

*Full length Research paper*

# The variable origin of dorsal branch of the ulnar nerve and its clinical significance

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Accepted 18 August, 2014.

The dorsal branch of ulnar nerve is usually arising proximal to the wrist innervating the skin on the dorsal aspect of the medial 1½ digits. The present study clarifies significance of the variable origin of the dorsal branch in case of coexistent ulnar palsy and neuroma result in diverse clinical pictures. Taking the distance between the medial epicondyle and the pisiform and dividing it into thirds (proximal, middle, distal) the current study, based on the dissection of 76 upper limbs, found that the dorsal branch of the ulnar nerve had a variable origin in the forearm, arising in the proximal, middle and distal thirds in 3.9%, 17.2%, 78.9% of specimens respectively. With a variability of dorsal branch of the ulnar nerve, there is a variability of clinical presentation according to site of ulnar nerve injury occurring before or after its origin. As a result, the injury occurring before the origin dorsal branch of ulnar nerve may present with dermatome and myotom dysfunction while the injury occurring after the origin dorsal branch of ulnar nerve may present with dermatome dysfunction. Therefore, the study clarifies the significance of the dorsal branch of the ulnar nerve origin to orthopaedic to decrease iatrogenic injury.

**Key words:** Ulnar nerve, dorsal branch of the ulnar nerve origin, ulnar nerve palsy, arthroscopy, claw hand internal fixation of ulna, ulnar neuropathy, ulnar neuroma, ulnar auto-graft.

## INTRODUCTION

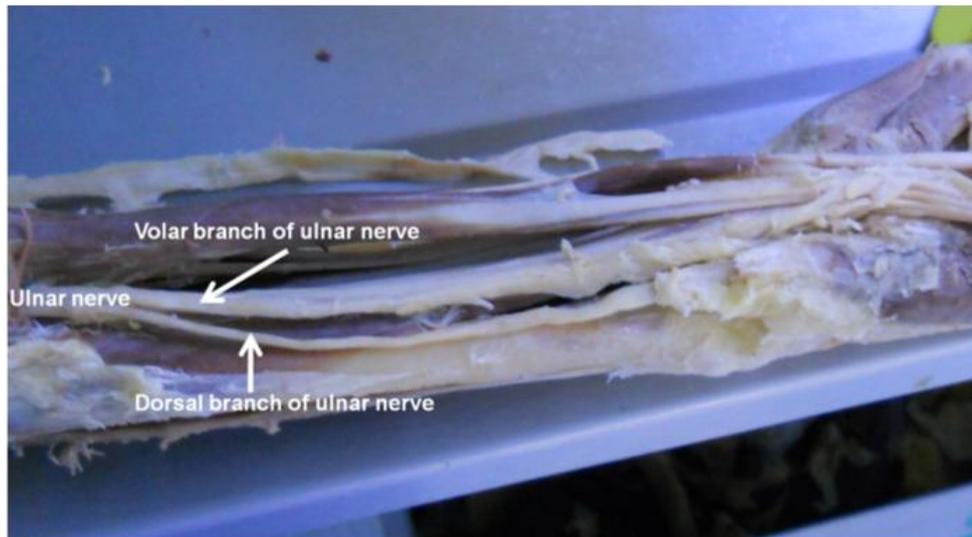
The ulnar nerve arises from the medial cord of the brachial plexus, being the only branch with a root value of C8 and T1 (Shea and McClain, 1969; Williams et al., 2005). It initially lies medial to the axillary and brachial arteries as far as the middle of the arm, then penetrates the medial inter-muscular septum to lie deep to the medial head of triceps brachii becoming superficial in the groove between the medial epicondyle and olecranon, where it gives an articular branch to the elbow joint. At the level of the elbow, it passes between the two heads of the flexor carpi ulnaris (FCU) to enter the forearm. During its course in the forearm it supplies FCU and the medial part of flexor digitorum profundus (Williams et al., 2005). Some 5 cm proximal to the wrist the ulnar nerve gives a dorsal cutaneous branch (Williams et al., 2005) which supplies the skin on the dorsal aspect of the medial 1½ digits; however, the origin of the dorsal branch can range from 6 to 8 cm proximal to the (Shea and McClain, 1969).

