

Value of Median Nerve Residual Latency and Terminal Latency Index as Electrodiagnostic Tools in Diagnosis of Carpal Tunnel Syndrome

Thesis

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Introduction

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy, which is caused by median nerve entrapment over the wrist-to-palm segment. Several electrodiagnostic techniques have been established as standard methods to facilitate diagnosis of CTS (*Lee et al., 2011*).

Based on both clinical symptoms and nerve conduction tests (NCT), overall prevalences of 3.0–5.8% among women and 0.6–2.1% among men have been found to have CTS in general population samples (*Aygül et al., 2009*).

Most cases of CTS are idiopathic. In some cases it is associated with diabetes mellitus (*Geoghegan et al., 2004*), thyroid dysfunction (*Palumbo et al., 2000*), pregnancy (*Padua et al., 2001*), obesity (*Bland, 2005*), wrist fractures, rheumatoid arthritis, osteoarthritis (*Geoghegan et al., 2004*), myxoedema, acromegaly and oral contraceptive pills (*Maddison et al., 1998*).

The diagnosis of carpal tunnel syndrome can be verified objectively using electrodiagnostic testing although the symptoms and signs of carpal tunnel syndrome are so characteristic either intermittent numbness in the distribution of the median nerve particularly prominent during sleep and relieved by wrist splinting in advanced cases, static numbness, atrophy, and weakness occur (*Watson et al., 2010*).



The most commonly preferred traditional electrophysiological methods in the diagnosis of CTS are median sensory nerve conduction, median motor distal latency, comparison of median and ulnar nerve sensory conduction, and comparison of fourth finger median-ulnar sensory peak latency. Terminal latency index (TLI) and residual latency (RL), calculated from distal motor latency, distal distance and proximal motor conduction velocities, are electrophysiological parameters used to identify abnormalities in the distal segment of the media nerve (*Sandin et al., 2010*).

It is well known that nerve conduction velocities in proximal nerve segments are greater than in the distal portion of the nerve. Because NCV in general is directly proportional to axon diameter, slowing is attributed to tapering of the nerve as it reaches the distal regions of the limb. Consequently, in an upper limb a nerve cannot be expected to conduct with the same velocity within a few centimeters of the nerve's termination compared to a region in the forearm. However, if one were to apply the forearm conduction velocity to the distance over which the distal motor latency were measured (the distance between the site of recording at the abductor pollicis brevis and the site of stimulation at wrist), this called the terminal latency. The time difference between the terminal latency and distal motor latency is referred as the residual latency (*Dumitru et al., 2001*).



Although, it has been reported that TLI gives additional information to conventional electrophysiological studies in mildly affected motor nerves, there are few studies on the sensitivity and specificity of TLI and RL in the diagnosis of CTS (*Uzar et al., 2011*).



Aim of the Work

The aim is to conduct a clinical study on patients having clinical carpal tunnel syndrome using median nerve residual latency and terminal latency index in order to test their values.



Anatomy of Carpal Tunnel

Definition:

Transverse carpal ligament, is a heavy band of fibers which runs between hamate & pisiform medially to scaphoid and trapezium laterally, and forms fibrous sheath which contains carpal tunnel anteriorly within fibro-osseous tunnel (*Wheless, 2013*); posteriorly, tunnel is bordered by carpal bones, and transports median nerve & finger flexor tendons from forearm to hand lies deep to palmaris longus & is defined by 4 bony prominences

- Proximally, by pisiform & tubercle of scaphoid.
- Distally by hook of hamate & tubercle of trapezium.
- From hamate & pisiform medially to scaphoid & trapezium laterally.
- Transverse carpal ligament, portion of volar carpal ligament, runs between these 4 prominences & forms fibrous sheath which contains carpal tunnel anteriorly within fibro-osseous tunnel.
- Posteriorly tunnel is bordered by carpal bones.

(Kent et al., 2010)

- Process of the hamate (*Amadio, 2013*).



Figure (1): A combination drawing/photograph made to illustrate the cross sectional anatomy of the carpal tunnel (*Henley, 2011*).

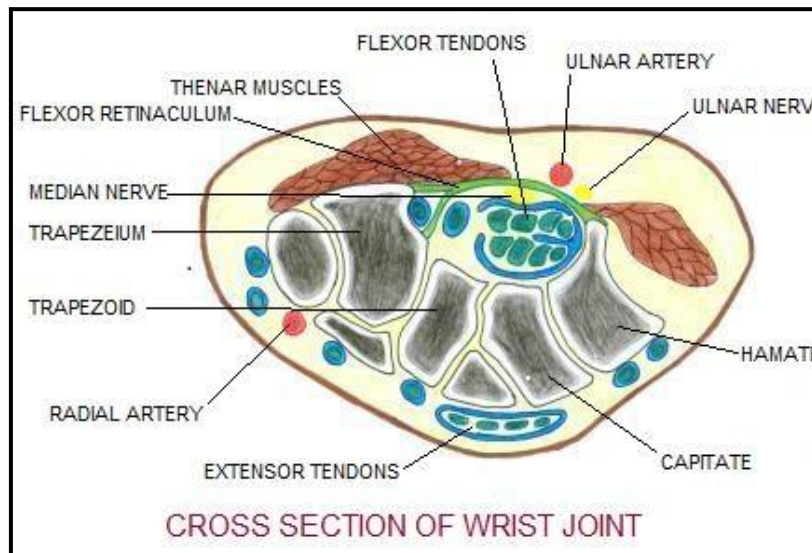


Figure (2): Transverse section through the carpus showing the carpal tunnel and its content (*Walsh, 2013*)

