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Anatomic Relationships and Branching Patterns of the Dorsal Cutaneous Branch of the Ulnar Nerve

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Abstract

Purpose—To describe the variable branching patterns of the dorsal cutaneous branch of the ulnar nerve (DCBUN) relative to identifiable anatomic landmarks on the ulnar side of the wrist.

Methods—We dissected the ulnar nerve in 28 unmatched fresh-frozen cadavers to identify the DCBUN and its branches from its origin to the level of the metacarpophalangeal joints. The number and location of branches of the DCBUN were recorded relative to the distal ulnar articular surface. Relationships to the subcutaneous border of the ulna, the pisotriquetral joint, and the extensor carpi ulnaris tendon were defined in the pronated wrist.

Results—On average 2 branches of the DCBUN were present at the level of the distal ulnar articular surface (range, 1-4). On average 2.2 branches were present 2 cm distal to the ulnar articular surface (range, 1-4). At least 1 longitudinal branch crossed dorsal to the extensor carpi ulnaris tendon prior to its insertion on the fifth metacarpal in 23/28 (82%) specimens. In 27/28 (96%) specimens, all longitudinal branches of the DCBUN coursed between the dorsal-volar midpoint of the subcutaneous border of the ulna and the pisotriquetral joint. In 20/28 (71%) specimens, a transverse branch of the DCBUN to the distal radial-ulnar joint was present.

Discussion—During exposure of the dorsal and ulnar areas of the wrist, identification and protection of a single branch of the DCBUN is unlikely to ensure safe dissection as multiple branches are normal. The 6-U, 6-R, and ulnar midcarpal arthroscopy portals may place these branches at risk. In the pronated forearm, the area between the dorsal subcutaneous border of the ulna and the pisotriquetral joint contained all longitudinal branches of the DCBUN in 96% of specimens.

Clinical Relevance—During surgery involving the dorsal and ulnar areas of the wrist multiple longitudinal branches and a transverse branch of the DCBUN are normally present.

Keywords

cutaneous; dorsal; nerve; sensory; ulnar nerve

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INTRODUCTION

For ulnar-sided wrist pain, surgical management including wrist arthroscopy and repair of the triangular fibrocartilage complex risks iatrogenic injury to branches of the dorsal cutaneous branch of the ulnar nerve (DCBUN). These branches are vulnerable to laceration, traction, avulsion, or strangulation by suture placement. If the branches of the DCBUN are injured, then painful neuromas may develop. A detailed working knowledge of this nerve's anatomic relationships and its branching patterns may help avoid injury.[1]

Branches of the DCBUN provide sensibility over the dorsal ulnar hand and dorsal aspects of the small and ring fingers.[2,3] The DCBUN originates from the ulnar nerve and passes dorsal to the flexor carpi ulnaris (FCU) tendon to lie subcutaneously as it emerges from beneath the tendon on the ulnar border of the distal forearm.[4] Longitudinal branches of the DCBUN course to the fingers while a previous study described a transverse branch in 83% (20/24) of specimens that innervates the dorsal distal radial-ulnar joint (DRUJ).[1,4]

This study was conducted to detail the branching patterns of the DCBUN in relation to anatomic landmarks identifiable during surgery. The rationale behind this study was that despite prior investigation into the DCBUN branch diameters and its point of origin, surgeons would benefit from knowing the expected number and location of branches from the DCBUN.[3] These data would also be relevant during exploration of the dorsal ulnar wrist for neurogenic pain after trauma or surgery.

MATERIALS AND METHODS

The ulnar nerve was dissected from the forearm to the metacarpophalangeal joints in 28 fresh-frozen cadaveric upper extremities amputated through the humerus. Specimens were equally male and female with a mean age at death of 73 years (range 52-92 years). All of the extremities were visually examined to confirm absence of wrist or hand trauma or prior surgery. The ulnar nerve was identified deep to the FCU in the volar aspect of the mid-forearm. The ulnar nerve was dissected distally under 3.5X loupe magnification to identify the origin of the DCBUN. All measurements were taken using a digital caliper (Hornady, Grand Island, NE). Dissections and measurements were carried out with the forearm in pronation to replicate the expected position when operating on the dorsal ulnar aspect of the wrist in a supine patient.