The current study aims to clarify the significance of the

origin of the dorsal branch in relation to ulnar injury such as ulnar palsy and neuro main which present with different clinical features. Knowing the origin variability of dorsal branch ulnar nerve origin may help in differential diagnosis. Further, a sufficient data of anatomical variation of dorsal branch ulnar nerve origin for surgeons may lead to minimize iatrogenic injury. Also, sufficient information may modify the surgical treatment of ulnar neuroma according to its origin site as well as flap harvest for hand reconstruction.

## MATERIALS AND METHODS

The present study is based on the dissection of 76 upper limbs (38 left, 38 right) from 38 cadavers (22 females, 16 males). After removing the skin of the forearm the flexor compartment was exposed to reveal the ulnar nerve and its branches. It was initially located between the humeral and ulnar heads of FCU as it entered the forearm post-



**Figure 1.** The dorsal branch of the ulnar nerve arising in the upper third of the forearm.



**Figure 2.** The dorsal branch of the ulnar nerve arising in the middle third of the forearm.

erior to the medial epicondyle. In the forearm, the nerve ran deep to FCU with the ulnar artery lying medially before giving dorsal and palmar branches at different levels.

Following the ulnar nerve as it emerged between the two heads of FCU and then deep to it enabled the level of division to be determined. Between the medial epicondyle and the pisiform the forearm was divided into thirds (proximal, middle and distal): the origin of the dorsal branch from the main nerve trunk was noted in relation to these thirds.

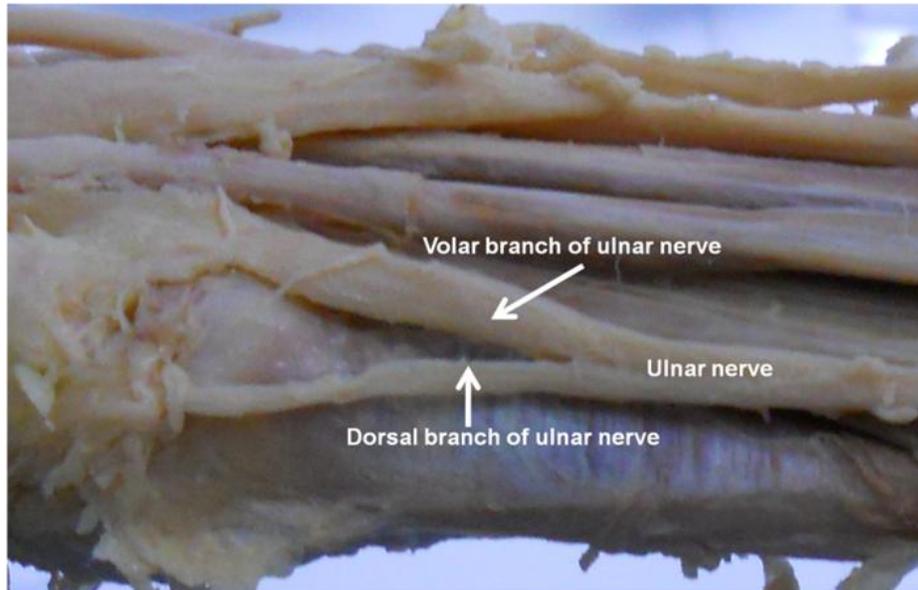
**RESULTS**

Irrespective of gender or side the dorsal branch most commonly (78.9%) arose in the distal third of the forearm,

in the middle third in 17.2% and in the proximal third in 3.9% (Figures 1, 2 and 3; Table 1). In females the origin was in the distal, middle and proximal thirds in 79.5%, 13.7% and 6.8% of specimens respectively; whereas in males there was no origin in the proximal third, with 21.9% and 78.1% of specimens being in the middle and distal thirds respectively (Table 2). Comparing right and left sides, the dorsal branch arose in the distal, middle and proximal thirds in 81.5%, 13.2% and 5.3% in the left limb and 76.3%, 21.1% and 2.6% in the right limb, respectively (Table 3).

**DISCUSSION**

Clinically, the dorsal cutaneous branch of the ulnar nerve can be affected either before or after its origin. In addition



**Figure 3.** The dorsal branch of the ulnar nerve arising in the distal third of forearm.

**Table 1.** The level of origin of the dorsal branch of the ulnar nerve.

Level of origin	Number of specimens	Incidence (%)
Upper third	3	3.9
Middle third	13	17.2
Lower third	60	78.9
Total	76	100.0

**Table 2.** The level of origin of the dorsal branch of the ulnar nerve by gender.

Gender	Number of specimens	Incidence (%)
Female Upper third	3	6.8
Female Middle third	6	13.7
Female Lower third	35	79.5
Total	44	100.0
Male Upper third	0	0
Male Middle third	7	21.9
Male Lower third	25	78.1
Total	32	100.0

