# Anatomical study of the dorsal cutaneous branch of the ulnar nerve (DBUN) and its clinical relevance in TFCC Repair

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*Journal of Plastic, Reconstructive & Aesthetic Surgery. 2016 Jul;69(7):983-7*

## ABSTRACT

The aim of this study was to define a detailed description of the Dorsal Branch of the Ulnar Nerve (DBUN) in particular in relevance to TFCC repairs.

Twenty embalmed arms were dissected and the course of the DBUN in each arm was mapped, photographed and measured against several bony landmarks. Furthermore, the presence of a Radio-Ulnar Communicating Branch (RCUB) was categorized.

There are three dorsal digital nerves (medial-, intermediate- and lateral branch), which runs at the dorsal ulnar aspect of the hand. The distance between the origin of the DBUN and the ulnar styloid process was 88 mm (44 mm to 111) The RUCB was present in 80 % of specimen.

No complete safe zone could be identified, but a longitudinal incision for the 6R portal is advised because of course of the DBUN. A more dorsal incision also prevents damage to the main branches of the DBUN.

## INTRODUCTION

The sensory innervation of the dorsal hand consist of three nerves; the Superficial Branch of the Radial Nerve (SBRN), the Dorsal Cutaneous Branch of the Ulnar Nerve (DBUN) and the lateral antebrachial cutaneous nerve (LABCN)[1]. The DBUN originates from the medial side of the ulnar nerve (at the distal third of the forearm) and pierces the antebrachial fascia volar to the ulna and passes dorsal to the flexor carpi ulnaris (FCU) tendon. The nerve divides into two or often three dorsal digital nerves (medial-, intermediate- and lateral branch) which runs subcutaneous and superficially at the dorsal ulnar aspect of the hand[2].

This pure sensory nerve supplies sensation to the dorso-ulnar hand and dorsal aspect of the fourth finger[3, 4]. The sensory innervation of the digits differ significantly between hands in the same individual[5]. In some cases, there is an accessory branch; this radial-ulnar communicating branch (RUCB) communicates with the medial branch of the superficial radial nerve on the dorsal surface of the hand. The rate of existence of the RUCB is not clear. The RUCB is only mentioned in 3,8% to 15% of the cases[4, 6]. Some studies do not even mention the existence of the RUCB at all.[1, 7-10]

Pain in the wrist can have several causes varying by location. Ulnar-sided wrist pain can be caused by triangular fibrocartilage complex (TFCC) injuries. Palmer and Werner first introduced the term TFCC to describe the cartilaginous and ligamentous structures at the ulnar side of the wrist joint. Since its description it has been of interest for its function and for the lesions associated with the TFCC. There are two main causes for TFCC injuries, either traumatic or degenerative with various sub classifications[11].

Many treatment modalities have been described for the treatment of TFCC damage. From the small arthrotomy with a high morbidity rate to the now widely used wrist arthroscopy technique. Wrist arthroscopy and repair of the triangular fibrocartilage complex (TFCC) risks iatrogenic injury to branches of the DBUN. Injury of the DBUN can cause development of painful neuromas[12,13]. Neurological complications due to arthroscopy vary from 0,1% to 2%[13-16]. For a safe approach for arthroscopic repair of the TFCC complex, the sixth Radial portal is routinely used to visualize the TFCC.

The aim of this study is to define a detailed description of the DBUN and postulate a safe zone for wrist portal positioning in TFCC repair in order to preserve the digital sensory innervation of the dorsal hand. Knowledge of the precise course of the DBUN is important to provide safe practice of hand surgical interventions[17]. There have already been studies making recommendations on safe zones for wrist portal positioning[18]. However, the correlation between wrist portal positioning in TFCC repair and post-operative pain has never been mentioned before. Furthermore, by using a new visualization technique the course of the nerves could be visualized to the location of the sixth radial portal.

Finally, a comparison was made between the course of the DBUN and the location of the scar of patients with known postoperative pain.

