Chula Med J Vol. 55 No. 2 March-April 2011

Correlation between nerve conduction study (NCS) and clinical improvement in carpal tunnel syndrome (CTS)

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Boonhong J, Somsud K. Correlation between nerve conduction study (NCS) and clinical improvement in carpal tunnel syndrome (CTS). Chula Med J 2011 Mar - Apr; 55(2): 107 - 15

Objective : *To determine the correlation between the changing of parameters of nerve conduction study (NCS) and clinical symptoms in carpal tunnel syndrome (CTS) patients after conservative treatments.*

Design : *Retrospective study.*

Setting : *Electrodiagnosis Laboratory Unit, the Department of Rehabilitation Medicine, King Chulalongkorn Memorial Hospital.*

Methods : *All NCS reports from 1 Jan 2006 to 31 Dec 2008 were reviewed and studies that met the inclusion criteria were recruited into the study. All parameters of NCS included distal sensory latency (DSL), sensory nerve action potential (SNAP) amplitude, distal motor latency (DML) and compound muscle action potential (CMAP) amplitude of median nerve that were tested at both pre- and post-treatments were recorded. The baseline characteristics and clinical responses to the treatments were reviewed and recorded from medical records (OPD card). Correlation coefficients were analyzed by SPSS program by using Spearman's rank correlation coefficient.*

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Results : *Reports of 59 hands of 41 CTS patients were recruited into the study. Fifty-six percent of the hands revealed a good improvement of symptoms after treatments. Correlation coefficients of the change in each NCS parameter (DSL, SNAP amplitude, DML and CMAP amplitude) and clinical symptoms were -0.337, 0.345, -0.228 and -0.004, respectively (p-value = 0.009, 0.007, 0.082 and 0.974).*

Conclusion : *The improvement of clinical symptoms was significantly correlated with the change of sensory nerve conduction study including both of DSL and SNAP amplitude at a weak level ($r < 0.4$), while motor nerve conduction study did not show a significant correlation (neither DML nor CMAP amplitude).*

Keywords : *Nerve conduction study, carpal tunnel syndrome, correlations*

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Received for publication. June 25, 2010.

จริยา บุญหงษ์, กรวิกา สมสุด. ค่าสหสัมพันธ์ระหว่างการเหนี่ยวนำกระแสประสาทและการตอบสนองอาการทางคลินิกในภาวะเส้นประสาทมีเดียนถูกกดรัดบริเวณอุโมงค์ข้อมือ. จุฬาลงกรณ์เวชสาร 2554 มี.ค. – เม.ย.; 55(2): 107 – 15

วัตถุประสงค์ : *เพื่อหาค่าสหสัมพันธ์ระหว่างการเหนี่ยวนำกระแสประสาทและการตอบสนองอาการทางคลินิกที่ดีขึ้นในผู้ป่วยที่มีภาวะเส้นประสาทมีเดียนถูกกดรัดบริเวณอุโมงค์ข้อมือภายหลังการรักษาแบบอนุรักษ์*

รูปแบบวิจัย : *การศึกษาชนิดย้อนหลัง*

สถานที่ศึกษา : *ห้องปฏิบัติการไฟฟ้าวินิจฉัยประสาทกล้ามเนื้อ ฝ่ายเวชศาสตร์ฟื้นฟู โรงพยาบาลจุฬาลงกรณ์*

วิธีการศึกษา : *ทบทวนผลรายงานย้อนหลังของการศึกษาการเหนี่ยวนำกระแสประสาทในช่วงเวลาตั้งแต่ มกราคม 2549 ถึง ธันวาคม 2551 รายงานของผู้ป่วยที่ผ่านเกณฑ์คัดเข้าจะได้รับคัดเลือกเข้าสู่งานวิจัย บันทึกค่าพารามิเตอร์ของการศึกษาการเหนี่ยวนำประสาท คือ ค่า distal sensory latency (DSL), sensory nerve action potential (SNAP) amplitude, distal motor latency (DML) และ compound muscle action potential (CMAP) amplitude ของเส้นประสาทมีเดียนทั้งก่อนและภายหลังการรักษา ข้อมูลพื้นฐานทั่วไปและอาการทางคลินิกที่เปลี่ยนแปลงภายหลังการรักษาสืบค้นจากเวชระเบียนผู้ป่วยนอก ทำการวิเคราะห์หาค่าสัมประสิทธ์สหสัมพันธ์โดยวิธีของ Spearman's rank correlation coefficient ด้วยโปรแกรม SPSS*