We recorded the location where the DCBUN divided from the ulnar nerve and where it emerged dorsal to the FCU fascia into the subcutaneous tissues. A needle was placed to mark the distal ulnar articular surface, which served as the reference for subsequent measurements of nerve branching. The number of DCBUN branches was recorded at 1 cm intervals from 2 cm proximal to 2 cm distal to the articular surface of the distal ulna. Relationships between the branches of the DCBUN with the following readily identifiable and clinically relevant regional landmarks were recorded: the distal ulnar articular surface, the subcutaneous border of the ulna (SBU), the pisotriquetral joint (PTJ), and the extensor carpi ulnaris (ECU) tendon (Figure 1) The presence of any DCBUN branches that crossed from volar to dorsal across the ulnar midaxial line were noted, as these branches would be at risk for injury during longitudinal exposure of the SBU between the ECU and FCU tendons. The number and location of nerve branches crossing from volar to dorsal over the ECU tendon between the ulnar head and the ECU's insertion on the fifth metacarpal base were recorded to define the number of branches at risk during creation of ulnar-sided arthroscopic portals. Each specimen was examined to determine if all branches of the DCBUN coursed between the SBU and the PTJ. In 23 of the 28 specimens, branching patterns of the DCBUN were diagrammed from the origin of the DCBUN to the level of the MCP joints.

Data Analysis

Descriptive statistics were produced to describe the mean number, range, and location ($\pm$ SD) of branches present. Branching diagrams (n=23/28) were visually examined by 2 of the investigators (*Blinded initials*) to determine consensus categories of branching patterns.

RESULTS

The DCBUN originated from the ulnar nerve at an average of 5.1 cm ($\pm$ 2.0; range 1.5cm-8.7cm) proximal to the distal articular surface of the ulna. The DCBUN became subcutaneous at 1.7 cm ($\pm$ 0.9; range 0.0-3.4cm) proximal to the distal articular surface of the ulna.

Moving incrementally from 2 cm proximal to 2 cm distal from the distal ulnar articular surface, the number of specimens with multiple branches of the DCBUN increased (Table 1). Longitudinal branches of the DCBUN were confined to the area between the SBU and PTJ in 27 of 28 specimens (96%). One specimen had a branch volar to the PTJ coursing to the palmar hypothenar region. No longitudinal branches of the DCBUN crossed dorsal to the midpoint of the longitudinal axis of the ulna. At least 1 longitudinal branch of the DCBUN crossed dorsal to the ECU tendon in 23 specimens (82%). When present, the most proximal branch crossed over the ECU tendon at an average of 1.4 cm distal to the distal ulnar articular surface (range 0.0-2.8cm).

In 20 specimens (71%), a transverse branch of the DCBUN to the DRUJ was present with this branch originating at an average of 0.2 cm distal (range 1.5 proximal to 1.3 cm distal) to the distal articular surface of the ulna (Figure 2). In 1 specimen, this branch crossed the subcutaneous border of the ulnar styloid. In 3 specimens, this branch to the DRUJ crossed dorsal to the ECU tendon at the level of the distal ulnar articular surface while in all others this transverse branch crossed the ECU over the ulnocarpal joint.

- The most common distal branching patterns are presented in Figures 3-5. The 3 patterns depicted accounted for 87% (20/23) of specimens. There appeared to be 1 dominant pattern (Figure 3, 52%), followed by 2 minor patterns (Figures 4, 5: 17% each). The remaining 3 specimens with branching patterns documented had either 2 branches to the ulnar side of the small finger, a branch toward the volar hypothenar soft tissues, or a branch to the radial side of the ring finger without long finger innervation.

DISCUSSION

Puna et al. and Botte et al. examined the origin of the DCBUN and reported origination at 5.1 cm and 6.4 cm proximal to the distal ulnar articular surface, respectively.[2,3] Our data confirm the findings of Puna et al. that the DCBUN originates at a mean of 5.1 cm proximal to the distal articular surface of the ulna. Neither of these prior investigations detailed branching patterns of the DCBUN. Botte et al. referred to the presence of 2-3 branches of the DCBUN proximal to the wrist and additional branches in the hand noting final destinations among ulnar digits.[3] Puna et al. made no mention of multiple branches of the DCBUN at the wrist level. Our study found an average of 2 branches of the DCBUN at the level of the distal ulnar articular surface.[2] As multiple nerve branches were present in 71% of specimens at this level with the prevalence of multiple branches increasing to over 90% 2 cm more distally, it is unlikely that isolation and protection of a single branch of the DCBUN will prevent iatrogenic injury during extensive surgical intervention in this area.

Injury to branches of the DCBUN has been described during wrist arthroscopy.[5-9] Although infrequent, multiple authors have reported such injury, which may necessitate

additional treatment for the injured branches.[5-9] Wrist arthroscopy raises the risk of iatrogenic injury.[10] Tindall et al. defined a safe zone for the 6R portal as one fifth of the distance from the ulnar styloid to the fourth web space.[11] Our data did not directly test this finding but we did note that 82% of specimens had at least 1 longitudinal DCBUN branch crossing dorsal to the ECU tendon prior to its insertion on the fifth metacarpal, which would place these branches near any 6R portal. We therefore support the recommendation by Goto et al. to always incise the skin only and spread bluntly down to the capsule to avoid damage to branches of the DCBUN when establishing 6U, 6R, and ulnar midcarpal arthroscopy portals.[12]

In 27 of 28 specimens, all longitudinal branches of the DCBUN coursed between the dorsal-volar midline of the SBU and the PTJ. These 2 readily palpable landmarks can be used to define the area where branches will likely be encountered. When exposing the ulnar side of the wrist we recommend marking these locations to assist in planning incisions and in taking care to avoid DCBUN branches. Also, an injection of local anesthetic agent the SBU and PTJ would likely provide reliable anesthesia in the DCBUN distribution if needed pre- or postoperatively.

