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Case Report

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Fascicular functional anatomy of median nerve revealed by ultrasonography

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Abstract

In a patient with partial injury to the median nerve, combining electroneuromyographic data with high resolution ultrasonogaraphic imaging confirmed fascicular topography surmised from past microanatomical studies.

Keywords: median nerve, fascicular anatomy, Avocado-related nerve injury, ultrasonography, sensory nerve action potential. antidromic stimulation, microneurography

Abbreviations: ABP: abductor pollicis brevis, CMAP: compound muscle action potential, SNAP: sensory nerve action potential, EMG: electromyogram, CT: carpal tunnel, MRI: magnetic resonance imaging

Introduction

The foundation of fascicular anatomy of peripheral nerves was laid by the pioneering work of Sydney Sunderland. His publication "The intraneural topography of the radial, median and ulnar nerves" describes the details of fascicular anatomy through the entire length of those nerves.[1] Since then there have been several papers describing fascicular anatomy of peripheral nerves by cadaveric dissection or by study of donor hands.[2,3,4,5,6,7] Unlike anatomic dissection, high frequency ultrasonic imaging provides a simple and easy technique to visualize fascicles in the median nerve in vivo. Zanetta et al.,[8] recently published paper titled "Sunderland's median nerve fascicular anatomy revisited by ultrasound;" one was a case of penetrating trauma to the wrist causing injury to the sensory fascicles of middle and ring fingers; the other patient sustained injury to radial aspect of the median nerve affecting the sensory fascicles to the thumb and the motor fascicles. This report describes a similar case in which there was more severe injury to the radial aspect of the median nerve, but mostly sparing the sensory fascicles to digits 3 and 4, the intact fascicles clearly visualized in ultrasonic image.

Case presentation

A 22 year-old male was seen three months after sustaining a knife injury to the volar aspect of the left wrist while cutting Avocados. He felt an electric shock-like sensation in the radial two digits immediately and thereafter lost sensation in those digits along with weakness of the left hand. Examination showed a scar over the volar aspect of the left wrist (Figure 1) with marked weakness of the abductor pollicis brevis (APB) and loss of pain, temperature, and light touch sensations over the thumb, index finger, and radial portion of the middle finger (Figure 1). The rest of the examination was normal.

Nerve conduction studies showed absent compound muscle action potential (CMAP) over APB and the 2nd lumbrical on median nerve stimulation at the wrist. No sensory nerve action potential (SNAP) could be evoked over digits 1 and 2 on antidromic stimulation of median nerve at the wrist; over digit 3 the SNAP showed decreased amplitude, whereas over digit 4 the amplitude was within normal limits. Superficial radial nerve stimulation evoked normal SNAP over the thumb and ulnar nerve stimulation evoked normal SNAP over digits 4 and 5. Needle EMG showed denervation of left APB with no motor units; EMG pattern was normal in the flexor pollicis longus, pronator teres, first dorsal interosseous and the extensor indicis.

Figure 1: Loss of pain and light touch sensations in the colored area. Note the site of injury overlying the course of median nerve.

Ultrasonic imaging showed neuroma in continuity in the median nerve at the wrist proximal to carpal tunnel (CT) inlet; on short axis view this appeared as a large hypoechoic area without fascicular pattern. However, on the ulnar side of the neuroma, there was an area with intact fascicles (Figure 2).

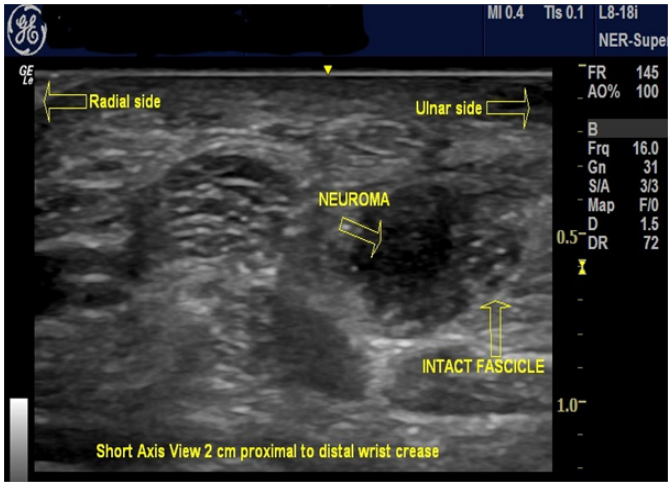

Figure 2: Ultrasonic image: Short axis view of the left median nerve at the site of injury. Note the hypoechoic enlargement with loss of fascicular pattern and an intact fascicle on the ulnar side of the nerve.

Discussion

There has been renewed interest in fascicular anatomy of nerves with the advent of fascicular nerve transfer procedures and development of distal neural prostheses for functional electric stimulation.[5,6,7] Jabaley et al.,[3] did microdissection and concluded that the individual branches and fascicles can be traced within the main trunk proximally and described techniques for repair, lysis and grafting. Planitzer et al.,[4] studied 21 distal median nerves from 12 body donors and found distinct motor and sensory topography; the fascicles supplying thenar and 1st lumbrical muscle came from radial side and 2nd lumbrical from ulnar side. Brill and Tyler[7] performed quantitative analysis of the median, ulnar and radial nerves to provide a source for design of neural electrodes and improve neurosurgical planning. Delagado-Martinez et al.,[6] studied 8 median nerves from 5 body donors using dissection and choline acetyl transferase immunochemistry followed by 3-D reconstruction to determine optimum electrode type and implant location for neuroprosthetic surgery; they concluded that fascicular organization occurs in a short segment distal to the epicondyles and remain unaltered until the muscular branches leave the main trunk. Those authors have provided excellent topographic maps of fascicular arrangement at different levels.

There has been recent interest in exploring peripheral nerve fascicular anatomy by non-invasive techniques. Bilgen et al.,[9] describes MRI microneurography as a potential method to study nerve fascicles, but the procedure may turn out to be costly and time-consuming. On the other hand, high frequency ultrasonography is a cost-effective and quick way to image nerve fascicles and ultrahigh frequency probes may provide even more details.[10]

The findings reported in this case confirm the fascicular topography surmised from the anatomical studies; the portion of the median nerve with intact fascicles seen in the ultrasonic image (Figure 2) corresponds to the sensory fascicles to the 3rd web space and the adjacent digits. This case also underscores the potential for ultrasonography (in combination with electroneuromyography) in cases on partial nerve injury, to provide useful data regarding fascicular anatomy and physiology of peripheral nerves for planning appropriate surgical repair.

Conclusion

Combining electroneuromyography with ultrasonic imaging in cases of partial nerve injury is likely to provide valuable insight into functional fascicular microanatomy of peripheral nerves and facilitate fascicular repair as well as electrode placement for functional electrical stimulation.

Conflict of interest

The author has no conflict of interest to disclose.

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