Reliability, Feasibility and Value of Ecography in Clinical-functional Results in Patients Affected by Carpal Tunnel Syndrome: is There a Correlation?

Mattia Manni1, Michele Bisaccia1, Giuseppe Rinonapoli1, Andrea Schiavone1, Luigi Meccariello2, Steven James Mccabe3, Olga Bisaccia4, Cristina Ibáñez Vicente1, Andrea Cappiello1, Auro Caraffa1

1Division of Orthopedics and Trauma Surgery, University of Perugia, S. Maria della Misericordia Hospital, Perugia, Italy
2Department of Orthopedics and Traumatology, Vito Fazzi Hospital, Lecce, Italy
3Director of Hand Program, University of Toronto, Toronto, Canada
4Department of Diagnostic Imaging, "Niguarda Ca’ Granda" Hospital, Milano Italy

Corresponding author: Luigi Meccariello, MD. Department of Orthopedics and Traumatology, Vito Fazzi Hospital, Via Ada Cudazzo, Block: A- Floor:V, Lecce, Italy.
Phone: +393299619574. Fax:+390823713864. E-mail: drlordmec@gmail.com

ACTA INFORM MED 2017 MAR; 25(1): 44-48
Received: Dec 27, 2016 • Accepted: Feb 19, 2017

ABSTRACT
Background: The aim of this study was to evaluate how the ultrasound examination in the carpal tunnel diagnosis could contribute to the clinical and neurophysiological evaluation. This was done by evaluating the cross-sectional area (CSA) and its correlation with symptoms and functionality data assessed by the BTQC questionnaire. Methods: 60 patients were subjected to open CTR for idiopathic carpal tunnel syndrome. The median nerve CSA was assessed both pre-operatively and in follow-up at 4 and 12 weeks. The Boston Carpal Tunnel Questionnaire (BCTQ) was proposed at the same time. Results: BCTQ score significantly improved after 4 weeks, but there was a less significant increase at 12 weeks for both the BCTQ-S and the BCTQ-F. The 4-week CSA, however, did not appear to have markedly improved, whereas the 12-week CSA turned out to be statistically significant. The correlation between BCTQ and CSA shows that post-surgery, the reduction of CSA of the median nerve is correlated with the symptomatic and functional reduction in patients. Conclusions: The study shows that the symptomatology and the functionality of the hand after surgery for the carpal tunnel resolves quickly. Furthermore, the reduction of the CSA proves to show that the use of ultrasound can help in the evaluation of patients with this state.

Keywords: Median nerve, Carpal tunnel syndrome, Ultrasonography, Carpal tunnel release.

1. INTRODUCTION
Carpal tunnel syndrome is considered the most common upper limb neuropathy, with a prevalence of 5% in the general population aged 50-60 years with a female/male ratio of 4/1 (1, 2, 3). The diagnosis appears to be mainly clinical aided by imaging analysis. The gold standard appears be electromyography, even if it can only assess the functional status of the median nerve, but cannot reflect the state of the surrounding structures (4). For this reason the importance of the ultrasound has increased in recent years, both in the initial diagnostic process of carpal tunnel syndrome, as well as in the follow-up of entrapment neuropathy of the median nerve in the carpal tunnel. Ultrasound is a dynamic method, easy to perform, non-invasive, which can provide information about the anatomy of the nerve and its relationship with surrounding structures (5). Therefore, to identify the cause of nerve trunk pain, the combined use of electromyography and ultrasound is often useful to better define the type, location and severity of the nerve damage, making the diagnostic precision and the therapeutic accuracy more effective. The aim of this study is to evaluate the effectiveness of the ultrasound examination as a support to clinical and electromyographic tests in the diagnostic process of carpal tunnel syndrome.

2. MATERIALS AND METHODS
This is a retrospective study aiming to demonstrate how the use of ultrasound as a diagnostic method aids patients with carpal tunnel syndrome. All patients were informed about the study and freely decided to participate. Two groups of patients were studied: Control group A, consisting of 60 voluntary patients (47 females and 13 males) and group B, consisting of 60 patients suffering from carpal tunnel syndrome (39 females and 21 males), with an average age of 47.8 years in both groups. All patients in the second group were operated on at the Hospital “Santa Maria della Misericordia”, Perugia, in the period between January and July 2015. The surgery was performed by
the same surgeon. The inclusion criteria to be part of the study were pain and/or numbness in the fingers in region of the median nerve, night pain with numbness, decreased grip strength dropping objects from the hands, testing positive for the “Phalen Test” and/or “Tinel Test”, or electrophysiological evidence of the presence of CTS (distal motor latency > 4.5 milliseconds, wrist–digit sensory latency > 3.5 milliseconds, or sensory conduction velocity at the carpal tunnel segment <40 m/s). The exclusion factors were: patient’s age under 18 years old, clinical or electrophysiological signs of proximal nerve compression, diabetes mellitus, renal failure, rheumatoid arthritis, hypothyroidism, pregnancy, previous surgery on the wrist or the presence of pacemaker.

