CLINICAL ARTICLE

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Predictive Value of Sensory Nerve Conduction in Carpal Tunnel Syndrome

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Objective : Electrodiagnostic test has shown diagnostic sensitivity and specificity in carpal tunnel syndrome(CTS). This study was to evaluate the correlation between clinical outcome of endoscopic carpal tunnel ligament release(ECTR) and the predictive value of sensory nerve conduction.

Methods : From January 1998 to December 2004, 87 patients (44 right hand, 37 left hand, 6 bilateral hands) with CTS who underwent ECTR were followed up in our hospital for an average of 2.4 months. We retrospectively analyzed the results with previous medical records. All patients underwent electrodiagnostic test and ECTR. The patients were divided into three groups according to the electrodiagnostic test results. Group (A) was normal sensory nerve response, Group (B) was slowing sensory response and Group (C) was no sensory response. Improvement of the symptom after ECTR was assessed using a visual analogue scale(VAS) score.

Results : Differences between the three groups on the correlation of severity of sensory potential and duration of preoperative symptoms were significant. The mean value of improved VAS scores for the three groups were 6.0 ± 0.96 in the Group A, 6.11 ± 0.48 in the Group B and 6.14 ± 0.53 in the Group C. There was no statistically significant difference between the severity of sensory nerve response and improvement in VAS score after ECTR. Complications included a wound infection, a case of skin necrosis, and two patients with persistent symptoms without any improvement.

Conclusion : Although electrodiagnostic test has been known to be useful, sensory nerve response is considered not to be a good prognostic value for carpal tunnel syndrome after ECTR.

KEY WORDS : Carpal tunnel syndrome · Sensory nerve · Electrodiagnostic test.

Introduction

Carpal tunnel syndrome(CTS) is a common clinical condition of compression neuropathy, which in the case of CTS results from the compression of the median nerve that passes through the carpal tunnel. It is a dominant sensory phenomenon that is associated with loss or impairment of superficial sensation in the thumb, index, and middle fingers. But it may later on result in motor impairment with muscular atrophy. Diagnosis of CTS depends on the presence of characteristic clinical symptoms and provocative clinical tests such as Tinel's sign and Phalen's sign. The electrodiagnostic test for median neuropathy has shown diagnostic sensitivity and specificity[20]. Padua et al.[18] reported that symptoms and pain scores decreased in patients with severe and mild neurophysiological impairment after surgery. However, Finsen[3] asserted that patients with typical carpal tunnel syndrome should undergo surgery regardless of the electrodiagnostic test. Moreover, there is no relationship between giving the electrodiagnostic test before surgery and the postoperative outcome[5]. Moreover, Grundberg[7] reported that patients treated surgically despite normal electrodiagnostic tests achieved clinical outcomes similar to those with abnormal finding in the electrodiagnostic tests.

The aim of our study was to evaluate the predictive value of sensory response in electrodiagnostic test on post-operative outcomes.

Materials and Methods

Population

Patients who underwent endoscopic carpal tunnel ligament release(ECTR) for CTS from January, 1998 to December, 2004

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Table 1. Demographic data

Characteristics	Group (A)	Group (B)	Group (C)	Total
Total hands (right : left)	15 (8 : 7)	29 (18 : 11)	49 (24 : 25)	93 (50 : 43)
Sex (male : female)	2 : 10	5 : 25	5 : 40	12 : 75
Mean age (years)	52.4	53.7	52.9	53.84
Thenar muscle atrophy	0	3	27	30

Group (A)= normal sensory nerve response, Group (B)= slowing sensory nerve response, Group (C)= no sensory nerve response

were included in the study and followed up in our hospital for at least one month, with an average duration of 2.4months. The diagnosis was based on clinical findings and the electrodiagnostic test. Clinical criteria included pain or numbness, sensory disturbance in the median nerve territory and the clinical test that are Tinel's sign and Phalen's sign.

There were 93 hands (47 right hands, 40 left hands and 6 bilateral hands) in 87 consecutive patients who were treated with ECTR (Table 1).

We retrospectively analyzed results with medical records. All patients had taken preoperative electrodiagnostic test and ECTR. However, most of the patients did not take the electrodiagnostic test after ECTR. The patients were divided into three groups according to electrodiagnostic test result. Group A was normal sensory response. Group B was delayed sensory response and Group C was no sensory response. Improvement with the surgical outcome was assessed using a visual analogue scale(VAS) score.

