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DORSAL CUTANEOUS BRANCH OF ULNAR NERVE

AN APPRAISAL ON THE ANATOMY, INJURIES AND APPLICATION OF CONDUCTION VELOCITY STUDIES IN DIAGNOSIS

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ABSTRACT - Classical textbooks and recent publications about the anatomy of the dorsal cutaneous branch of the ulnar nerve are revisited and correlated with methods of measurement of its conduction velocity, in order to evaluate the indications and limitations of the procedure. Etiology and pathogenesis of isolated lesions of this nerve branch are discussed.

KEY WORDS: dorsal cutaneous ulnar nerve, anatomy, nerve conduction velocity, peripheral neuropathy, handcuff neuropathy, pricer palsy.

Ramo dorsal do nervo ulnar: avaliação sobre a anatomia, neuropatias e utilidade do exame da velocidade de condução para diagnóstico

RESUMO - O conhecimento da anatomia normal de um nervo e de suas variantes tem importantes implicações na indicação, realização e interpretação do exame neurofisiológico do mesmo. Apresentamos avaliação sobre aspectos anatômicos clássicos e recentes sobre o ramo dorsal do nervo ulnar. Correlacionamos marcas anatômicas ao método de medida da sua velocidade de condução e discutimos causas e mecanismos patogênicos das lesões deste ramo nervoso.

PALAVRAS - CHAVE: ramo dorsal do nervo ulnar, anatomia, velocidade de condução nervosa, neuropatia periférica, neuropatia por algemas, paralisia após movimentos repetitivos.

In order to correctly interpret the results of conduction velocity studies of a particular nerve, it is mandatory to know its anatomy, the most frequent territory of innervation, anatomical variants and their frequency. In this paper we review the above items regarding the dorsal cutaneous branch of the ulnar nerve (DCU).

DCU provides all sensory modalities of the medial portion of the dorsal aspect of the hand and the dorsal surfaces of the proximal and medial phalanges of the fifth and fourth fingers[1]. The remainder of the dorsum of the hand is innervated by the superficial radial nerve[1]. Variability in this distribution has been documented[2-5]. DCU and superficial radial nerve conduction velocities have been employed in the investigation of the detailed innervation pattern of the fingers, and a sensory map was proposed[5]. Accumulation of data on DCU anatomy and on the innervation of the dorsum of the hand is useful to devise an appropriate sampling strategy of the nerves of interest. This must be programmed before and during testing, so that results may help to decide between normality, anatomical variants and disease.

Several authors[6-11] studied DCU electrophysiology. Among them, Jabre[6] and Kim et al.[7] proposed similar techniques to measure DCU conduction velocity. Two publications are available from our country[12,13]. Both have studied reference values, but the techniques employed were different.

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We here review the anatomy of DCU, discussing its territory of innervation and anatomical landmarks, thus providing theoretical basis for conduction velocity studies. Causes and mechanisms of DCU injuries are revisited and application of its conduction velocity in diagnosis is emphasized.

ANATOMY AND ELECTROPHYSIOLOGY

Dorsal cutaneous nerve of the hand[14] or DCU is one of the terminal rami of the ulnar nerve[14,15]. Ulnar nerve fibers derive from the eighth cervical and first thoracic roots, in the majority of cases, but it may be formed solely from the eighth cervical or by seventh and eighth cervical roots[14]. Nerve fibers pass to the medial cord of brachial plexus and are individualized as ulnar nerve in the axilla. In the upper arm, the ulnar nerve is in relation to major vessels and gives branches only in the proximal forearm[2,14,16].

Intraneural topography of fibers to various branches of the ulnar nerve was first studied by Sunderland[14] who could trace DCU fibers from some centimeters above the humeral epicondylar line to two centimeters below the ulnar styloid process. He observed a relatively precise localization of DCU fibers in the ulnar trunk, emphasizing their long independent intraneural course just to the take-off as a terminal ramus. Jabaley et al.[16] had the same experience based in own dissections. They concluded that "DCU and ulnar nerve are two separate nerves traveling within a common epineural conduit while still retaining their autonomy".