## MATERIAL AND METHODS

For this study twenty formalin-embalmed adult cadaveric upper limbs were used. Sixteen arms came from different individuals and four arms came from the two individuals in order to also study the difference between a right and left arm. The cadavers were flushed with Anubifix to regain flexion after rigor mortis and embalmed with a 4.4% formalin solution. Specimens were equally left and right upper limbs with a mean age at death of 82 (range 69-93 years). The male: female ratio is 12:8. All specimens had no wrist- or hand trauma and never underwent wrist- or hand surgery.

Specimens were placed in full pronation to simulate the expected position when operating on the dorsal hand. Dissection was performed under a 5-diopter magnifying glass and in a bright setting. The DBUN was dissected as described below.

### Dissection

First, the cutis was dissected from medial epicondyle to the metacarpophalangeal (MCP) joints. The FCU muscle can be located mid-ulna and blunt dissection revealed the ulnar nerve dorsal of the FCU. Incisions were extended distally until DBUN was found and traced distally till MCP joints. Care was taken not to disturb the soft tissue attachments of the branches and thereby alter its position. All branching points and terminal branches were marked with colored pinpoints.

### CASAM

The following anatomic landmarks were palpated and pinpointed with the same color; humeroradial joint, medial epicondyle, radial styloid process, ulnar styloid process and the second, third and fifth MCP joint. These were defined as bony landmarks. Between the pinpoints evenly measured distances were marked as following (Figure 1). These were defined as non-bony landmarks. The specimens were then recorded with a Nikon D60 SLR camera (Sigma 50 mm 1:2.8 DG Macro lens) from a dorsal and lateral view.

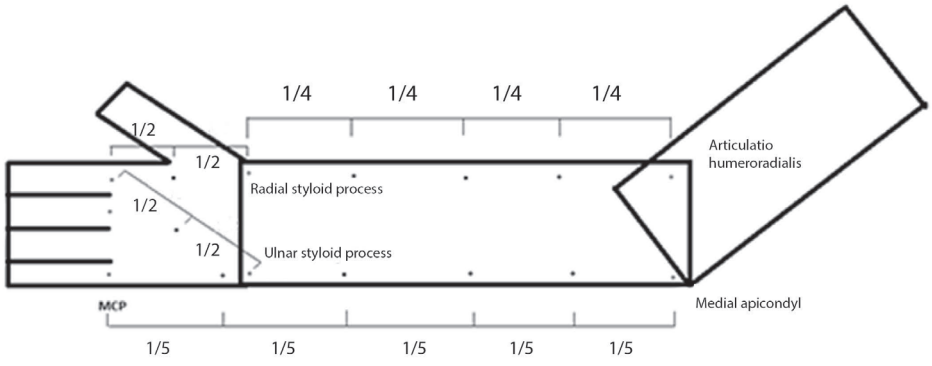


**Figure 1.** Bony and non-bony landmarks used

Using a warping technique, the pictures of the specimens could be rescaled to average dimensions and the renditions could be compared directly. Renditions were then studied using Adobe Photoshop CS4 Extended Edition. (19, 20)

### Measurements

The point where the DBUN originates from the ulnar nerve in relation to the ulnar styloid process, and the branching of the RUCB and first branch of DBUN in relation with the ulnar styloid process was measured. (Figure 2)

The distances between the DBUN origin, RUCB and first branch in relation to the ulnar styloid process were measured using a waterproof digital caliper (Hogetex Digital Caliper IP67 Type B*).