Flexor retinaculum

The flexor retinaculum (FR) is a strong fibrous band, measuring 2-3 cm both transversely and longitudinally, which lies across the front of the carpus at the proximal part of the hand. Its proximal limit lies at the level of the distal dominant skin crease



on the front of the wrist. It is attached to the hook of the hamate and the pisiform medially and to the tubercle of the scaphoid and the ridge of the trapezium laterally (*Zieske et al., 2013*).

- a) The four tendons of the superficial flexor are separate and lie in two rows, with the middle and ring finger tendons in front of the index and little finger tendons. The tendons of flexor digitorum profundus lie deeply in one plane, with only the tendon to the index finger being separate from the others, which remain attached together till they reach the palm (*Claassen et al., 2013*).
- b) The median nerve passes deep to the flexor retinaculum between the flexor digitorum superficialis tendon to the middle finger and the flexor carpi radialis tendon (*Barry, 2011*).

The Median Nerve

The median nerve has two roots from the lateral (C 5, 6, 7) and medial (C8, T1) cords, which embrace the third part of the axillary artery, uniting anterior or lateral to it.

Some fibers from C7 often leave the lateral root in the lower part of the axilla passing distomedially posterior to the medial root, usually anterior to axillary artery, to join the ulnar nerve; they may branch from the seventh cervical ventral ramus. Clinically they are believed to be mainly motor to the flexor carpi ulnaris. If the lateral root is small, the musculocutaneous nerve (C5, 6, 7) connects with the median nerve in the arm (*Rodner et al., 2013*).



The median nerve enters the arm at first lateral to the brachial artery. Near the insertion of the coracobrachialis it crosses in front of (rarely behind) the artery, descending medial to it to the cubital fossa where it is posterior to the bicipital aponeurosis and anterior to the brachialis, separated by the latter from the elbow joint (***Paraskevas et al., 2012***).

It usually enters the forearm between the heads of the pronator teres, crossing to the lateral side of the ulnar artery and separated from it by the deep head of pronator teres. It proceeds behind a tendinous bridge between the humero-ulnar and radial heads of the flexor digitorum superficialis, descending posterior and adherent to the flexor digitorum superficialis and anterior to the flexor digitorum profundus (***Rodner et al., 2013***).

About 5 cm proximal to the flexor retinaculum it emerges from behind the lateral edge of the flexor digitorum superficialis becoming superficial just proximal to the wrist between the tendons of the flexor digitorum superficialis and carpi radialis, projecting laterally from behind the tendon of the palmaris longus. It then passes deep to the flexor retinaculum into the palm. In the forearm it is accompanied by the median branch of the anterior interosseous artery (***Tosti and Ilyas, 2012***).

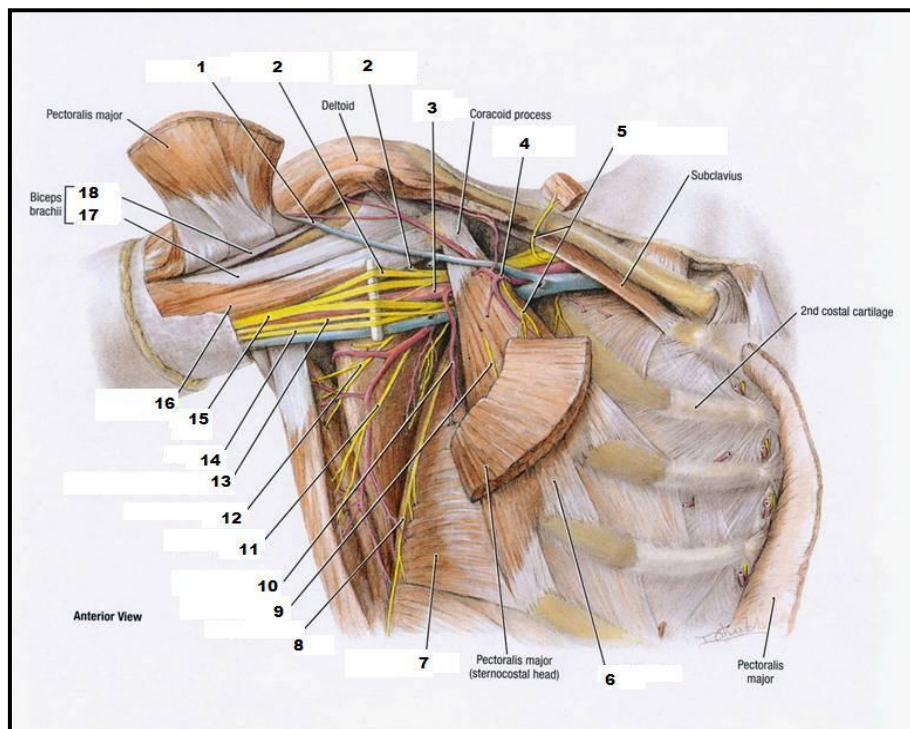


Figure (3): Median nerve and its relation in axilla quoted from study blue.com.

