal to the cross-over. After passing over the muscle bellies of the APL and EPB,

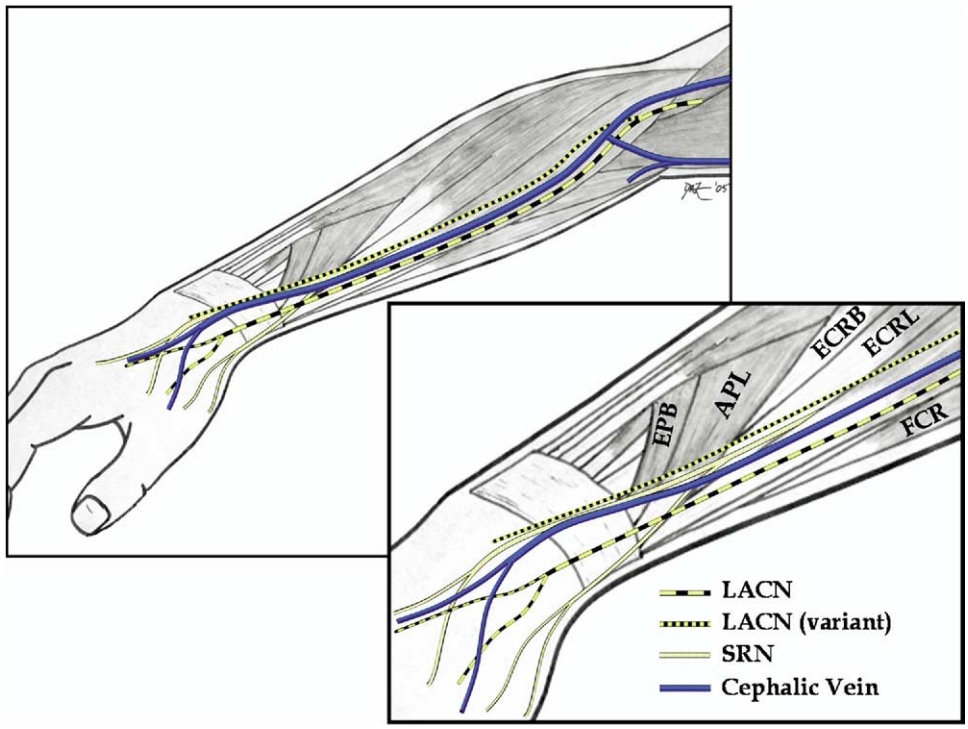

Figure 1. The LACN ran parallel and volar to the cephalic vein in the forearm in 84% of specimens but crossed deep to the vein at the elbow to run dorsal to the vein in the forearm in 14% of specimens. In 2% of specimens there were 2 major branches of the LACN: 1 volar and 1 dorsal to the cephalic vein. A routine surgical exposure for placement of external fixation pins places both the SRN and the LACN at risk.

the LACN and SRN frequently arborized and moved away from the cephalic vein.

Clinical Study

The LACN, SRN, and cephalic vein were identified in all patients via our routine 2-cm dorsolateral forearm incision. The LACN was found to be associated with the cephalic vein within the subcutaneous fat in every patient (Fig. 2A). The nerve was found volar to the vein in 16 patients and dorsal in 4 patients.

The SRN pierced the forearm fascia to become subcutaneous at the interval between the brachioradialis and the ECRL in all patients (Fig. 2B).

Discussion

To our knowledge only 1 anatomic study of the LACN has been performed distal to the elbow. Mackinnon and Dellon[1] found that the SRN and the LACN had significant anatomic overlap at the level of the wrist, with an interconnected plexus in 32% of specimens and partial to complete overlap in 70%. Abrams et al[8] also reported on the existence of an interconnected plexus in 7 of 20 cadaveric specimens in their study of the SRN. The high degree of overlap is consistent with our results. The investigators made no mention, however, of the association between the

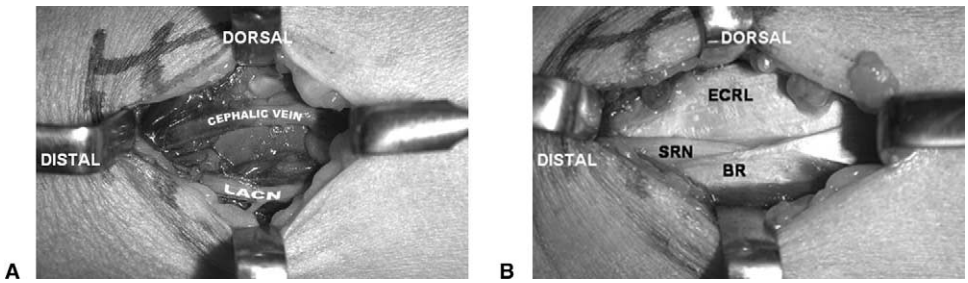

Figure 2. Clinical dissection for external fixation of the distal radius. (A) The cephalic vein and the LACN were found consistently in the subcutaneous tissue overlying the interval between the ECRL and brachioradialis. (B) The SRN pierced the forearm fascia at this interval to become subcutaneous distally.