ผลการศึกษา : *รายงานของผู้ป่วยจำนวน 59 มือ, 41 คน ได้รับการคัดเลือกเข้าสู่การศึกษา จำนวนมือที่พบว่ามีอาการทางคลินิกตอบสนองต่อการรักษาดีคิดเป็น 56 เปอร์เซ็นต์ พบว่าค่าสัมประสิทธ์สหสัมพันธ์ของการเปลี่ยนแปลงก่อนและหลังการรักษาของพารามิเตอร์แต่ละตัวของการเหนี่ยวนำประสาท (DSL, SNAP amplitude, DML และ CMAP amplitude) และอาการทางคลินิกที่ดีขึ้นเท่ากับ -0.337, 0.345, -0.228 และ -0.004 ตามลำดับ (ค่า p value เท่ากับ 0.009, 0.007, 0.082 และ 0.974)*

สรุป : *อาการทางคลินิกที่ดีขึ้นมีความสัมพันธ์อย่างมีนัยสำคัญกับการเปลี่ยนแปลงค่าการเหนี่ยวนำกระแสประสาทรับความรู้สึกทั้งค่าของ DSL และ SNAP amplitude ในระดับต่ำ ($r < 0.4$) ขณะที่การเหนี่ยวนำกระแสประสาทสั่งการไม่พบความสัมพันธ์อย่างมีนัยสำคัญ*

คำสำคัญ : *การเหนี่ยวนำกระแสประสาท,อุโมงค์ข้อมือ, ค่าสหสัมพันธ์.*

Carpal tunnel syndrome (CTS) is the most common nerve entrapment in the general population. [1, 2] and frequently referred to electrodiagnostic laboratory for doing nerve conduction studies (NCS) of the median nerve. NCS is a gold standard test for diagnosis and grading of severity in CTS. [3,4] Because it is a useful technique for quantifying the median nerve function with a good reliability, reproducibility and objectivity, [5] it also be used to follow up the improvement of patients' nerve function and access the effectiveness of treatment methods. However, in clinical practice, we found that some patients had a change of symptoms that did not go along with a change of NCS results. Previous studies have shown that the correlation of NCS and clinical symptoms in CTS disease were still inconclusive. [6-13]

You H *et al* [9] examined the relationships between severity of symptoms and nerve conduction measures of the median nerve in CTS and reported that the primary measurement of symptom scale is more related to nerve conduction measures (r = 0.21-0.58) than the secondary measures (r= 0.10-0.34).

Dudley Porras AF *et al.* [10] studied the relationship between NCS (both sensory and motor nerve) and clinical outcomes of before and after surgery in CTS, and concluded that there was a significant correlation between improvement in sensory nerve conduction velocity and clinical improvement at follow up. But in fact, the authors did not assess the correlations of the improvement in NCS with the change of clinical symptoms. They just explored the relationship between the symptom severity and functional status' outcomes and compared NCS parameters between preoperative and postoperative results.

Schrijver HM *et al.* [8] reported a low correlations (r <0.4) between NCS and clinical outcome after one year of follow up after splinting or doing surgery. The authors suggested that the results do not support NCS for routinely performing in clinical practice to evaluate the treatment effects.

Both studies of You H *et al.* [9] and Schrijver HM *et al.* [8] had studied correlations at a point of time that could not exactly the same as correlations of changes in both of NCS and symptoms after treatments.

The objective of this study is to determine the correlation between the change of NCS parameters included distal sensory latency (DSL), sensory nerve action potential (SNAP) amplitude, distal motor latency (DML) and compound muscle action potential (CMAP) amplitude and the improvement of clinical symptoms in CTS after at least 6 months of a conservative treatment.