Branches of median nerve (*Barry, 2010*):

a) Branches in the arm

These are vascular branches to the brachial artery and usually a branch to the pronator teres at variable distance proximal to the elbow joint.

**b) Branches in the forearm**

These are muscular, articular, anterior interosseous, palmar cutaneous and communicating branches.

- 1) **Muscular branches:** are given off proximally (near the elbow) to the superficial flexor muscles to the pronator teres, flexor carpi radialis, palmaris longus and the flexor digitorum superficialis. *The branch to the part of the flexor digitorum superficialis for the index finger may arise from anterior interosseous nerve.*
- 2) **Articular branches:** arising at or just distal to the elbow joint supplying it and the proximal radio-ulnar joint.
- 3) **Anterior Interosseous nerve:** Branch arises posteriorly from the median nerve between the two heads of pronator teres just distal to the origin of branches to the superficial forearm flexor. With the anterior interosseous artery it descends anterior to the interosseous membrane between and deep to the flexor pollicis longus and digitorum profundus and supplying both.
- 4) Terminally, it is posterior to the pronator quadratus supplying its deep surface and supplies the distal radioulnar, radiocarpal and carpal joints.
- 5) **Palmar cutaneous branch:** this starts just proximal to the flexor retinaculum pierces it or the deep fascia and divides into lateral branches supplying the thenar skin and connecting with the palmar cutaneous branch of the ulnar nerve.



- 6) **Communicating branches:** which may be multiple, often arises in the proximal forearm and pass medially between flexor digitorum superficialis and profundus and behind the ulnar artery to join the ulnar nerve. This communication is a factor in explaining anomalous muscular innervation in the hand.

c) Branches in the hand

1- Muscular branch: this is short and thick, and arise from the nerve's lateral side, it may be the first palmar or a terminal branch arising level with the digital branches.

- It runs laterally, just distal to the flexor retinaculum with a slight recurrent curve beneath the part of the palmar aponeurosis covering the thenar muscles. It turns round the distal border of the retinaculum to lie superficial to the flexor pollicis brevis, usually supplying it and either continuing superficial to it or traversing it.
- It gives a branch to the abductor pollicis brevis, which enters the medial edge of the muscle and then passes deep to it supply the opponens pollicis, entering its medial edge. Its terminal part occasionally gives a branch to the first dorsal interosseous which may be the sole or partial supply.
- The muscular branch may arise in the carpal tunnel and pierces the flexor retinaculum. A point of surgical importance.



- 2) Palmar digital branches:** the median nerve usually divides into four or five digital branches. It often divides first into a lateral ramus which provides digital branches to the thumb and the radial side of the index finger, and a medial ramus, which supplies digital branches to adjacent sides of the index, middle and ring fingers. Other modes of termination can occur.
- Two proper palmar digital nerves, sometimes from a common stem, pass to the sides of the thumb, the nerve supplying its radial side crosses in front of the tendon of flexor pollicis longus. The proper palmar digital nerve to the lateral side of the index also supplies the first lumbrical. Two common palmar digital nerves pass distally between the long flexor tendons. The lateral divides in the distal palm into two proper palmar digital nerves which traverse adjacent sides of the index and middle finger. The medial divides into two proper palmar digital nerves which supply adjacent sides of the middle and ring fingers. The lateral common digital nerve supplies the second lumbrical. The medial receives a communicating twig from the common palmar digital branch of the ulnar nerve and may supply the third lumbrical. In the distal part of the palm the digital arteries pass deeply between the divisions of the digital nerves: the nerves lie anterior to the arteries on the sides of the digits.



- The median nerve usually supplies palmar cutaneous digital branches to the radial three and one-half digits (thumb, index, middle and the lateral side of the ring). Sometimes the radial side of the ring finger is supplied by the ulnar nerve.
- Occasionally, there is a communicating branch between the common digital nerve to the middle and ring fingers (derived from the median nerve) and the common digital nerve to the ring and little fingers (derived from the ulnar nerve). This can explain variations in sensory patterns that do not confirm to the classic pattern.
- The proper palmar digital nerves pass along the medial side of the index finger and both sides of the middle and the lateral side of the ring finger. They enter these digits between slips of the palmar aponeurosis.
- Together with the lumbricals and palmar digital arteries, they pass dorsal to the superficial transverse metacarpal ligament and ventral to the deep transverse metacarpal ligament. In the digits, the nerves run distally beside the long flexor tendons (outside their fibrous sheaths), level with the anterior phalangeal surfaces and anterior to the digital arteries, between Grayson's and Cleland's ligaments. Each nerves gives off several branches to the skin on the front and sides of the digit where many end in Pacinian corpuscles. It also sends branches to the metacarpophalangeal and interphalangeal joints.



(Barry, 2010).