The DCU leaves the main ulnar nerve at about the junction of the medial and distal thirds of the forearm, according to classical textbooks[1,15,17]. Rarely, DCU may leave the ulnar trunk just below the medial humeral epicondyle (Poirier and Charpy, *apud* Sunderland[14]), having a subcutaneous course[18]. Like the main ulnar nerve, DCU is positioned between the ulnar bone and the *flexor carpi ulnaris* muscle, covered by its muscular portion. At the level of its tendon, DCU is situated postero-medially. DCU leaves the ulnar nerve, piercing the antebrachial fascia, 4,8 to 10,0 cm above the ulnar styloid process[14,16,19] or a mean distance of 8,3 cm (SD=2,4) from the proximal border of pisiform bone[20], taking a posterior direction. These measures are important references for placing stimulating electrodes.

DCU then courses around the ulnar styloid process medially and dorsally and, at the fifth metacarpal joint (2 cm[21] or 3 cm[3] distally to the ulnar styloid process), it gives off two[17,19,22] or three[1,15,23] main branches. Alexandre and Martinon[3] dissected thirty hands and found both types of branching in a proportion of 2:1 respectively for two and three rami. In hands with two main branches, lateral and medial, there is a secondary division in the lateral ramus[3]. These data are the rationale for the location of the recording electrodes. The active electrode may be positioned either along the fifth metacarpal bone[7] or between the fourth and fifth metacarpals[6,9,13] and the reference electrode is placed 3 cm distally[6,7,9,13].

The dorsum of the hand may be innervated entirely by the superficial radial nerve[18] as in a case of DCU agenesis[24]. DCU was also found to be absent in one out of 24 dissected upper extremities[20]. Alternatively the posterior or the lateral cutaneous nerves of the forearm may extend further distally than usual[2], modifying the standard pattern of innervation. Variability in dorsal hand innervation may be caused also by communicating branches which may be either ulnar-radial or ulnar-ulnar. A DCU to radial branch in the dorsum of the hand is less frequent (3/30) than radial to DCU (23/30)[3]. Anastomosis between the superficial radial nerve and DCU was found in 1/26[20] and 3/20 hands[25]. Complete absence of anastomosis is also possible, as shown by 4/30 anatomical specimens[3]. The anatomical variants mentioned above may be responsible for low amplitude or absence of response in the conduction velocity test, thus predisposing to wrong physiological diagnosis[10]. A paired conduction velocity examination between DCU and superficial radial nerve should help avoid misinterpretation[8].

Kaplan[19] described a peculiar pattern of branching of DCU proximal to its division in the dorsum of the hand and distally joining the volar sensory branch of ulnar nerve. As the pisiform bone and the tendon insertion of the *flexor carpi ulnaris* are very near this anastomosis, a neural injury may occur in fractures of the pisiform or in surgical procedures in the area. Poirier and Charpy [*apud* Sunderland[14]] had noted a similar anatomical anastomosis. In 1/50 hands studied anatomically by Bonnel and Vila[26] there was communication between DCU and the ulnar proper palmar digital nerve of the fifth finger. This anomalous branch of DCU has been designated as Kaplan's anastomosis and it may join the superficial[27] or the deep rami[28] of the ulnar nerve. In 1/25 hands Kaplan's anastomosis left the DCU medially and about 2,5 centimeters proximal the ulnar styloid process, providing innervation to the radiocarpal joint, the *abductor digiti minimi* muscle, and the fifth carpometacarpal joint[28].

DCU NEUROPATHY

DCU nerve lesion is unusual compared with the more frequent ulnar nerve injuries at the elbow, near the ventral wrist or the palm[2,29]. DCU is vulnerable to laceration, blunt trauma or iatrogenic injury due its superficial situation. However, comparison between the frequency of isolated neuropathy of DCU and that of the superficial radial nerve showed that DCU is relatively more protected[29].

Neuropathy of DCU was first reported by Stopford[30] (1922) in two patients as a result of compression by tight wrist watches. De Wulf and Razemon[31] called attention to possible damage of DCU after resection of the distal end of the ulna; they found 16 DCU neuropathies among 95 cases obtained from two series in the French literature.