Materials and Methods

All of the NCS reports from 1 January 2006 to 31 December 2007 and their medical records were reviewed. Inclusion criteria for selecting the reports were: 1) reports of patients whose NCS results diagnosed as CTS; 2) completed medical record on the improvement of clinical symptoms, and the patient was treated with conservative treatment; and 3), it had a complete result of repeated NCS with a duration of more than 6 months from the first study. Exclusion criteria were: 1) NCS results show the evidence of peripheral neuropathy; 2) reports of patients who had fractured distal end of radius bone; and 3), reports had any value of NCS that shows no response. All included reports were reviewed baseline data

including age, sex, treatment method, and symptom improvement from medical records. NCS reports were reviewed and recorded value of each parameters of both sensory and motor NCS (DSL, SNAP amplitude, DML and CMAP amplitude) at pre- and post-treatment and graded a severity as mild, moderate and severe degree. [14] The improvement of clinical symptoms, included pain and numbness sensation, was categorized into 4 numeric grading: 4 = resolved or totally cured; 3 = improved; 2 = same or did not change; and, 1 = worse.

Nerve conduction studies: Sensory nerve action potentials were recorded antidromically with ring electrodes around the proximal (active) and distal (reference) of second digit. The wrist stimulation point was 13 cm proximal to the recording electrode. The DSL was measured at the onset of the SNAP. The CMAP was recorded from the thenar eminence, with active electrode placed on the abductor pollicis brevis muscle and the reference electrode was placed over its tendon. The DML was measured at the onset of CMAP with wrist stimulation and active electrode 8 cm apart. The amplitude of SNAP was determined from negative to positive peak and the amplitude of CMAP was determined from baseline to negative peak. The criteria used to diagnosis of CTS were: 1) mild degree, if DSL = 2.8 to 3.2 ms plus positive Bactrian test or DSL > 3.2 ms; 2) moderate degree, if DML > 4.2 ms; and, 3) severe degree, if CMAP amplitude < 5.0 μv. NCS of all patients were studied by physiatrists staff or residency training doctors, supervised by the staff of the Department of Rehabilitation Medicine to use the same equipments in the environment of electrodiagnostic laboratory room.

The SPSS statistical program version 12.0 was used to analyze the data. The qualitative and quantitative data were presented in frequency, percent, mean and SD as appropriate. Spearman rank correlation coefficient was used to analyze the correlation between the symptom improvement (numeric grading score 1 to 4) and the changed value of each parameter of NCS between pre- and post-treatment. The differences between the pre- and post-treatment of NCS were tested by paired t-test with statistical significance at $p < 0.05$.

Results

Reports of 59 hands of 41 CTS patients were included into the study. The demographic and baseline data shows in Table1. The majority of subjects were middle-aged female patients. All of them were received vitamin B1-6-12 supplement. About 70 percent of patients diagnosed as moderate degree of CTS. The averaging duration of repeating the NCS was about one year after conservative treatment.

In Table 2, mean values of each NCS parameter of median nerve at pre-and post-treatment are shown. All the differences of each parameter were not statistically different. The results of improved and resolved clinical symptoms more than half of the studied hands after treatment programs are shown in Table 3.

The correlations between the changed values of NCS and clinical symptoms are shown in Table 4. The changed value of DSL and SNAP amplitude were significantly correlated with the clinical symptom changed at a weak level (r = 0.34-0.35). The changes of DML and CMAP amplitudes were not significantly

correlated with the symptoms. The association of DSL was conversely correlated, while SNAP amplitude show a corresponding correlation.

Table1. Patient baseline characteristics.

Characteristics	Valued
Age in years (mean ± SD)	55.56 ± 10.66
Sex: Female / male (%)	35 (85.4) / 6 (14.6)
Duration of follow up NCS (months) (mean ± SD)	11.66 ± 3.75
Treatment (%)	
Vitamin	100
Splint	33.9
NSAID drug	13.6
Steroid injection	6.8
Severity grading from NCS at first (%)	
Mild degree	11.9
Moderate degree	71.2
Severe degree	16.9

Table 2. The NCS results of median nerve at pre- and post-treatment (n = 59).

