High Frequency Ultrasonography in the Management of Carpal Tunnel Syndrome

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ABSTRACT

Objectives: To evaluate the diagnostic usefulness of high frequency ultrasound in the management of Carpal Tunnel Syndrome among patients suspected of having this syndrome.

Methods: Twenty- six patients (22 women and 4 men) with a mean age of 48.5 years(range 27-70 years) suspected of having carpal tunnel syndrome were examined by high frequency ultrasound at the middle of the carpal tunnel within two weeks after electro diagnostic testing and included in the study. Fourteen patients had bilateral symptoms and 12 patients had unilateral symptoms (total 40 symptomatic hands) (Twenty-six patients (five men and 21 women, mean age 38 years, range 23 71 years)). The cross- sectional area of the median nerve was measured at the carpal tunnel. The hook of the hamate, the pisiform bone and the flexor retinaculum were used as landmarks to margins of carpal tunnel. The cut- off point for the cross –sectional area was chosen to be 9.7milimetre squared. Sensitivity and specificity of ultrasound were determined on the basis of the final diagnosis derived from the patient's history and electromyographic studies results which was used as the gold standard.

Results: High-frequency ultrasound had a sensitivity of 94% and a specificity of 75%. The increased cross-sectional area of the median nerve was the most consistent finding in 80% (32 /40) of patients, while thickening of the flexor retinaculum was found in 25% (10/40) and tenosynovitis of the flexor tendon in 22% (9/40). Flattening of the median nerve was present in10% (4/40) while ganglion and swelling of the median nerve were present in 7.5% (3/40) respectively.

Conclusion: High- frequency ultra- sonography is an effective method for the diagnosis of and may be preferred as the first step in the assessment of carpal tunnel. Furthermore, ultrasound may also provide information about the cause of carpal tunnel syndrome and thus helping planning treatment and follow-up of patients.

Key wards: Carpal tunnel syndrome, Electromyography, Ultrasonography.

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Introduction

Carpal tunnel syndrome (CTS) is probably the most commonly encountered compression neuropathy in clinical practice. It is due to compression of the median nerve as it passes through the carpal tunnel.[1] Carpal tunnel syndrome usually affects patients between 35 and 60 years of age and is three to five times more common in

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females than males.[2] It affects 1% of the general population.[3, 4]

In most cases CTS can be diagnosed on clinical basis.[5] The nerve conduction studies are mainly useful in less typical cases were the diagnosis is questionable and to rule out other causes of peripheral neuropathy.[6]

Advances in ultra-sonographic technology had made a reliable diagnosis of CTS possible mainly based on increased cross-sectional area (CSA) of the median nerve in the carpal tunnel.[7] It has the advantage over the nerve conduction study in that it provides additional information about the possible cause of CTS, such as, tenosynovitis, rheumatoid arthritis etc.[8,9] Ultrasonographic findings correlated well with electrophysiological tests in CTS patients.[10]

We performed this study to evaluate high-frequency- quantitative ultra sonography (US) as a modality for the diagnosis of CTS using the electrodiagnostic study as a reference standard.

Methods

This study was conducted at Queen Alia Military Hospital between September 2007 and March 2008. Twenty-six patients were included in this study (22 women and 4 men). Mean age, 48.5, range (27-70 years). Fourteen patients had bilateral symptoms and 12 had unilateral symptoms, resulting in a total of 40 wrists were examined. The right hand was most commonly involved. All participants had both hands examined sonograpgically and electro-physiologically for the presence of CTS. Clinical diagnosis of CTS was based on the American Academy of Neurology diagnostic criteria1993.[11] A detailed history, a complete clinical examination and baseline laboratory tests to rule out secondary causes of CTS were done. Only patients with idiopathic CTS were included. A positive Phalens sign was seen in 34(85%) while a positive Tinels sign was elicited in 28 wrists (70%). Tingling, numbness, and parasthesia were found in 38 hands (95%) while atrophy of abductor pollicis and vaso-motor changes were noticed in 4 hands (10%).