Spinner[2] showed that painful neuromas of DCU may occur after laceration of the dorsal aspect of the hand. He also observed that the nerve may be chronically damaged in left-handed persons as they write with the wrist in flexion and the ulnar dorsum of the hand against a hard surface.

McCarthy and Nalebuff[32] found at a surgical procedure an anomalous branch of DCU, an example of Kaplan's anastomosis. It passed medially the pisiform bone and was compressed by the *flexor carpi ulnaris* tendon. There was chronic pain and functional restriction of the hand. Decompression of this branch had excellent clinical result.

Lucas[33] described three cases of DCU nerve lesion related to cystic proliferative synovitis in the ulnar side of the wrist or the radio-ulnar distal joint. Inflammation and stretching of DCU were the suspected pathogenetic mechanisms and clinical improvement occurred after excision of the offending masses.

Wertsch[34] described an occupational neuropathy, "pricer palsy", due to a combination of flexor position of the wrist and fast repetitive pronation of the forearm performed in front of a code-reading machine. In this circumstance, the DCU was injured against the distal ulnar bone.

Henderson et al.[35] reported on the first isolated DCU neuropathy caused by handcuffs. Similarly caused lesions are more frequent in the superficial radial nerve, and may also affect the median or the ulnar nerves[36]. The distribution of lesions may differ in the right and left sides of the same patient[36,37]. Isolated injury of DCU in the right hand of a patient was associated with a superficial radial nerve lesion in his left hand[38]. In another case, injuries of the superficial radial nerve and of DCU occurred in the same hand[8]. DCU lesion was thought to be due to pressure against the ulnar bone or the tendinous portion of the *flexor carpi ulnaris* muscle[38].

Chiu[39] wrote about another interesting DCU neuropathy in a young trainee of karate. In this case the dorsal ulnar digital nerve for the fifth finger was damaged, presumably by the blows of the medial aspect of the hand against the hard surfaces characteristic of this sport.

USEFULNESS OF DCU CONDUCTION VELOCITY STUDIES

Routine ulnar electroneuromyography in the majority of laboratories does not yet include studies of DCU nerve conduction velocity. However, this sort of study can prove particularly useful in patients in whom an exclusive injury of DCU is clinically suspected. As DCU is relatively distant from other ulnar rami, it may be damaged separately from the ulnar nerve from its take-off down to its terminal branches. In these cases, conventional ulnar electroneuromyography must be normal.

In the patients of Henderson et al.[35] and of Sheean and Morris[38], examination of conduction velocity revealed inexcitability of DCU, i.e., no sensitive action potential (SAP) could be recorded in the affected hand. In contrast, SAP within normal values was recorded on the healthy side. Case 2 of Hoffmann et al.[8] presented a low amplitude of DCU SAP and no response of the superficial radial nerve. The interpretation that both nerves were affected was possible because the study was paired.

In the patient with pricer palsy[34] a prolonged latency and 40% reduction in amplitude of DCU SAP was observed in the symptomatic hand when compared with the asymptomatic side. These abnormalities disappeared in a further exam, after neurolysis of DCU.

In cases of ulnar nerve lesion or entrapment in the distal arm, at the elbow or in the forearm DCU fibers may be injured totally or partially[2]. Thus, examination of the conduction velocity of DCU may provide good complementary information in the electroneuromyographic analysis of ulnar nerve palsies. Reduction in amplitude or absence of DCU SAP may give indications about the severity and intraneural topography of the ulnar axonal loss, as long as anomalous innervation of the hand has been considered and deemed unlikely by stimulation of the superficial radial[7,9] and musculocutaneous[7] nerves. Conversely, SAP parameters and conduction velocity within normal reference values are highly suggestive of integrity of DCU fibers[13]. On the other hand, a normal SAP associated with any neurophysiological features of denervation in the ulnar territory should be diagnosed as partial ulnar palsy[11].

In addition, patients may express symptoms and signs in DCU territory, associated with more widespread peripheral neuropathy, as occurs in mononeuropathy multiplex or polyneuropathies. In these patients, DCU conduction velocity together with other nerve conduction velocity samples may aid in the diagnosis. DCU biopsy has been proposed and may be also helpful in cases of hanseniasis[40,41].

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