Surgical method

The Menon's single-portal method[11] was applied to all of the 93 hands. After exsanguination of the arm and inflation of a tourniquet up to 280mmHg, transverse incision about one cm long was made on proximal wrist crease at the ulnar side of the palmaris longus tendon after local anesthesia (lidocaine 1%). Through subcutaneous dissection expose, the antebrachial fasica and ulnar bursa were exposed and subligamentous dissection toward the ring finger made a space for the endoscopic device. An obturator was introduced under the fascia and into the carpal tunnel. An endoscope was then inserted into the proximal end of the cannula and the transverse carpal tunnel ligament was visualized. A forward facing knife was inserted and the transverse carpal tunnel ligament was incisied from proximal to distal end. All the while, the endoscope followed immediately behind the knife, visualizing the TCL. A probe was used to palpate the cut ends of the transverse carpal tunnel ligament, several passes made to assure full transection of the ligament. Endoscope was reinserted on the cannula, now the palmar fat into the carpal tunnel was seen, and increased transillumination through the palm was possible. The incision was closed with 4.0 nylon sutures and bulky compressive dressing by elastic bandage and the tourniquet was released. The advantage of this method is that an endoscope follows immediately behind the knife to aid in visualization throughout the transection.

Electrodiagnostic test and Classification

Both hands were tested. For sensory and motor nerve conduction, using surface electrodes for stimulating and recording. Latencies were measured from the stimulus onset to the initial negative response, and amplitudes were measured from the baseline to the end of the negative peak. The sensory nerve action potentials were recorded antidromically, with ring electrodes around the proximal and distal interphalangeal joints. Median sensory nerve conduction velocity was measured from the wrist to the index and ring fingers. Ulnar nerve sensory conduction was measured from the wrist to the ring finger. The distances between the median and ulnar stimulation sides at the wrist and the recording electrodes on the ring finger were equal.

According to the response of sensory nerve conduction, the patients were classified into the three groups. A Group A denotes the normal sensory nerve response; Group B, a slowing sensory never response; and Group C, no sensory nerve response or abnormal motor nerve response. Slowing sensory nerve response is delayed latency between the median and ulnar sensory nerve action potential at the ring finger of above five ms. Abnormal motor nerve response is prolonged latency or reduced amplitude of median compound muscle action potentials.

Statistical analysis

The statistical program, SPSS ver 10, was used for statistical analysis. The Chi-square test was used for the comparing of Tinel's sign and Phalen's sign with severity of sensory nerve response, symptom duration with the severity of sensory nerve response, and improvement of VAS score with the severity of sensory nerve response. The Wilcoxon signed rank test was used for the comparison between the preoperative VAS score and the severity of sensory nerve response, and between the postoperative VAS score and the severity of sensory nerve response. A p-value of <0.05 was considered significant.

Results

No thenar muscle atrophy was observed in Group A, but 3 hands with thenar muscle atrophy were included in Group B, and 27 hands were included in Group C. The severity of thenar muscle atrophy showed gradual increment as the severity of sensory nerve response increased (Table 1).

With regards to the relationship between severity of sensory potential and Tinel's sign or Phalen's sign, Tinel's sign was

Table 2. Tinel's & Phalen's sign and severity of sensory nerve response

Characteristics	Group (A)	Group (B)	Group (C)
Tinel's sign (+)	9 (60.0%)	19 (65.5%)	32 (65.3%)
Phalen's sign (+)	13 (86.7%)	24 (82.7%)	41 (83.7%)

(P-value=0.965, P<0.05)

Table 3. The relation between the severity of sensory nerve response and preoperative symptom duration

Preoperative symptom duration	Group (A)	Group (B)	Group (C)	Total
1 year	8	9	8	25
above 1 year	7	20	41	68
Mean duration	0.95	1.71	1.75	1.63

(P-value=0.015, P<0.05)

Table 4. Comparison between improved VAS score after ECTR and severity of sensory nerve response

Improved VAS score	Group (A) (No of hands)	Group (B) (No of hands)	Group (C) (No of hands)
7	6	13	20
6	4	9	19
5	4	4	8
4	1	3	2
Average of Improved VAS score	6.00±0.96	6.11±0.48	6.14±0.53

(P-value=0.933, P<0.05)

positive in 9 hands in Group A, 19 hands in Group B, 32 hands in Group C and Phalen's sign was positive in 13 hands in Group A, 24 hands in Group B, and 41 hands in Group C. There was no significant difference between Tinel's sign and Phalen's sign among these groups (P=0.965) (Table 2). There were seven subjects with preoperative symptoms that lasted longer than one year in Group A, 20 in Group B, and 41 in Group C (Table 3). There was significant difference in symptom duration among these groups (P=0.015).

