Combined Sensory Index Test versus Diagnostic Ultrasonography in Early Detection of Carpal Tunnel Syndrome

Thesis

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Physical Medicine, Rheumatology and Rehabilitation

By

Mennatallah Mohammed Mohammed
(M.B., B.Ch.)

Under Supervision of

Prof. Nagwa Nassar
Professor of Physical Medicine
Rheumatology and Rehabilitation
Faculty of Medicine - Ain Shams University

Prof. Irene Raouf Amin
Professor of Physical Medicine
Rheumatology and Rehabilitation
Faculty of Medicine - Ain shams University

Dr. Hossam Salaheldin Abdel Mohsen
Lecturer of Physical Medicine
Rheumatology and Rehabilitation
Faculty of Medicine - Ain shams University

Faculty of Medicine
Ain Shams University
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Mennatallah Mohammed Mohammed

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List of Abbreviations

Abb.	Full term
CMAP	Compound Motor Action Potential
CSA	Cross Sectional Area
CSI	Combined Sensory Index
CT	Carpal Tunnel
CTS	Carpal Tunnel Syndrome
CV	Conduction Velocity
DML	Distal Motor Latency
EMG	Electromyography
IOR	Inlet-Outlet Ratio
MRI	Magnetic Resonance Imaging
NCS	Nerve Conduction Study
SCV	Sensory Conduction Velocity
SNAP	Sensory Nerve Action Potential
US	Ultrasound
NMUS	Neuromuscular Ultrasound

INTRODUCTION

Carpal Tunnel Syndrome (CTS) is the most common entrapment neuropathy, which is caused by median nerve entrapment over the wrist to palm segment ***(Lee et al., 2012).***

The estimated prevalence of CTS in the general population is 1 to 5 percent. CTS is more frequent in women, with a female to male ratio of approximately 3 to1 ***(Kothari et al., 2018).*** Moreover, CTS incidence in general population is 139/100,000 per year for men and 506/100,000 per year for women ***(Dabees et al., 2015).***

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),*** myxedema, acromegaly and oral contraceptive pills ***(Maddison et al., 1998).***

Typical guidelines to diagnose CTS include the combination of clinical and electrodiagnostic findings especially considering that there is no “gold standard” for diagnosis. Moreover, Nerve conduction studies are only 85%–90% sensitive for CTS overall, and some patients may have

asymptomatic median mononeuropathy at the wrist without having actual CTS ***(Werner and Andary, 2011).***

Sensory fibers are typically affected earlier in CTS, as they have a higher content of large myelinated fibers with a high-energy requirement, and are more susceptible to ischemia ***(Malladi et al., 2010).***

Many symptomatic patients with early CTS symptoms have single sensory nerve conduction test negative so sensory comparison tests are recommended ***(Lawrence et al., 2014).***

One of these comparison studies is the combined sensory index (CSI) which is the sum of three median sensory comparison values (Ring-difference, thumb-difference, and palm-difference) for early detection of CTS, which has higher sensitivity than the individual test ***(Robinson et al., 2000).***

Sensitivity improved from 70% for single tests, to 84% for the CSI, while maintaining specificities of 95% or greater ***(Lawrence et al., 2014).***

However, this still leaves a small number of patients with the clinical symptoms of CTS and normal NCS ***(Taylor et al., 2010).***

High-resolution ultrasonography has been proposed as a useful tool for early detection of CTS and it can assess anatomical abnormalities that NCS do not evaluate. .The attraction of ultrasonography for diagnosis of CTS lies in its

wide availability, lower cost, noninvasiveness, and shorter examination time ***(Visser et al., 2008).***

High-resolution ultrasound (US) used increasingly to confirm a clinical diagnosis of CTS with a sensitivity and specificity range from 70 to 88% and 57 to 97% respectively ***(Bathala et al., 2013).***

US diagnosis of CTS based on increase in the median nerve cross-sectional area at the level of the pisiform bone (tunnel inlet) ***(Beekman and Visser, 2003).***

Aim of the Work

The aim of this work was to evaluate combined sensory index test (CSI) versus diagnostic ultrasonography in early detection of carpal tunnel syndrome.

