Comparison of Sonography and Electrodiagnostic Tests in Diagnosis and Treatment of Carpal Tunnel Syndrome

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Abstract: Diagnosis of carpal tunnel syndrome is based on clinical findings and electrodiagnostic findings are used to confirm the diagnosis. On the other hand, sonography has enjoyed attention as a noninvasive method for diagnosis of carpal tunnel syndrome. 76 hands of patients in whom the diagnosis of carpal tunnel syndrome was confirmed and 80 hands in the control group were enrolled in the study. In both groups the surface area of median nerve was measured by sonography and electrodiagnostic studies were performed on the patient group. The patient group was followed up for at least 6 months. The difference between the surface areas of the median nerve measured by sonography was statistically significant (p < 0.0001). In the same way the difference between before and after operation Dash Score in the patient group was statistically significant (p< 0.001). Sonography was 95% sensitive and 93% specific for the diagnosis of carpal tunnel syndrome. A weak correlation was present between the severity of the disease in electrodiagnostic studies and sonography (p=0.047 and r=0380). No correlation was proved between the sonographic or electrodiagnostic findings and Dash score before or after the operation (p>0.05 and r<0.5). Based upon the findings of the present study, sonography may be a very suitable module for the diagnosis of carpal tunnel syndrome, but its finding or electrodiagnostic ones' are not related to functional score of the patient. Answering the question whether it is a substitute for electrodiagnostic test needs further investigation.

Key words: Carpal tunnel syndrome • Ultrasonography • Electrodiagnosis

INTRODUCTION

Carpal tunnel syndrome is used to describe a complex of symptoms associated with compression of median nerve in the wrist and is the most common location of compressive neuropathy in the upper limb [1]. It affects 5% of the population and is by far more common in females. The symptoms include pain and paresthesia in median nerve distribution (3.5 radial fingers) or whole of the hand, typically more severe at night. Diagnosis of the syndrome is mainly a clinical one [2], based on the history and physical examination by tinnel, phanel and nerve compression tests, but electrodiagnostic tests are used to confirm [1, 3]. Though it has been stated that these tests are very specific [4], some studies have reached upon 10 to 20% false positive and negative results for them [5, 6, 7]. Again it must be noted that performing these tests needs experienced personnel, takes a considerable time and causes considerable pain and discomfort for the patient. On the other hand, sonography has enjoyed much attention as a noninvasive method for diagnosis of the syndrome [8-14]. The purpose of the present study was to assess the value of sonography in diagnosis of carpal tunnel syndrome and in determining the response to surgical treatment in comparison to electrodiagnostic tests.

MATERIALS AND METHODS

This prospective study was conducted after proposal and ethic committee approval in Kerman neuroscience research center, Kerman University of medical sciences, between September 2008 and July 2010. 80 hands of patients with carpal tunnel syndrome candidates for surgical treatment entered the “patient group” and 80 hands of 40 normal volunteer subjects without any sign
or symptom attributable to carpal tunnel syndrome or any other neurologic disorder were enrolled in the “normal group”. The inclusion criteria for the disease group were as follows:

- Informed consent for participation.
- Fe/male above 18 years old.
- Surgery candidate for carpal tunnel release, so that idiopathic condition and response to treatment would be definite.
- Not undergoing simultaneous bilateral surgery.
- Electrodiagnostic and sonographic studies having performed before surgery, at most one week apart.

It must be clarified that for bias prevention, diagnosis of carpal tunnel syndrome and decision for surgery were performed solely based upon clinical signs and symptoms and in cases in which the patient decided for surgery, electrodiagnostic studies and sonographic studies were performed (not more than one week apart) and surgery was performed, regardless of the result. The aim of this hard protocol was to prove the diagnosis of idiopathic carpal tunnel syndrome.

In the patient group these information were recorded: age, sex, sonographic measurement of the median nerve, electrodiagnostic studies results and DASH score before surgery and the latest follow up of the patient (at least six months after surgery). The sonographist measured the median nerve surface area immediately before its entrance to the carpal tunnel. According to EMG/NCV, the patient could be placed into one of the three mild, moderate or severe groups. The criteria were as follows:

**Motor Studies:**

- Median motor= stimulate median nerve 8 cm proximal to APB; record from APB.