In addition to longitudinal branches to the dorsal hand and digits, the DCBUN provides a transverse branch to the DRUJ.[1] This branch, when injured, was noted by Lourie et al. as a possible cause of dysesthesia and pain.[1] They also found that in patients who were re-explored over the dorsal ulnar side of the DRUJ, 3 patients had symptomatic neuroma formation resulting from transection of this transverse nerve branch. While we do not have any clinical experience treating iatrogenic injury to this branch, our cadaveric findings are similar to Lourie et al.'s report of this transverse branch to the DRUJ.[1] Our study showed a 70% incidence of this transverse branch compared to an 80 % incidence described by Lourie.

Several limitations are inherent to our cadaveric study. During any investigation of anatomic relationships, the finite number of specimens examined may have failed to identify all anatomic variants and infrequent nerve branching patterns. Additionally, we did not perform dissections in multiple forearm positions. We chose the position of pronation to reproduce the most common surgical positioning in our practice but acknowledge that alternative forearm positioning may have impacted our data. Relevant to that fact, we acknowledge that wrist arthroscopy is often performed with the forearm in neutral position. Although forearm rotation may affect the location of branches of the DCBUN during sharp dissection over the distal ulna, this should not alter the course of the nerves that either cross or do not cross dorsally over the ECU. In all forearm positions, the ECU remains dorsal to the subcutaneous border of the ulna, and the branches' final destinations in the hand are unchanged. Thus, forearm rotation may alter the distance that branches of the DCBUN cross the ECU tendon distal to the articular surface of the distal ulna, analogous to the variation in distance from where the posterior interosseous nerve crosses the long axis of the radius distal to the capitellum.[13] Finally, surgical exposure may occur when the anatomic relationships of the DCBUN branches may be altered. We did not model any traumatic conditions or perform dissection following subcutaneous extravasation of saline as commonly encountered during open exposure for fracture fixation or following wrist arthroscopy.

The DCBUN is sometimes depicted as a single nerve at the level of the ulnocarpal joint in texts.[4,14] This may have contributed to the authors' experience that surgeons, both practicing and in training, may have isolated only a single branch of the DCBUN at the level of the ulnocarpal joint before continuing dissection with the belief that they were then safe from producing a nerve injury. Our data indicate that multiple branches of the DCBUN are

the rule, not the exception, when surgically approaching the ulnocarpal joint and the dorsal or ulnar aspect of the hand.

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Figure 1.

Photograph of ulnar wrist marking the longitudinal axis of the subcutaneous border of the ulna (SBU – green line) and ECU tendon (blue dotted line) with outlines (pink) of ulna, pisiform, and triquetrum noting the distal articular surface of the ulna (arrowhead) and pisotriquetral joint (PTJ - arrow).

Figure 2.

This photograph of the ulnar side of a right wrist demonstrates a representative specimen with multiple nerve branches at the level of the distal ulnar articular surface (needle). Longitudinal branches are present (*) as well as a transverse branch to the distal radioulnar joint (arrow). Orientation: Distal is up.

Figure 3.

Diagram of the most common longitudinal branching pattern (52% (12) of specimens) with branches to the ulnar side of the small finger, a second branch ending at the radial side of the small finger and the ulnar side of the ring finger, and a final branch ending at the radial side of the ring finger and the ulnar side of the long finger.

Figure 4.

Diagram of the longitudinal branching pattern (17% (4) of specimens) with 1 branch to the ulnar side of the small finger and a second branch on the radial side of the small finger and the ulnar side of the ring finger.

Figure 5.

Diagram of the longitudinal branching pattern (17% (4) of specimens) with 1 branch to the ulnar side of the small finger and a second branch to the radial side of the small finger and the ulnar side of the ring finger. Two additional radial branches coursed to the radial side of the long finger. "Or" indicates a branch point where the subsequent branch went in 1 of 2 directions.

Table 1

Number of dorsal cutaneous nerve branches present relative to the distance from the distal ulna articular surface.

	Number of Branches Present				
	2cm Proximal	1cm Proximal	Distal Ulna Articular Surface	1cm Distal	2cm Distal
Mean	1.2	1.6	2.0	2.3	2.2
Range	1-2	1-4	1-4	1-3	1-3
Specimens with multiple branches (%)	6 (21%)	13 (46%)	20 (71%)	27 (96%)	26 [*] (93%)

* Fewer specimens with multiple branches compared to 1cm distal to the distal ulnar articular surface as at least one transverse branch to the DRUJ did not reach this location.