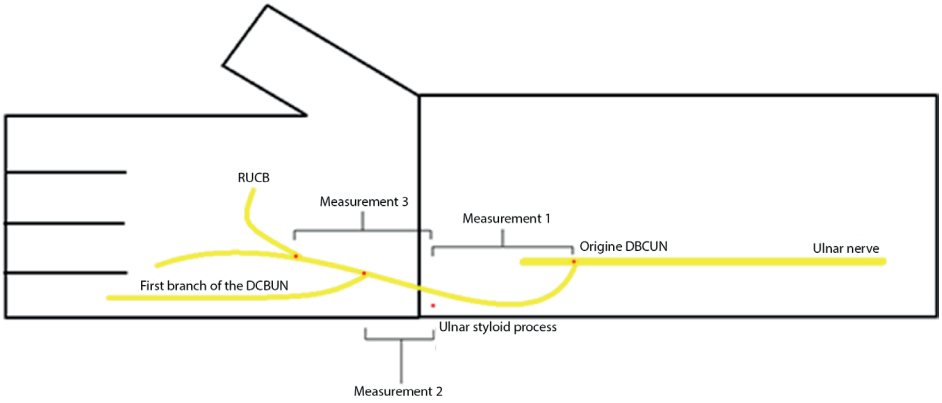


**Figure 2.** Schematic view of specimen

## RESULTS

The anatomical data obtained from the specimens are shown in table 1. The distance between the origin of the DBUN in relation to the ulnar styloid process ranges from 55 mm to 111 mm (Mean 88 mm; STD 14 mm). The distance between the ulnar styloid process and the RUCB ranges from 1 mm to 54 mm (Mean 19 mm; STD 13 mm). A RUCB was not present in four specimens. The third measurement between the ulnar styloid process and the lateral distal branch shows a range of 6 mm to 28 (Mean 10 mm; STD 9 mm). A measurement is negative when branching of the lateral distal branch occurs proximal of the ulnar styloid process. Specimens nr. 6 and nr. 12 are from the same person. Post-measurement observation shows us that measurements 1-3 are similar in these cadaveric upper limbs. Similarity in measurements is also observed in specimens nr. 8 and nr. 14, these upper limbs are also from the same person.

**Table 1** Measurements performed on the specimens

| Specimen | Left/Right | Gender | DCBUN - US (mm)/ Measurement 1 | US - RUCB (mm)/ Measurement 2 | US - lateral DCBUN (mm)/ Measurement 3 |
|---|---|---|---|---|---|
| 1 | Right | Male | 110 | - | 18 |
| 2 | Right | Male | 100 | 25 | 7 |
| 3 | Right | Female | 78 | 31 | 6 |
| 4 | Right | Female | 88 | 9 | 14 |
| 5 | Right | Male | 111 | 6 | 5 |
| 6[1)] | Right | Male | 96 | 24 | 16 |
| 7 | Right | Male | 96 | 23 | 9 |
| 8[2)] | Right | Male | 80 | 12 | 5 |
| 9 | Right | Female | 104 | 11 | 28 |
| 10 | Left | Female | 72 | - | -3 |
| 11 | Left | Female | 103 | - | 4 |
| 12[1)] | Left | Male | 87 | 25 | 15 |
| 13 | Left | Male | 84 | 29 | -4 |
| 14[2)] | Left | Male | 81 | 9 | 3 |
| 15 | Left | Male | 78 | - | 26 |
| 16 | Left | Male | 55 | 11 | 5 |
| 17 | Left | Male | 74 | 54 | 23 |
| 18 | Left | Female | 93 | 23 | 16 |
| 19 | Left | Female | 86 | 1 | -6 |
| 20 | Left | Female | 75 | 26 | 6 |
| **Mean (mm)** | | | 87.5 | 18.7 | 9.7 |
| **STD (mm)** | | | 13.7 | 12.5 | 9.3 |

- = absent

[1)] 6 and 12 same individual

[2)] 8 and 14 same individual

The dorsal- and lateral views of the DBUN are shown in figure 3 and 4. In general, figure 3 shows three dorsal digital nerves (medial-, intermediate- and lateral branch), which run at the dorsal ulnar aspect of the hand. Figure 3 also shows an abundant presence of the RUCB and a large variation in location of the RUCB.

Eight unique branching patterns in twenty dissected specimens could be identified. The distal branches innervate lateral and/or medial of the third and/or fourth web space. The lateral distal branch is consistently present in all twenty specimens. Specimens nr. 8 and nr. 14 are from the same individual and the branching patterns are also the same. Surprisingly, nr. 6 and nr. 12 do not have the same branching patterns while they are obtained from the same individual.