The patients were asked to estimate their general satisfaction by VAS score on a scale from one to ten, one being very good and ten being very poor. Before ECTR, distribution of general satisfaction of the patients showed that seven hands in Group A, 14 in Group B, and 27 in Group C were rated an eight point VAS score. Five hands in Group A, ten in Group B, and 18 in Group C were rated a seven point VAS score (Fig. 1). The mean VAS score for Group A was 7.2, 7.27 for Group B, and 7.45 for Group C. Differences between three groups in correlation with severity of sensory potential and preoperative VAS score were not significant (P=0.576).

Comparing of the improvement of VAS score after the ECTR with severity of electrodiagnostic test, improvement of seven point VAS score was observed in six hands in Group A, in 13 in Group B, and in 20 in Group C. However, mean improved VAS score after ECTR was 6.1±0.81 for Group A, 6.11±0.48 for Group B, and 6.14±0.53 for Group C (Table 4). The Wilcoxon signed rank test was used to study the difference in the surgical outcome of each of the groups. A statistically significant difference on severity of sensory response and improved VAS score after ECTR was not seen among these groups (P=0.933).

Complication

Numeric value patients (38%) after ECTR complained of pillar pain, but all of theses symptoms ceased after 1 month. There were one wound infection, one skin necrosis and two other patient with persistent clinical symptoms underwent second ECTR. These patients showed good outcomes.

Discussion

Carpal tunnel syndrome is currently the most common peripheral nerve compression neuropathy, affecting an estimated 1% of the population[16]. The incidence of CTS is increasing in the workplace. Symptoms are almost consistent with the distribution of the median nerve and with electrodiagnostic test. It is generally accepted that sensory disorders in CTS are considered as a type of neuropathic pain. This pain may be a result of the impairment of small fibers in CTS[13]. Repeat shaking of the affected hand in order to ameliorate these symptoms may lead to contracture and degeneration of the nerve epineurium and endoneurium[17].

The sensory fibers are affected more than the motor fiber, and sensory conduction velocity abnormalities occur earlier than prolongation of the distal motor latency[4]. Therefore a decrease in the sensory nerve action potential amplitude occurs earlier than a decrease in the compound muscle action potential in the CTS[6]. When the relative sensitivity of the median sensory nerve response and the motor nerve response are compared, median sensory nerve response studies confirm the diagnosis more frequently than motor studies do[8]. However, because sensory fiber in CTS is very sensitive to heat, the effect of these action potential changes should be greater in the slow conduction compound sensory action potentials of the patients. The electrodiagnostic test is usually performed in a warm environment. Skin temperature is also maintained above 32°C by aid of a thermocoupled infrared heater[2]. Nerve conduction studies mainly evaluate the function of large myelinated nerve fibers. Therefore, in the early stage, electrodiagnostic test findings may be normal every in patients with clinically evident CTS. Electrodiagnositc tests are useful in diagnosing equivocal cases to estimate the severity of the median never lesion or to discriminate between cases of painful polyneuropathy that are related to carpal tunnel syndrome or not[22].

Our study has shown different results in the relationship that existed between the severity of electrodiagnostic test and pr-

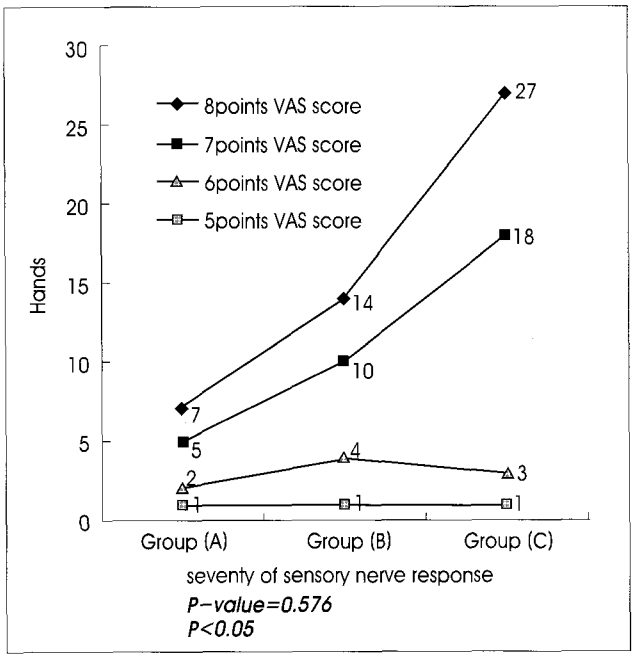

Fig. 1. Correlation between VAS score before ECTR and severity of sensory nerve response.

eoperative symptom duration (P=0.015). The longer the duration of preoperative symptoms, the more severe the electrodiagnostic test results. Because compression is chronic, ischemia is followed by intrafascicular edema, fibroblast infiltration and scar formation[21]. The axonal damage creates more electrodiagnostic impairment. The amplitude of the sensory nerve action potential and motor nerve action potential reflect the functional state of axons, and are useful parameters for assessing clinical grading based on nerve conduction velocity[15].