All patients were evaluated by the same operator, who has more than five years of experience with musculoskeletal ultrasounds. During the examination, the patients were sitting on a comfortable chair with the hand supinated, positioned on a stand on a table, with the wrist in hyperextension and the elbow flexed. The high frequency linear probe (715 MHz) was used positioned transversely with respect to the path of the median nerve to evaluate the cross-sectional area (CSA) and subsequently, longitudinally to the nerve to evaluate the compression below the channel. After surgery, patients were evaluated by ultrasound and by the same operator in the same position with the same ultrasound parameters at 4 and 12 weeks.

The BCTQ (Boston carpal tunnel questionnaire) was proposed for the clinical evaluation pre-operatively and at 4 and 12 weeks post-surgery (6). It consists of 2 scales: symptom (BCTQ-S) and functional (BCTQ-F) evaluation. BCTQ-S consists of 11 questions which consider the severity and frequency of pain, numbness, weakness and loss of maneuverability. Five possible responses are offered for each question and are scored from 1 (no symptom) to 5 (severe). Results are expressed as the average scores of the 11 responses. BCTQ-F is composed of 8 questions that address difficulties in performing daily tasks. Responses are also scored using a 5-point scale (1 to 5, where 5 indicates greatest difficulty), and again results are averaged. At first, we compared the average values obtained from the median nerve CSA-pisiform and from the ulnar nerve CSA-ulnare with the respective SD in the two groups, using the relationship between the two as a reference point that should be less than 1.79 to rule out the disease (5). These values were then compared with the results obtained from the BCTQ questionnaire to assess whether or not ultrasound, symptomatic, and functional correlations of this disease coexist.

We compared the average value of the CSA below the carpal canal near the pisiform in the control group and in group B before surgery and at distance of 4 and 12 weeks post-surgery to assess whether there were statistically significant differences between the control group and the group of operated patients. These values were correlated and compared with the results obtained from the BCTQ-S and BCTQ-F questionnaire to see if there was a relationship between the ultrasound and the clinical confirmation. Finally, given that the ratio CSA-pisiform/CSA-ulnare must be less than 1.79 to rule out the disease, we compared the same with the BCTQ questionnaire to see if there were any correlations (7).

### Statistical analysis

For statistical analysis, the T-student tests was used which allowed us to correlate the results between the proposed questionnaire and the sectional area of the median nerve obtained in the three steps under consideration. The goal was to assess whether or not there were objective improvements of the nerve post-surgery and of symptoms. We present the average results +/- SD with statistical significance with p-value <0.05.

### 3. RESULTS

The values obtained of the CSA-pisiform and CSA-ulnar in control group patients (group A) were on average 7.80 +/- 1.49 mm2 and 4.37 +/- 1.39 mm2 compared to the patients in group B which were 12.43 +/- 6.43 +/- 3.23 mm2 and 1.2 mm2 with a p-value <0.001, respectively.

Furthermore, considering the relationship between CSA-pisiform/CSA-ulnar, in control group cases an average value of 1.78 +/- 0.72 mm2 was reported, whereas in the pre-operative group 1.93 +/- 0.98 mm2 with a p-value <0.01. In both cases, we obtained statistically significant results as can be assessed from Table 1.

We also compared the values of the CSA-pisiform and CSA-ulnar at 4 and 12 weeks between the control group and the group of patients operated on, as shown in Table 2, with...
Reliability, Feasibility and Value of Ecography in Clinical-functional Results

<table>
<thead>
<tr>
<th>Control group [A]</th>
<th>CTS group [B]</th>
<th>n=60</th>
<th>n=60</th>
<th>mean±SD</th>
<th>Pre-op</th>
<th>Post-op</th>
<th>4 weeks</th>
<th>12 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA-pisiform(mm²)</td>
<td>7.80±1.49</td>
<td>10.94±4.9</td>
<td>9.4±3.2</td>
<td>12.43±3.23</td>
<td>0.01*</td>
<td>1.0</td>
<td>12.43±3.23</td>
<td>0.01*</td>
</tr>
<tr>
<td>CSA-ulnar(mm²)</td>
<td>4.73±1.9</td>
<td>9.70±0.8</td>
<td>4.6±3.9</td>
<td>6.43±2.01</td>
<td>0.01*</td>
<td>2.0</td>
<td>6.43±2.01</td>
<td>0.01*</td>
</tr>
<tr>
<td>CSA-pisiform/CSA-ulnar</td>
<td>1.78±0.72</td>
<td>9.19±0.98</td>
<td>2.0±0.5</td>
<td>9.19±0.98</td>
<td>0.01*</td>
<td>3.0</td>
<td>9.19±0.98</td>
<td>0.01*</td>
</tr>
</tbody>
</table>

Table 1. *p<0.01. CSA-pisiform: median nerve cross-sectional area measured at the level of the pisiform bone, CTS: carpal tunnel syndrome.

Table 2. *p<0.05. CSA-pisiform: median nerve cross-sectional area measured at the level of the pisiform bone, CSA-ulnar: ulnar nerve cross-sectional area measured at the level of the pisiform bone, CTS: carpal tunnel syndrome.