Chapter 1

ANATOMY OF CARPAL TUNNEL

Carpal tunnel is a non-extendible osteofibrous tunnel located between the flexor retinaculum (FR), which forms the roof, and the carpal sulcus, which forms the base. It is limited on the ulnar edge by the hamate hook and pisiform bone and on the radial edge by the scaphoid bone, trapezoid bone and tendon of the flexor carpi radialis (FCR) muscle. The base is formed by the capsule, and the anterior radiocarpal ligaments cover the underlying portions of the scaphoid, lunate, capitate, hamate, trapezium and trapezoid ***(Wheeless et al., 2013).***

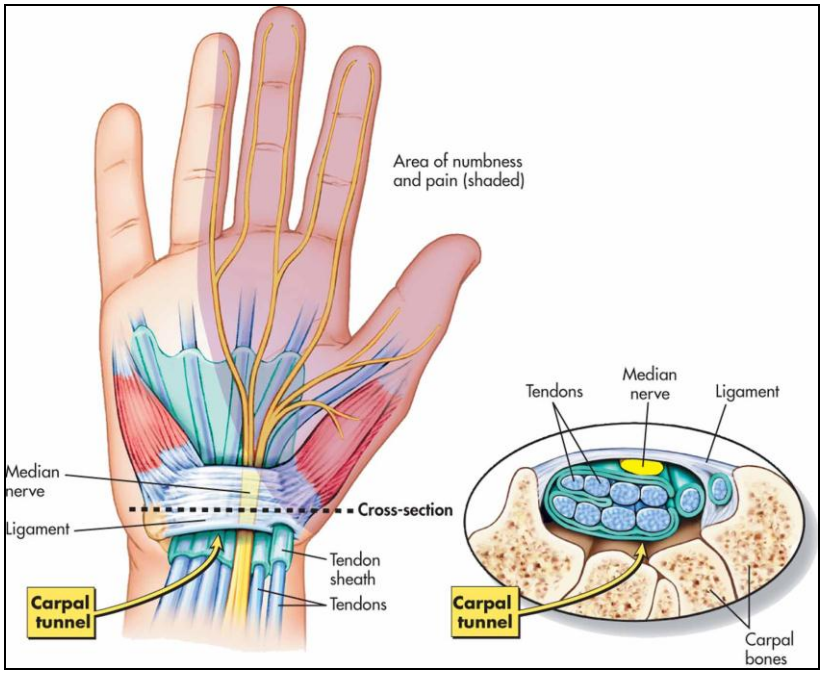

Figure (1): Longitudinal and Transverse section showing the carpal tunnel and its content ***(Netter, 2010).***

Flexor retinaculum:

Is a strong fibrous band, measuring 2-3cm both transversely and longitudinally, which lies across the front of the carpal bones at the proximal part of the hand.

FR can be differentiated into three continuous segments:

1) A proximal thin segment called the volar carpal ligament.
2) The middle tough segment is the transverse carpal ligament which is a strong fibrous band formed from bundles of fibrous connective tissues (average width is 25mm and length is 31 mm). It extends from the distal part of the radius to the distal segment of the base of the third metacarpal ***(Cobb et al., 1993).***
3) The distal segment is formed from an aponeurosis that extends distally between the thenar and hypothenar muscles ***(Ghasemi, 2014).***

The tunnel gives passage to:

1. Four tendons of the flexor digitorm superficialis that flex the metacarpophalangeal joints, proximal interphalangeal joints of the middle 4 fingers, and the wrist.
2. Four tendons of the flexor digitorum profundus, which is the only muscle that can flex the distal interphalangeal joints of the middle 4 fingers. It also flexes metacarpophalangeal joints and the wrist.

3. Flexor pollicis longus tendon for the thumb that cause Flexion of the interphalangeal joint and metacarpophalangeal joints of the thumb.

4. The median nerve ***(Katz and Simmons, 2000).***

Median nerve arises from brachial plexus in axilla by two roots: lateral and medial. The lateral root (C5, C6, and C7) arises from lateral cord of brachial plexus and medial root (C8 and T1) arises from medial cord of the brachial plexus. The medial root crosses in front of the third part of axillary artery to unite with lateral root in a Y-shaped manner either in front of or on the lateral side of the artery to form the median nerve. Therefore, the root value of median nerve is C5, C6, C7, C8, and T1 ***(Barry, 2010).***

Median nerve before entering the carpal tunnel, it gives off its palmar cutaneous branch, which passes superficial to the flexor retinaculum to supply the skin over the thenar eminence and lateral part of the palm. Median nerve enters the palm by passing through carpal tunnel where it lies deep to flexor retinaculum and superficial to the tendons of FDS, FDP and FPL and their associated ulnar and radial bursa ***(Vishram, 2010).***

In the palm, the median nerve flattens at the distal border of the flexor retinaculum and divides into lateral and medial divisions. The lateral division gives a recurrent branch,