The electrodiagnostic severity showed a significant correlation with the clinical impairment, but not with the functional status in CTS[9]. Our studies have shown different results in that electrodiagnostic severity did not show significant correlation with the clincial impairment reflecting preoperative VAS score (Fig. 1, P=0.576) or with Tinel' sign and Phalen's sign (Table 1, P=0.965). Levin[10] assessed that no statistical relationship was found between the patients' clinical impairment and the severity of electrodiagnostic test. On the contrary Nathan[12] and White[23] emphasized on that there was a relationship between severity of electrodiagnostic test and clinical impairment. Controversy on the relationship between clinical impairment and severity of electrodiagnostic test still exists.

Sectioning of the flexor retinaculum is the elective therapy of the choice for the CTS when symptoms are associated with severe of median nerve potential in electrodiagnostic test and when daily activities are limited. As increased pressure within the carpal tunnel is thought to lead to the occlusion of intraneural vessels which in turn leads to ischemia[21] when this compression is released, the pressure is relieved and so the circulation improved[19]. This corresponds to the rapid improvement of symptoms seen in most patients after ECTR. Almost all of our patients showed complete relief of their symptoms and half of them reported immediate relief of their paraesthesia postoperatively. Our study shows that there was no significant difference between the relationship with severity of sensory nerve potential and improved VAS score after ECTR (P value =0.933). These results indicate that sensory nerve potential is not considered a good prognostic value for CTS after ECTR. It supports the previous studies which concluded that electrophysiological tests do not provide significant data for the prediction of the functional and symptomatic recovery[1,5,18].

The limitation of this study is that although the ECTR was performed by a single individual, electrophysiological tests were not, but rather by a number of different operators. Also, we did not evaluate follow up electrodiagnostic tests after ECTR, and the follow ups themselves may have been too short. On this basis, it would be unwise to make emphatic conclusions from the data.

Conclusion

Nerve conduction studies are of established value in the diagnosis of CTS. And, since the sensory fiber is more commonly affected than the motor fiber, sensory conduction velocity abnormalities occur earlier than motor nerve prolongation. However, according to the study results, sensory nerve response is a useful measure, but it is not considered a good prognostic value of surgical outcome with the carpal tunnel syndrome.

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Commentary

In this manuscript, authors have described the predictive value of sensory nerve conduction in carpal tunnel syndrome in 84 patients who underwent endoscopic carpal tunnel ligament release(ECTR). Authors have grouped patients into three (normal sensory nerve response, slowing sensory response, and no sensory response) and evaluated the differences between these groups with regards to correlation of severity of sensory potential and duration of preoperative symptoms with the degrees of improvement of symptoms. Although there were significant differences between these groups on correlation of severity of sensory potential and duration of preoperative symptoms, the mean values of improved symptoms (VAS scores) among three groups after ECTR were not statistically significant (good outcome in all three groups in similar degrees). Thus, it was concluded that despite the usefulness of electrodiagnostic test in this clinical setting, sensory nerve response may not be a good prognostic value for carpal tunnel syndrome after ECTR.

Although not much additional information is added to current knowledge available in conjunction with the usefulness of sensory nerve response in patients with carpal tunnel syndrome for evaluation of degrees of severity and postoperative outcome evaluation, this study results demonstrate that, because there may not be significant difference of outcome regardless of preoperative severity of sensory response, good surgical outcome can be expected. This could mean that patient selection and meticulous surgical technique using ECTR technique may be the most important predictive factors in obtaining the good surgical outcome.

However, followings are some of contents that need to be better clarified and elucidated before one can be more confident on such speculations. Follow up duration with mean needs to be described more in detail. Also, more than 1 month, as indicated in the manuscript, of follow up seems to be too short to evaluate in full the outcome of operation and pre- & postoperative diagnostic study results. Authors need to verify the changes of mean values of VAS and statistical significance and also to clarity the difference of severity of sensory potentials with clinical signs with levels of statistical significance values. Surgical technique used by authors should be described with more in detail, if any different from other or usual technique in the literature, to add any advantages compared to standard method. Lastly, although authors have emphasized that sensory nerve response was good diagnostic measure with sensitivity and specificity but poor prognostic value, the sensitivity and specificity values were not given, in general and results from authors, and the phrase "poor prognostic value" needs to be described more in detail in the manuscript. Other limitations of this study, including no follow up electrodiagnostic tests after ECTR and short follow up period need to be carefully taken into consideration in future study to add useful information with regards to degrees and duration of long term results. Also, the results of electrodiagnostic tests need to be classified in standardized fashion to provide more useful information on therapeutic guidelines with better verification and consistency.

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