Exclusion Criteria

History of underlying disease known to cause CTS; history of previous surgery on the wrist; history of wrist fracture, and history of steroid injection.

Electro-Diagnostic Evaluation

All subjects included in this study underwent electro- physiologic studies by an experienced examiner according to the protocol provided by the American Association of Electro- diagnostic Medicine recommendations.[12] All tests were done by the same examiner, in the same room and under similar temperature conditions.

Ultra-sonographic Examination

All patients underwent high-resolution real time sonography of both wrists using a diagnostic Egalant sono 450 series and 10 MHZ linear array transducer. The radiologist was blinded to the electro-diagnostic study result. Ultrasound was done 2-14 days after the electro-diagnostic test; the carpal bones (hook of the hamate and the pisiform) and the flexor retinaculum were used as landmarks of the carpal tunnel. The median nerve in the carpal tunnel was identified. Measurements in both longitudinal and transverse planes were taken. The presence of fluid, swelling of the median nerve, any constriction and the presence of any masses were noted, identified and reported. The CSA of the median nerve was measured by direct tracing with electronic calipers.

Around the margin of the nerve at the time of the examination, the flattening ratio (the major axis of the nerve to its minor axis) was also noted at the mid tunnel point.

Statistical Analysis

Statistical analysis was performed using the non-Parametric U test. The CSA of the median nerve was calculated taking the upper limit of normal cross-sectional area (CSA) of the normal contralateral hands and other hospital staff hands. Sensitivity and specificity were calculated on the basis of the final diagnosis determined by electro-diagnostic study which was used as the gold standard in this study.

Results

A total of 40 symptomatic wrists in 26 consecutive patients with symptoms and signs of CTS were enrolled in this study. Twenty– two were women and 4 were men (ratio, 11:2), their mean age was 48.5 years (range, 27-70) and the mean duration of symptoms was 4-months (range, 1-7 months).

Electro-diagnostic findings were as follow: normal study in 6 hands (15%); mild CTS in 12 hands

Table I. The clinical and electro-diagnostic findings

Clinical findings	No. of patients	%
Tingling ,numbness in median nerve distribution	38	95
Positive phalen's sign	34	85
Positive Tinel's sign	28	70
Weakness of ABD muscle	4	10
Atrophy of ABD muscle	4	10
Electro- diagnostic findings		
Normal EMG	6	14.5
Mild CTS	12	30
Moderate	16	40
Severe	6	15

Table II. Ultrasound measures in 40 symptomatic hands and 12 asymptomatic hands

Ultrasound measure	Symptomatic hands			Asymptomatic hand
	mild	moderate	severe	
CSA(squared mm)	9.7	10.2	11.2	7.8
(mean, range)	8.8-11	9.2-11	9.2-13	4.6-9.5
Flattening ratio (square mm)	2.4	2.55	2.7	2.2
(mean, range)	2.2-2.6	2.2-2.7	2.5-2.9	2.1-2.5

CSA: cross- sectional area; FR: flattening ratio

Table III. Causes of carpal tunnel as detected by ultra-sonography

Causes identified by US	No. of patients	%
Thickening of the flexor tendon	10	25
Tenosynovitis	9	22.5
Ganglion	3	7.5
Bifid median nerve	1	2.2