To systemic diseases, such as diabetes mellitus, being a cause of ulnar palsy (Feindell and Stratford, 1958; Vanderpool et al., 1968; Ekerot, 1977), the ulnar nerve is also susceptible to iatrogenic palsy. Budinger (1894) was the first describe iatrogenic palsy with respect to the ulnar nerve in relation to upper limb position during surgery. The condition can be diagnosed by the presence of three classical features: post-operative general anaesthesia; persistent neural deficit as well as clinical and

electrophysiological evidence of a pure ulnar neuropathy (Miller and Camp, 1979). Alvine and Schurrer (1987) reported that ulnar nerve palsy ranged from 11% to 16% due to operative procedures involving prolonged flexion of the elbow: compression of the nerve being between the table and bone when lying supine, or due to continuous blood-pressure cuff measurement. However, high origin of the dorsal branch of the ulnar nerve could give rise to sensory disturbances without general nerve

**Table 3.** The level of origin of the dorsal branch of the ulnar nerve in left and right limbs.

<b>Limb and level</b>	<b>Frequency</b>	<b>Incidence (%)</b>
Left upper third	2	5.3
Left middle third	5	13.2
Left lower third	31	81.5
Total	38	100.0
Right upper third	1	2.6
Right middle third	8	21.1
Right lower third	29	76.3
Total	38	100.0

palsy. Sunderland (1978) identified sensory fibres running superficially which may be susceptible to compression during prolonged flexion of the elbow during some surgical procedures. Acute mechanical compression has three histopathological features: fibre injury beyond the compression site; small fibres are not in danger; and Node of Ranvier destruction leading to intussusceptions of the myelin sheath (Ochoa and Noordenbos, 1979). Moreover, ulnar palsy effects thumb function due to denervation of adductor pollicis, the first dorsal interosseous and flexor pollicis brevis: specifically a weak pinch is due to adductor pollicis paralysis (Duerksen and Schwarz, 2004). Ulnar nerve palsy also affects wrist joint stability due to the denervation of FCU leading to ulnar deviation in addition to interphalangeal hyperflexion (Froment's sign) or metacarpophalangeal hyperextension (Z-thumb) (Duerksen and Schwarz, 2004). With a lesion at the elbow ulnar palsy also presents with a minor claw hand clinically. Claw hand is a deformity defined as hyperextension of the metacarpophalangeal joint and flexion of the interphalangeal joints of the 4<sup>th</sup> and 5<sup>th</sup> fingers. This occurs due to the inability to oppose the long extensors and lumbricals of the 4<sup>th</sup> and 5<sup>th</sup> fingers, innervated by radial and median nerves respectively (Williams et al., 2005; Sammer and Chung, 2009).

In addition, traumatic ulnar neuritis is an anatomically defined lesion involving the ulnar nerve at the medial epicondyle level as a result of a direct irritation of the nerve against bone. Pathologically, ulnar neuritis is classified into three grades according to the severity of lesion presentation: 1<sup>st</sup> grade, a minimal lesion without any motor weakness of the hand; 2<sup>nd</sup> grade, an intermediate lesion with loss of sensation and weakness of the intrinsic muscles of the hand, with or without insignificant wasting; 3<sup>rd</sup> grade, a severe lesion with entire loss of the sensory and motor function of the ulnar nerve (McGowan, 1950). Therefore, the previous conditions include the dorsal branch of ulnar nerve because the lesion occurred before its origin. As a result, the high origin the dorsal branch of the ulnar nerve could be spared injury and thus be used in nerve repair as well as

graft tissue because of its origin proximity. However, the high dorsal branch may confuse the orthopaedics in case of traumatic ulnar nerve with coexistence of preserved dermatome in which the ulnar nerve lesion located after its origin (Figure 1 and 2).

Further, the dorsal cutaneous branch of the ulnar nerve can be affected after its origin. Therefore, the lesion of occurred during its course. Anatomically, the dorsal branch of ulnar nerve has a superficial course (Sunderland, 1978; Williams et al., 2005). Accordingly, the dorsal branch is highly susceptible to iatrogenic injury (Henderson et al., 1991; Grossman et al., 1998; Tsu-Hsin et al., 2006) during various orthopaedic operation such as open reduction and internal fixation in case of ulnar fractures, ulnar fractures complication, ulna osteotomy, chronic osteomyelitis as well as elongating and shortening ulnar procedures (Hoppenfeld and de Boer, 2003). Moreover, the dorsal branch has a high risk of orthopaedic procedures such as arthroscopy (Tsu-Hsin et al., 2006; Puna and Poon 2010) result in numbness, dysaesthesia and pain over its skin innervation or painful neuroma (Grossman et al., 1998; Puna and Poon, 2010).