Parameters	Pre-treatment Mean ± SD	Post-treatment Mean ± SD	*p*-value*
DSL	3.81 ± 0.86 ms	3.97 ± 0.87 ms	0.11
SNAP amplitude	28.75 ± 18.34 mV	29.97 ± 19.30 mV	0.64
DML	5.91 ± 1.94 ms	6.00 ± 1.99 ms	0.56
CMAP amplitude	7.86 ± 2.92 mV	8.19 ± 3.42 mV	0.37

DSL = Distal sensory latency, SNAP = Sensory nerve action potential, CMAP = Compound muscle action potential

* Compared each parameter between pre- and post-treatment

Table 3. Clinical symptom improvements after treatment.

Severity grading	Clinical symptom changes			
	Resolved	Improved	Same	Worse
		N (%)		
Mild degree (n = 7)	1 (14.2)	1 (14.2)	4 (57.1)	1 (14.2)
Moderate degree (n= 42)	2 (4.7)	27 (64.2)	10 (23.8)	3 (7.1)
Severe degree (n= 10)	0	2 (20.0)	5 (50.0)	3 (30.0)
Total (n= 59)	3 (5.1)	30 (50.8)	19 (32.2)	7 (11.9)

Table4. Correlations between the change of each parameter of NCS and the numeric grading score of symptom improvement (n = 59).

Parameters	Correlation coefficients	p value
DSL	-0.337	0.009
SNAP amplitude	0.345	0.007
DML	-0.228	0.082
CMAP amplitude	-0.004	0.974

Discussion

The baseline characteristics of CTS patients in this study were mean aged of fifty-five years old and more proportion of female are similar to the other studies. [8, 10, 13] All patients were treated with conservative treatments including vitamin supplements, NSAID drugs, splinting and steroid injection. In general, the moderate degree CTS was a major group for seventy percent. After conservative treatments of 6 to 12 months, more than half of the patients (56 %) had resolved or improved of clinical symptoms in both numbness and pain. While NCS parameters, both of sensory and motor nerve conduction studies did not significantly change. Similar to Lee JH *et al*. [14]'s report that demonstrated a significant improvement in clinical symptoms after steroid injection but no significant improvement of any NCS parameters.

The change of sensory nerve conduction study (both of DSL and SNAP amplitude) had a significant correlation with a clinical improvement at a low level, but motor nerve conduction study (both of DML and CMAP amplitude) did not . Even though not quite identical, the study of Schrijver HM *et al*. [8]

also reported low level of correlation coefficient between NCS finding and clinical outcome measured at the follow-up.

Dudley Porras *et al*. [10] studied the relationship between electrodiagnostic test and clinical outcome in patients who had been treated with surgery, and reported that sensory nerve conduction study had a significant relationship with clinical improvement in CTS patients. It is similar to the present study which shows a significant correlation between symptom improvement and changes of DSL and SNAP amplitude.

This study explored the correlation of NCS and clinical improvement in a different way from previous studies by analyzing the changed value of each NCS parameter between pre- and post-treatment. Our results confirmed a low value of correlation coefficient, similar to the others. The clinical response of patients may more sensitive and rapidly changes than the functional change on NCS. The prospective study for long term, sequential evaluation of this correlation may help to clarify this issue.

Despite the limitation of retrospective study, results of this study had some clinical and research implications. Physicians should assess both of patient symptoms and NCS finding together during treating and follow up period. Using only NCS finding may miss the real information. In the next study, a more correlation method or protocol for evaluation of outcome which may combines both clinical and NCS assessment is necessary.

Conclusion

The improvement of clinical symptoms was significantly correlated with the change of sensory nerve conduction study included both of DSL and SNAP amplitude at a weak level ($r < 0.4$) ,while motor nerve conduction study did not show a significant correlation (neither DML nor CMAP amplitude).

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