(30%); moderate CTS in 16 wrists (40%), and severe CTS was found in 6 wrists (15%). Table I summarizes the clinical and the electro- diagnostic findings in patients included in the study. In comparison with the normal hands US assessment of the median nerve in the diseased hand showed that the CSA was increased in 80% (32\40) wrists. Mean CSA of the median nerve was 10.2 (range, 9.2-11.7) for moderate cases of CTS and the mean CSA of the median nerve for severe cases of CTS was 11.2 (range, 9.2-13) and the mean CSA for mild cases was 9.7 (range, 8.8-11) while the mean CSA of the unaffected wrists was 7.8 (range, 4.6-9.5). In our study, the flattening and swelling of the median nerve frequently being present in 4 and 3 wrists respectively, therefore, the flattening ratio was considered not significant, although, there was a good correlation with the severity of CTS. Table II shows the ultra- sonographic measures in patients included in the study. Ultra-sonography helps identify local causes of median nerve compression at the carpal tunnel and thus, may help in planning treatment for the patient. Thickening of the flexor retinaculum was found in 25% (10\40), tenosynovitis was elicited in 22.5 % (9\40) while ganglion and bifid median nerve were seen in 3 and 1 patients respectively. Table III summarizes the local causes of CTS identified by US. The patients tolerated well the ultrasound examination. They reported no complications and preferred this method over the electro-diagnostic testing.

Discussion

Until recently, the diagnosis of CTS was based on a combination of positive clinical history, positive provocative tests, such as, Tinels or Phalens tests,[13-15] combined with a positive nerve conduction study.[16] Although, electro-diagnostic tests are still used as the gold standard to confirm CTS, many cases of carpal tunnel syndrome may be missed, especially the milder ones. Many authors pointed out that those conventional electro-diagnostic tests may not be appropriate for detecting mild CTS. The pathology causing the symptoms may be totally different from that causing delay or abnormality on electro- physiologic test.[17] Several attempts have been made to improve the diagnostic precision of the nerve conduction study to improve reproducibility to minimize false-negative results in

the diagnosis, such as the incorporation of 0.3 ms difference in sensory latency between the median and ulnar nerves or between the median and radial nerves,[18] but still there is a high incidence of false - positive results reaching in some reports up to 40%, as reported by Edmond MD *et al*.[19]

Ultra- sonographic evaluation of the musculoskeletal system is used for the diagnosis of many disorders such as bursitis, tendonitis, and detection of joint effusion. The concept of neuro-radiological investigation for CTS including computed tomography (CT), magnetic resonance imaging (MRI) and US of the wrist is evolving and gaining more interest.[20] Ultra- sonography had been used for the diagnosis of peripheral nerve lesions following fractures, post operatively and during the surgical repair to describe and localize the lesion.[21]

Ultrasound is simple to handle, safe to apply, cheap and practical and readily available tool to examine the content of the carpal tunnel and diagnose median nerve compression.[2] Earlier studies,[22] which used quantitative US to examine changes in the carpal tunnel were confirmed by studies which used MRI testing for the same purpose.[23]

Current US criteria for the diagnosis of CTS are: Swelling, flattening and an increase in CSA of the median nerve. The variations in the CSA were rated corresponding to the severity of CTS.[22] This was confirmed by our study where there is significant correlation between CSA and severity of CTS. Our cut-off point of 9.7 for the mean CSA of the median nerve corresponds with the previously reported findings in the literature.[6,24,25] In comparison to the results of Wang,[26] our study showed a sensitivity of 94% and a specificity of 75%,

In our study, further information about the etiology of CTS was provided by US making it a better tool for patient's evaluation and planning treatment. We recognize several limitations to our study; firstly, we did not include a control group and the data from contralateral asymptomatic hands and hands from hospital staffs were only used to choose our cut-off point for the median nerve CSA. Secondly, physicians, rheumatologists and even the radiologists lack the experience and training in the use of US in the diagnosis of peripheral nerve lesions including CTS; therefore, they often refrained from ordering or performing ultra-sonography. Lastly, in our study we used the electro- diagnostic tests as the gold standard for the diagnosis of CTS so we were unable to make a comparison with the electro- diagnostic studies.

Conclusion

High- frequency ultra- sonography of the median nerve and measurement of its CSA seems to be an effective tool in the diagnosis of CTS. Ultrasound examination also provides additional information regarding the cause of median nerve compression in the carpal tunnel that may affect the management and future treatment planning of patients with CTS. Finally, ultrasound examination is a safe, simple, cheap and widely available even in district hospitals making it the preferred tool in the initial assessment of carpal tunnel syndrome.

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