Anatomically, the dorsal branch of the ulnar nerve usually arises at 5 cm proximal to the wrist (Williams et al., 2005) whereas it was 3 cm estimated by and described as anomalous in past (Linell, 1921). In fact, the origin of dorsal branch of the ulnar nerve ranging between 4.8 and 10.0 cm in series studies (Sunderland, 1978; Jabaley et al., 1980; Botte et al., 1990; Lourie et al., 1994; Grossman et al., 1998; Goto et al., 2010; Puna and Poon, 2010) indicating the its origin occurred entirely in distal part of forearm. Therefore, the dorsal branch arising at the junction of the middle and distal thirds of the forearm has been expected by Kaplan (1963) previously. In contrast, the dorsal cutaneous branch of ulnar nerve arises at the distal third with origin average 5.7 cm proximal to the wrist recently (Le Corroller et al., 2013). In present study, the majority of dorsal branch of ulnar nerve arises in the distal third of the forearm (Figure 3). Based on previous series study, the dorsal branch of ulnar nerve arose at the level of the elbow therefore this nerve variation has been emphasized with its clinical significance (Linell, 1921;

Hovelacque,1927).This elbow level is a high origin of the dorsal cutaneous branch of ulnar was commonly (Linell, 1921). Recently, few case studies have reported a higher origin of the dorsal branch of the ulnar nerve in the forearm (Paul et al., 2006; Lama et al., 2009; Sawant et al., 2012). In the present study it arose in the proximal third of the forearm in 3 limbs (3.9%) and the middle third in 13 limbs (17.1%), indicating the high origin of the dorsal nerve occur in 20%.

Therefore, the high origin of dorsal branch of the ulnar nerve may have a clinical significance in electrodiagnosis to select the accurate place of electrode (Peterson et al., 1992). Also, the dorsal branch is a highly predisposed to iatrogenic injury leading to painful neuromas or handcuff neuropathy (Henderson et al., 1991). The present study shows the high origin of dorsal branch of the ulnar nerve occurred in 21% indicating a high risk of iatrogenic injury. Based on anatomical and ultrasound study done by Le Corroller et al(2013) to identify the origin and course of dorsal branch of the ulnar nerve, there was no difference in course description from its origin to styloid process. Therefore, the ultrasound has to be enrolled as a safe procedure previous to forearm orthopaedic operation to limit the post-operative complication such as ulnar bone reconstruction. Also, the high origin of dorsal branch of the ulnar nerve may have a clinically significant for plastic surgeons to choose appropriate flap transplant (Peterson et al., 1992).

## CONCLUSION

The dorsal branch of the ulnar nerve usually arises in the distal third of the forearm, but may arise at a different level. In these cases, an auto-graft could be used to preserve motor function of the nerve by anastomosing the dorsal branch to the ulnar nerve trunk. For example, fracture of the ulna distal to the origin of the dorsal branch is occasionally associated with palmar palsy; during internal fixation a high dorsal branch origin may be anastomosed to the interrupted palmar nerve to improve palmar conductivity and prevent paralysis of the ulnar nerve. Such a procedure will restore the motor and sensory function of the ulnar nerve where both functions were lost. An auto-graft from the dorsal to the palmar branches is also possible. With dorsal branch of the ulnar nerve variability, orthopaedic surgeons have to be careful during arthroscopy to avoid iatrogenic trauma due to either by instrument or unnecessary ligation. Therefore, identifying the origin and course of the dorsal cutaneous branch of the ulnar nerve by ultrasound study is a mandatory to previous to surgery. Furthermore, there is variability of nerve conductivity in populations with a history of organic disease; there may also be variability between the two upper limbs due to an early or delayed origin of the dorsal branch.

## ACKNOWLEDGMENTS

I would like to thank the donors of cadavers have been used in this research study. I would like to thank Professor Roger Soames who assisted me in the success of this research study. Also, I would like to thank the entire staffs working in Centre for Anatomy and Human Identification who provide the necessary facilities for the preparation of the paper as well as King Saud bin Abdulaziz University for Health Sciences.

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