Ultrasound diagnostic of carpal tunnel syndrome

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Purpose

Carpal tunnel syndrome (CTS) is a median neuropathy, causing paresthesia, pain, numbness and other symptoms in the distribution of the median nerve, due to its compression in the carpal tunnel at the wrist. The pathophysiology is not completely understood, but compression of the median nerve running through the carpal tunnel can be considered.

Symptoms of chronic carpal tunnel syndrome include:

- Intermittent numbness of the thumb, index, long and radial half of the ring finger.
- Cold hands with warm forearms due to constriction of blood circulation in and around the carpal tunnel. Restricted blood circulation is a contributing factor to chronic CTS.
- Burning pain that radiates up the center of the forearm.
- Difficult grip the steering wheel and overall decreasing grip strength as the hand and muscles atrophy, due to pain and lower level of hand activity.
- Clumsiness with hands, routinely dropping objects or inability to make a fist.
- Loss of fine motor skills in the hand, limiting such tasks as writing, tying a shoe, working a mouse, picking up coins, etc.
- Inhibited hand and wrist movement due to pain, and numb tingling hands or tingling fingers.
- Loss of feeling or swollen-like sensations in the hand or fingers.
- Routine sleep interruption. The CTS sufferers often complain that they wake up 2 to 10 times per night due to numb tingling hands and due to pins and needles feeling. Most sufferers find it extremely annoying to be awakened constantly with tingling fingers and numb hands. In more milder cases people wake up in the morning with numb tingling hands. Without treatment mild CTS symptoms will progress to chronic sleep loss.
- Long standing CTS leads to permanent nerve damage with constant numbness, atrophy of some muscles of the thenar eminence and weakness of palmar abduction.

Most cases of carpal tunnel syndrome are of unknown causes or idiopathic. CTS can be associated with any condition that causes pressure on the median nerve at the wrist. Some common conditions that can lead to CTS include obesity, diabetes, hypothyroidism, arthritis and trauma. Other causes include pressure exerted from outside the tunnel like benign tumors such as lipomas, ganglion, and vascular malformation.
The carpal tunnel is an anatomical compartment located at the base of the palm (Fig.1). Nine flexor tendons and the median nerve (yellow) pass through the carpal tunnel, that is surrounded on three sides by the carpal bones, that form an arch. The median nerve provides feeling or sensation to the thumb, index finger, long finger, and half of the ring finger. At the level of the wrist, the median nerve supplies the muscles at the base of the thumb that allow it to abduct, or thumb opposition. The carpal tunnel is located at the middle third of the base of the palm, bounded by the bony prominence of the scaphoid tubercle and trapezium at the base of the thumb and the hamate hook that can be palpated along the axis of the ring finger.

The median nerve can be compressed by a reduce size of the canal, an increase in the size of the contents (such as the swelling of lubrication tissue around the flexor tendons) or both. Simple flexion the wrist to 90 degrees will decrease the size of the canal.

Palliative treatment for CTS includes use of night splints and corticosteroid injection. The only scientifically established disease-modifying treatment is surgery to cut the transverse carpal ligament.
Methods and Materials

In 2010-2011 we examined 98 patients (109 median nerves) with clinical symptoms of carpal tunnel syndrome and positive electromyography and a group of healthy volunteers (50 median nerves).

Sonographic examination were performed after the electromyography by a radiologist experienced in musculoskeletal sonography. Examinations were performed by using 17MHz linear transducer (Philips iU22). Subjects were seated facing the examiner. The forearms were supinated, wrist were rested on a hard flat surface and the fingers were semiextended (Fig.2). Carpal bones and the flexor retinaculum were used as landmarks to margin the carpal tunnel. The flexor retinaculum is seen at a high-resolution sonography as a variably bowed echogenic band spans the carpus.

We assessed the echogenicity, thickness, and structure of the median nerve and noted visible causes of the compression. We also measured the cross-sectional area of the nerve at the level of entrance to the carpal tunnel.

Border value of the nerve disability area was set 10mm$^2$(3).

We excluded subjects in both, the CTS and control groups, who had anatomic variations of the nerve, such as high nerve branching.
Images for this section:

Fig. 2

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Fig. 1: Carpal tunnel - scheme

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**Results**

We have found, that 98 of median nerves with carpal tunnel syndrome had less echogenicity compared to healthy radial nerve and an enlargement of the median nerve proximal to the carpal tunnel. In this group the average cross-sectional area of the median nerve at the entrance to the carpal tunnel was $15.5 \pm 5.6 \text{ mm}^2$ compared to an average of $6.8 \pm 2.3 \text{ mm}^2$ in the healthy volunteers ($p > 0.000005$).

In the group of patients with carpal tunnel syndrome the area of median nerve was smaller than border value just in 4 cases. 7 cases were excluded for high branching or cicatricial changes.

In our group of patients sensitivity of high-resolution sonography was 96% and specificity 89%.
**Fig. 3:** Median nerve - healthy volunteer

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Fig. 4: Median nerve - healthy volunteer

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Fig. 5: Median nerve - healthy volunteer, sagital view

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Fig. 6: Median nerve - patient with carpal tunnel syndrome

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Fig. 7: Median nerve - patient with carpal tunnel syndrome, sagital view. Less echogenicity and an enlargement of the median nerve proximal to the carpal tunnel.
Conclusion

Ultrasound is an easy and repeatable method useful in diagnostic algorithm of carpal tunnel syndrome, the median nerve cross-sectional area measurement correlates well with the presence of carpal tunnel syndrome and is both sensitive and specific for the diagnosis.
References