  DML: 2.2-4.2 ms NCV=50-60 m/s

- Median motor: mid-palm = stimulate recurrent branch of median nerve in mid-palm
- Ulnar motor= stimulate ulnar nerve 8 cm proximal to ADM; record from ADM.
- Median DML - Ulnar DML< 1 ms

**Sensory Studies:**

- Median sensory (antidromic)

  DSL= 2.9 3.6 ms

- Ulnar sensory (antidromic)

  DSL= 2.6-4.1 ms

- Median/Sensory (antidromic)

  Median and ulnar nerves are excited between the 2\textsuperscript{nd} and 3\textsuperscript{rd} and 4\textsuperscript{th} and 5\textsuperscript{th} metacarpals respectively in thumed-palm. Recording is with bar electrode over the median and ulnar nerves 8 cm proximal to mid-palm cathode. Median -ulnar<0.3 ms

- Median/Radial (antidromic)

  Ring electrodes on 1st digit. Radial nerve excited 10 cm along radius. Median nerve excited 10 cm following course similar to motor. Median-radial<0.5 ms

**Electromyography (EMG):** Needle EMG of APB or OP/P. Teres/FPL,…… for R/O DDX.

**Grading Severity:**

Mild=prolonged DSL +/- SNAP Amplitude below the lower limit of normal
Moderate= mild + prolonged DML
Severe=prolonged DSL and DML + Absent Median SNAP or low amplitude or absent thenar CMAP. Neurogenic EMG findings in ABP or OP.

The sonographist did not know whether the person being examined was in the patient or control group and the physiatrist performing the electrodiagnostic studies did not know that a study is being performed.

16 wrists of volunteer persons were examined by two sonographists to assess the interobserver and intraobserver variability of this measurement. The electrodiagnostic tests were performed only on the patient group and once.
RESULTS

Ultimately 76 hands from the patient group were followed up for at least 6 months (6 to 15 months, mean 9). Sonography was performed on 80 wrists of the control group. The two groups did not show statistically significant difference with regard to their sex, age, weight and height.

In the patient group, the mean surface area of the median nerve was 15.3 ± 6.7 and 6.85 ± 1.19 mm² in the control group (p=0.001). In the same way the difference between preoperative and postoperative DASH score was significant in the patient group (125.03 ± 6.638 and 48.47 ± 9.383 respectively, p=0.001). The difference between the median nerve surface area in left and right wrists of the control group was not statistically significant (p=0.485).

Considering 8.5 mm as the cutoff point, sonography had a sensitivity and specificity of 95 and 93% respectively for the diagnosis of carpal tunnel syndrome. Considering the numbers 7.5 and 9.5 for the subject, sensitivity was calculated to be 97.5 and 92% and specificity was 70 and 100% respectively. The area under the ROC curve (AUC) was 0.98 (CI95%: 0.96-1.0).

With respect to the interobserver and intraobserver reliability of sonographic measurement of the median nerve, 0.78 (CI95%: 0.22-0.85) and 0.62 (CI95%: 0.49-0.88) were calculated respectively, which correspond to moderate and weak reliability. According to established criteria for judgment; high reliability, 0.90-0.99; good reliability, 0.80-0.89; fair reliability, 0.70-0.79; poor reliability, less than 0.69 [15].

No correlation was found between the surface area of the nerve and preoperative (p=0.152) or postoperative DASH score (p=0.44), i.e. no increase or decrease in the DASH score was noted with increase in the surface area of the nerve. In the same way, no correlation was noted between the severity of disease according to electrodiagnostic studies and preoperative or postoperative DASH score (p>0.05 and r<0.5). A weak correlation was noted between sonographic and electrodiagnostic findings (p=0.001 and r=0.380), i.e. with increase in surface area of median nerve, the patient was in a “more severe” group of electrodiagnostic studies. Among the other variables of the study, the correlation between preoperative and postoperative DASH score was statistically significant (weak negative correlation, p=0.047 and r=-0.228). No patient had any complaint of sonography, but all had experienced pain with electrodiagnostic studies. The cost of electrodiagnostic studies was 4 times more than sonography. The time for performing sonography was roughly half that of electrodiagnostic studies.

DISCUSSION

The main purpose of the present study was to evaluate the correlation between sonographic and electrodiagnostic findings in carpal tunnel syndrome and the functional score of the patient. In fact no correlation was found. This is true while sonography proved itself very suitable for the diagnosis of carpal tunnel syndrome as a noninvasive and inexpensive method.

Usefulness and reliability of sonography in diagnosis of carpal tunnel syndrome is in concordance with many other studies, but interesting is their disagreement on the normal surface area of median nerve and in other words what is the number above which the diagnosis of carpal tunnel syndrome should be considered? In fact previous studies have reached upon figures 9 to 12 mm [16-19] and even 15 mm [20], so the figure 8.5 mm in the present study is near to the finding of some investigators.

An interesting finding of the present study was the figure 0.98 for area of the under the curve of ROC for sonographic measurement of the median nerve, which is indicative of excellent diagnostic value of sonography for the purpose [21] (area under the curve, 0.9 to 1 means excellent diagnostic value, 0.8 to 0.9 good, 0.7 to 0.8, worthless and less would be worthless).