<table>
<thead>
<tr>
<th>CSA-pisiform(mm²)</th>
<th>CSA-ulnar(mm²)</th>
<th>CSA-pisiform/CSA-ulnar</th>
<th>CSA-ulnar(mm²)</th>
<th>CSA-pisiform/CSA-ulnar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-op 12.43±3.23</td>
<td>10.94±4.9</td>
<td>9.4±3.2</td>
<td>6.43±2.01</td>
<td>9.19±0.98</td>
</tr>
<tr>
<td>Post-op 4 weeks</td>
<td>12.43±3.23</td>
<td>9.4±3.2</td>
<td>6.43±2.01</td>
<td>9.19±0.98</td>
</tr>
<tr>
<td>Post-op 4 weeks</td>
<td>12.43±3.23</td>
<td>9.4±3.2</td>
<td>6.43±2.01</td>
<td>9.19±0.98</td>
</tr>
</tbody>
</table>

Table 3. The obtained values of p in the pre-operative and follow-up at 4 weeks and at 12 weeks.

<table>
<thead>
<tr>
<th>CSA-pisiform(mm²)</th>
<th>CSA-ulnar(mm²)</th>
<th>CSA-pisiform/CSA-ulnar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-op 12.43±3.23</td>
<td>10.94±4.9</td>
<td>9.4±3.2</td>
</tr>
<tr>
<td>Post-op 4 weeks</td>
<td>12.43±3.23</td>
<td>9.4±3.2</td>
</tr>
<tr>
<td>Post-op 4 weeks</td>
<td>12.43±3.23</td>
<td>9.4±3.2</td>
</tr>
</tbody>
</table>

Table 4. Correlation between CSA-pisiform and BCTQ-S and BCTQ-F in the pre-operative and at follow-up, p<0.01.

<table>
<thead>
<tr>
<th>CSA-pisiform(mm²)</th>
<th>CSA-ulnar(mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-op 12.43±3.23</td>
<td>10.94±4.9</td>
</tr>
<tr>
<td>Post-op 4 weeks</td>
<td>12.43±3.23</td>
</tr>
</tbody>
</table>

Table 5. Correlation between CSA-pisiform/CSA-ulnar in pre- and post-operative p<0.05.
sary to evaluate the causes for which there is not a statistically significant correlation for BCTQ-S at 4 weeks post-surgery.

There was no onset of symptoms related to compression of the ulnar nerve even though its CSA was slightly increased, as proposed in the literature (7, 9). As hypothesized Yurdakul (7), this may be related to morphological changes caused by the prolonged persistent symptoms that worsens with time. So much so, that we observed a similar reduction at 12 weeks, but with a non-statistically significant result. Finally, in the conclusions of his work, Yurdakul (7) affirms that the CSA-pisiform turns out to be a real method for diagnosing carpal tunnel, while the relationship between CSA-pisiform/CSA-ulnar can only be used for the diagnosis of CTS in the final stages. In this study, we saw the important correlation between the CSA-pisiform and diagnosis of CTS, but we have also shown that the ratio CSA-pisiform/CSA-ulnar can be used as a diagnostic tool and not only in the late stages of the disease.

The CSA value of the median nerve at 4 weeks did not have a clear improvement compared to the pre-operative values, while at 12 weeks the reduction was statistically significant with an average size of 9.4 +/- 3.2 mm², which agrees with the threshold described by Eugene G. McNally (8) of 10 mm².

It is also in accordance with what Yesildag (10) described, where the value of the CSA of the median nerve below the transverse carpal ligament is found to have a sensitivity of 89% and a specificity of 97% when the cut-off is of 10.5 mm².

We decided to use the BCTQ questionnaire for the assessment of symptoms and functionality because, as described by Levine (6), it is a reproducible evaluation scale and responsive to clinical changes in symptoms following surgery. By using the BCTQ, we can also make comparisons with the literature as in the work proposed by Kim (11).

The BCTQ results obtained post-operatively at 4 weeks demonstrated a significant improvement both symptomatically and functionally. The increase was, however, less significant at 12 weeks post-surgery. In both cases the values are statistically significant. Kim (11) has shown in his work that there is an improvement in symptoms after surgery, but reported a lack of correlation between the values of BCTQ and the median nerve CSA. Compared to the work of Kim (11), our work was based on a follow-up at 4 and 12 weeks as opposed to 2 and 12 weeks. In patients evaluated, we found a correlation between the value of the CSA of the median nerve and the symptomatic and functional outcomes of the BCTQ with statistically significant p values. Many studies have in fact reported a correlation between the change in the CSA of the median nerve post-surgery and a reduction of the patient’s symptoms (12, 13, 14, 15, 16).

5. CONCLUSIONS

Our work has shown that the use of ultrasound in the diagnosis of carpal tunnel syndrome is a useful adjunct to clinical and neurophysiological evaluations. The value of CSA-pisiform correlates with symptoms just as the relationship of CSA-pisiform/CSA-ulnar both in the early stages of symptoms and in the later stages, in a statistically significant manner. The ultrasound findings were correlated with those of symptomology and functionality based on the values of the BCTQ questionnaire proposed to our patients.

REFERENCES


10. Yesildag A, Kutluhan S, Sengul N, Koyuncuoglu HR, Oyar O.