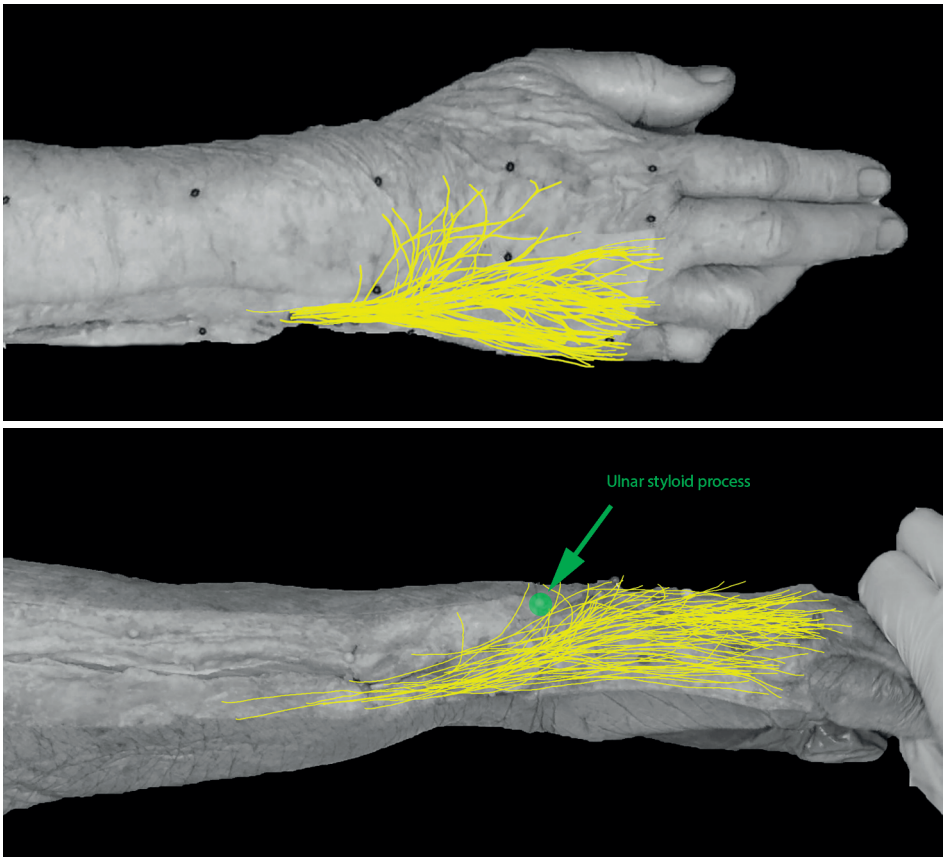


**Figure 3 & 4.** Dorsal view & lateral view

### Safe zone for 6R portal insertion

No complete safe zone could be identified in which none of the ulnar nerves were present.

## DISCUSSION

The DBUN is a terminal sensory branch, which supplies sensation to the dorso-ulnar hand and dorsal aspect of the fourth finger. Injury of the DBUN can cause development of painful neuromas or the development of neuropathic pain.

The origin of the DBUN can be found 87 mm proximal to the ulnar styloid process. This finding is similar to the results of previous studies who reported origination at 48 to 100 mm proximal to the distal ulnar styloid process[3, 4, 7, 21, 22]. Furthermore, eight unique patterns in twenty dissected specimens could be identified. The anatomical variation of the DBUN is abundant. Almost all branches travel distally across the dorsum of the hand to the

third- and fourth web space. Variation lies in the fact that distal branches innervate lateral and/or medial of the third and/or fourth web space. The lateral distal branch is consistently present. Although measurements 1-3 are similar, branching patterns may differ in the same individual. This finding is similar to the conclusion of Stappaerts[5] about significant difference in sensory innervation between hands in the same individual.

Many authors deny the existence of the RUCB.[1, 7, 10]. Previous study demonstrated the existence of a RUCB in 60% of the hands[23]. Our study shows that in sixteen of the twenty specimens the RUCB is present (80%). Hence it is safe to say that the RUCB is abundantly present. Interestingly Botte et al[4], with a similar sample size (n=24), only reported a prevalence of 3.8%. In addition, Mok et al.[1] had a sample size of n=30 and made no mention of the existence of the RUCB.

We can only speculate about the function of the RUCB. It is likely that the RUCB provide collateral supply to the SBRN when the DBUN is damaged. This explains why hypoesthesias of some areas in the hand do not follow the classical anatomical description.