We cannot clearly justify the low interobserver and intraobserver variability of sonographic measurement of median nerve observed in the present study. In fact this is in sharp contrast to the findings of the previous studies, two of which concerned mainly on the topic [22, 23] and the other described it briefly [24]. These studies have all reported on high reliability of sonography. Perhaps the relatively low sample size of the present study, the sonographists’ experience, different methods of sampling and the difference among the sonographic devices would account for the observed difference and anyway this may suggest the need for larger studies.

Another finding of the present study was a weak direct correlation between sonographic and electrodiagnostic findings. This has been the concern of other studies too, which some have mentioned no correlation [25, 26], while others have noted a very strong correlation [27]. We suggest that a larger study with a larger sample size would clarify the topic.
The main purpose of the present study was to find a possible correlation between functional score of the patient and sonographic or electrodiagnostic findings. It has been noted that DASH score shows a statistically significant decrease after carpal tunnel release [28], which was a strong finding of the present study too, but up to our best knowledge this is the first study that examines the correlation between sonographic or electrodiagnostic findings and preoperative and postoperative DASH score. We found that there is no correlation and in other words the severity of the disease in sonography or electrodiagnosis would not be predictive of high or low DASH score, before or after operation or its decrease with operation. It is interesting that the preoperative and postoperative DASH scores showed a negative correlation and in other words the patients who had worse scores preoperatively benefitted more from the surgery. Again this is in contrast to the findings of the only study that we could find and had focused on the topic [28].

As mentioned, most previous studies had found sonography as a suitable diagnostic aid for carpal tunnel syndrome, but one study had reached upon the conclusion that sonography could not replace electrodiagnostic studies for the purpose, as it is not as specific, though sensitive. In the present study electrodiagnostic studies confirmed the disease in all of the patients and in other words they were 100% sensitive, but this has not been the finding of others [5, 6, 7, 29]. Again it must be noticed that we included only surgery candidates. We think that the diagnosis of carpal tunnel syndrome would take place based upon the clinical findings and confirmed with electrodiagnostic and/or sonographic studies. The specificity of electrodiagnostic studies in carpal tunnel syndrome cannot be assessed by the findings of the present study, as we did not perform them on the control group.

The most important limitation of the present study was the fact that we only included surgery candidates, as we thought that this the only way that one can confirm the presence of idiopathic carpal tunnel syndrome and on the other hand we aimed to assess the preoperative and postoperative DASH scores. Anyway this may have caused inclusion of more severe cases of carpal tunnel syndrome. Another limitation of the study was the absence of control group for electrodiagnostic studies.

**CONCLUSION**

Based upon the findings of the present study sonography would be a good diagnostic aid in carpal tunnel syndrome, but electrodiagnostic findings and the surface area of median nerve as measured in sonography have no correlation with the functional score of the patient. Whether sonography could replace electrodiagnostic studies necessitates further investigations.

<table>
<thead>
<tr>
<th>Variables</th>
<th>P-value and r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nerve surface area in sonography</td>
<td>Severity of disease in electrodiagnosis 0.001 and 0.38</td>
</tr>
<tr>
<td>Nerve surface area in sonography</td>
<td>DASH score before operation 0.152</td>
</tr>
<tr>
<td>Nerve surface area in sonography</td>
<td>DASH score after operation 0.44</td>
</tr>
<tr>
<td>DASH score before operation</td>
<td>DASH score after operation 0.047 and -0.228</td>
</tr>
</tbody>
</table>

Table 1: Cut off Point, specificity and sensitivity of sonography

<table>
<thead>
<tr>
<th>Cut off point (mm)</th>
<th>Specificity (%)</th>
<th>Sensitivity (%)</th>
<th>LR+</th>
</tr>
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<tbody>
<tr>
<td>6.5</td>
<td>32.5</td>
<td>100.0</td>
<td>1.48</td>
</tr>
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<td>7.5</td>
<td>72.5</td>
<td>97.4</td>
<td>3.54</td>
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<td>8.5</td>
<td>92.5</td>
<td>94.7</td>
<td>12.6</td>
</tr>
<tr>
<td>9.5</td>
<td>100.0</td>
<td>92.1</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

1. LR+: Likelihood ratio

Table 2: Correlations between variables of the study

<table>
<thead>
<tr>
<th>Variables</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nerve surface area in normal group</td>
<td>Nerve surface area in diseased group 0.0001</td>
</tr>
<tr>
<td>DASH score before operation</td>
<td>DASH score after operation 0.0001</td>
</tr>
</tbody>
</table>
REFERENCES