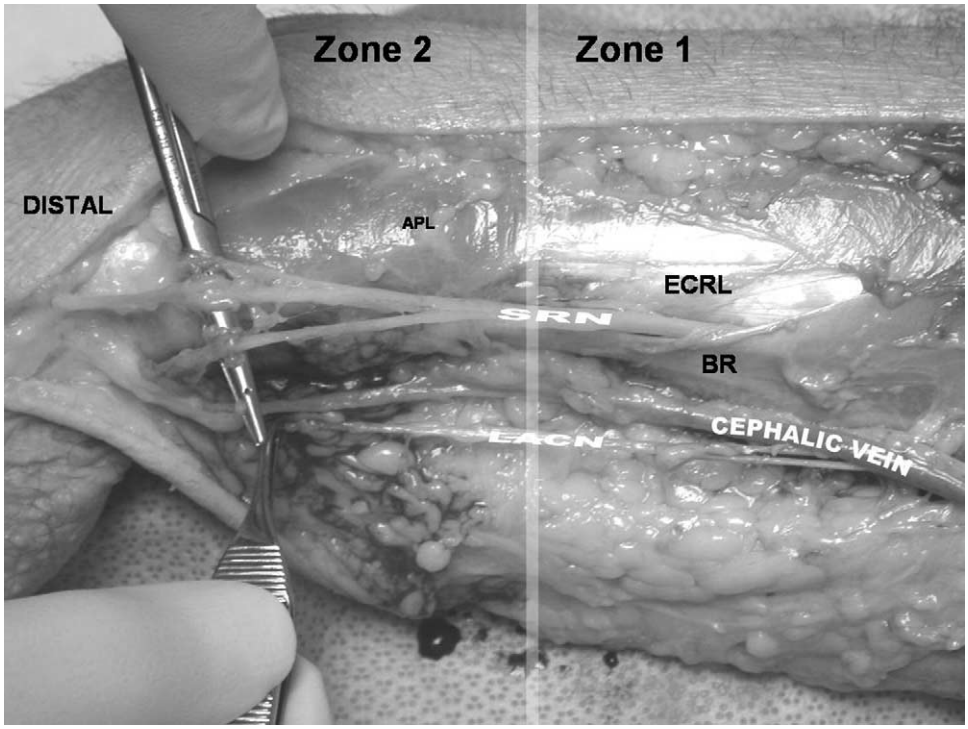

Figure 3. Anatomic dissection showing the proximity of the LACN to the cephalic vein. In zone 1 the LACN is superficial and distinguished easily from the SRN. In zone 2 both nerves arborize at the same soft tissue depth, making identification through limited incisions difficult.

LACN and the cephalic vein, nor the relevant tissue planes where the nerves were identified.

As previously described by McFarlane and Mayer[9] we found the LACN to be associated closely with the cephalic vein in all patients and cadaveric dissections. This vein and nerve were found consistently in all specimens midway between the skin and fascia of the forearm within the subcutaneous fat. The LACN was found consistently at the same tissue depth as the cephalic vein.

The relationship of the cephalic vein to the LACN may be analogous to the relationship between the lesser saphenous vein and the sural nerve. Both of these nerves are harvested routinely for nerve grafting because their absence leads to an acceptable level of morbidity. Unrecognized injury to these nerves, however, can lead to painful neuromas that may be difficult to treat.

Based on our dissections we found it clinically useful to divide the forearm into 2 zones (Fig. 3). Zone 1 began at the interepicondylar line and continued to the proximal margin of the cross-over of the APL and EPB with the ECRL and ECRB. This cross-over is an easily palpable structure even in fracture cases. Zone 2 was distal to the proximal margin of the cross-over. Within zone 1 the LACN was superficial to the forearm fascia, located volar to the cephalic vein in 84% of specimens and dorsal in 14%. Unlike the Mackinnon and Dellon[1] study we found that a high division of the LACN at the elbow was uncommon, accounting for only 1 specimen in our cadaveric dissections. Nonetheless any surgeon performing surgery on the dorsoradial forearm for either a neuroma resection or external fixation should be aware of the possible existence of 2 major trunks of the LACN. Moreover because the nerve may be volar or dorsal to the cephalic vein there is no safe zone in this area of the forearm where the nerve is not at risk.

The SRN in zone 1 was deep to the forearm fascia until 1.8 cm proximal to zone 2, where it pierced the fascia between the brachioradialis and ECRL tendons to become a more superficial structure distally. Because the SRN remained just superficial to the forearm fascia after it pierced the fascia for a few centimeters the SRN and LACN were never at the same tissue depth in zone 1.

In zone 2 both the SRN and LACN were found at the same depth as the cephalic vein, superficial to any fascial compartments. As it passed into zone 2 the LACN lost its close association with the cephalic vein as it began to arborize. The SRN likewise

branched after it entered zone 2. The LACN and SRN therefore are difficult to differentiate in this zone, with multiple branches that often overlap and interconnect. Definitive identification may require tracing the nerves back to zone 1. Within zone 1 the 2 nerves are distinguishable easily through limited incisions based on their tissue planes.

A better understanding of the complex anatomy of the distal forearm, as divided into specific anatomic zones, will help the surgeon identify quickly and more confidently the LACN and SRN either for appropriate protection during exploration or for surgical repair after traumatic laceration.

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