## Safe zone for 6R portal insertion.

Goto et al.[24] recommend to always incise the skin only and spread bluntly down to the capsule to minimalize risk to branches of the DBUN when establishing 6U, 6R, and ulnar midcarpal arthroscopy portals. Mok et al. [1] proposed a safe zone which correlates with the location of the RUCB.

Our study is limited in the way that only twenty cadaver upper limbs have been dissected. Therefore, not all anatomical variants are identified.

When the CASAM images are taken into account, no location could be identified in which the DBUN is not at risk during the placement of the sixth radial portal. However, a number of recommendations could be made. Firstly, most surgeons perform a stabbing incision followed by the portal. At the portals location most nerves run proximal to distal, therefore it is advised to make a longitudinal incision. Secondly, one could argue that because of the complex anatomy it is less harmful to damage the RCUB than the digital branches of the DBUN and therefore a more dorsal incision should be attempted. However, this is thought during many wrist arthroscopy and wrist surgery courses. This study visualizes the course of the nerves again highlights the importance of a proper incision technique during wrist surgery.

## Relationship postoperative pain and TFCC repair.

In a group of 54 arthroscopic TFCC repairs we found that one patient who complained of post-operative pain and loss of sensation, the insertion site coincides with the area in which the DBUN's end-branches runs to the fingers. However, in all patients the course of the scar was located in an area in which the DBUN was present. This finding further illustrates the dense and unpredictable course of the DBUN and the need for a good portal placement

technique during TFCC repair. During dissection we also found that if portals are placed correctly, there still is a chance of the DBUN being strangled by the suture for TFCC repair (Fig 5).

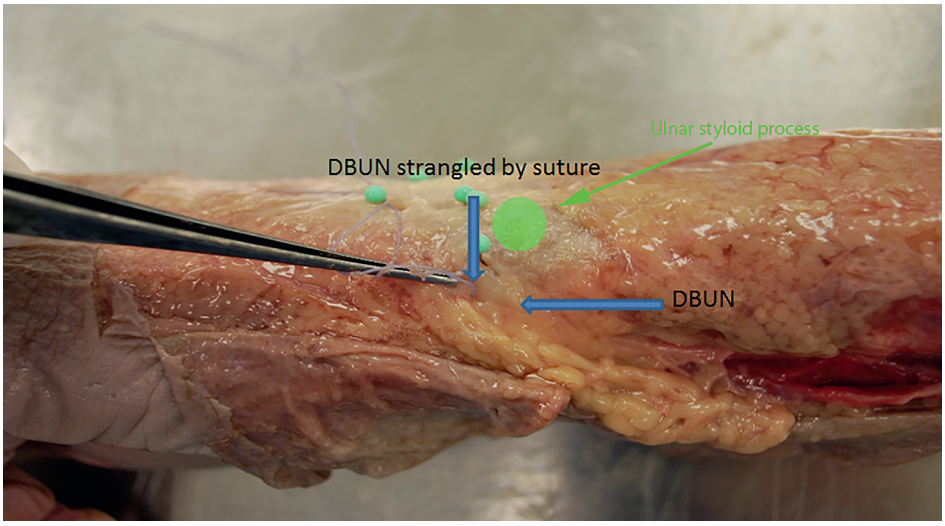


**Figure 5.** Damage done to ulnar nerve

The use of formaldehyde fixation and the high age of the specimens (instead of younger fresh-frozen material) are possibly confounding but unavoidable factors since the dissection and measurements are highly time-consuming. However, the trends of the measurements are correct because the results have always been interpreted in relation to other displacements in the same structure.

The SBRN was not fully dissected, thereby the relationship between RUCB and SBRN is not well known. Furthermore, pronation of the arm was chosen to reproduce the most common surgical position. However, wrist arthroscopy in supination position is done as well. This causes displacement of the DBUN subcutaneously. Botte et al.(4) concluded that pronation of the arm causes displacement of the nerve in palmar direction.

## REFERENCES


1. Mok D, Nikolis A, Harris PG. The cutaneous innervation of the dorsal hand: detailed anatomy with clinical implications. J Hand Surg Am 2006: 31: 565-74.
2. Le Corroller T, Bauones S, Acid S, Champsaur P. Anatomical study of the dorsal cutaneous branch of the ulnar nerve using ultrasound. Eur Radiol 2013: 23: 2246-51.
3. Puna R, Poon P. The anatomy of the dorsal cutaneous branch of the ulnar nerve. J Hand Surg Eur Vol 2010: 35: 583-5.
4. Botte MJ, Cohen MS, Lavernia CJ, et al. The dorsal branch of the ulnar nerve: an anatomic study. J Hand Surg Am 1990: 15: 603-7.
5. Stappaerts KH, Van Hees J, Van den Broeck EA. Peripheral cutaneous nerve distribution to the fingers. Physiother Res Int 1996: 1: 41-9.
6. Auerbach DM, Collins ED, Kunkle KL, Monsanto EH. The radial sensory nerve. An anatomic study. Clin Orthop Relat Res 1994: 241-9.
7. Grossman JA, Yen L, Rapaport D. The dorsal cutaneous branch of the ulnar nerve. An anatomic clarification with six case reports. Chir Main 1998: 17: 154-8.
8. Casoli V, Verolino P, Pelissier P, et al. The retrograde neurocutaneous island flap of the dorsal branch of the ulnar nerve: anatomical basis and clinical application. Surg Radiol Anat 2004: 26: 8-13.
9. Ikiz ZA, Ucerler H. Anatomic characteristics and clinical importance of the superficial branch of the radial nerve. Surg Radiol Anat 2004: 26: 453-8.
10. Bas H, Kleinert JM. Anatomic variations in sensory innervation of the hand and digits. J Hand Surg Am 1999: 24: 1171-84.
11. Palmer AK. Triangular fibrocartilage complex lesions: a classification. J Hand Surg Am 1989: 14: 594-606.
12. Cravioto H, Battista A. Clinical and ultrastructural study of painful neuroma. Neurosurgery 1981: 8: 181-90.
13. Beredjiklian PK, Bozentka DJ, Leung YL, Monaghan BA. Complications of wrist arthroscopy. J Hand Surg Am 2004: 29: 406-11.
14. Rodeo SA, Forster RA, Weiland AJ. Neurological complications due to arthroscopy. J Bone Joint Surg Am 1993: 75: 917-26.
15. Culp RW. Complications of wrist arthroscopy. Hand Clin 1999: 15: 529-35, x.
16. De Smet L. Pitfalls in wrist arthroscopy. Acta Orthop Belg 2002: 68: 325-9.
17. Cavusoglu T, Ozden H, Comert A, et al. Topographical anatomy of the dorsal branch of the ulnar nerve and artery: a cadaver study. Surg Radiol Anat 2011: 33: 229-33.
18. Tindall A, Patel M, Frost A, et al. The anatomy of the dorsal cutaneous branch of the ulnar nerve - a safe zone for positioning of the 6R portal in wrist arthroscopy. J Hand Surg Br 2006: 31: 203-5.
19. Kerver AL, Carati L, Eilers PH, et al. An anatomical study of the ECRL and ECRB: feasibility of developing a preoperative test for evaluating the strength of the individual wrist extensors. J Plast Reconstr Aesthet Surg 2013: 66: 543-50.
20. Kerver AL, van der Ham AC, Theeuwes HP, et al. The surgical anatomy of the small saphenous vein and adjacent nerves in relation to endovenous thermal ablation. J Vasc Surg 2012: 56: 181-8.
21. Root CG, London DA, Schroeder NS, Calfee RP. Anatomical relationships and branching patterns of the dorsal cutaneous branch of the ulnar nerve. J Hand Surg Am 2013: 38: 1131-6.
22. Jabaley ME, Wallace WH, Heckler FR. Internal topography of major nerves of the forearm and hand: a current view. J Hand Surg Am 1980: 5: 1-18.

23. Loukas M, Louis RG, Jr., Wartmann CT, et al. The clinical anatomy of the communications between the radial and ulnar nerves on the dorsal surface of the hand. Surg Radiol Anat 2008: 30: 85-90.
24. Goto A, Kunihiro O, Murase T, Moritomo H. The dorsal cutaneous branch of the ulnar nerve: an anatomical study. Hand Surg 2010: 15: 165-8.