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The Role of Electrophysiological Severity Scales for Decision-making with Regard to Surgery in Idiopathic Carpal Tunnel Syndrome

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The distribution of electrophysiological severity of carpal tunnel syndrome (CTS) in an outpatient setting and whether electrophysiological severity could be an objective tool for decision-making regarding choice of surgery were investigated. During conservative treatment, 1079 outpatients with idiopathic CTS were classified according to the electrophysiological severity scale (Stage 1-5). The results were provided to the patients and explained, but they were not indicated a treatment protocol intentionally. We recommended surgery to those outpatients who presented with difficulty in pinching due to severe thenar atrophy and/ or showing poor response to conservative treatment. However, the decision-making of surgical or nonsurgical treatment remained with patients. In the distribution of severity stages, Stage 4 was the most common (34%). Two hands were not classifiable. Surgery was chosen in 443 of 1077 hands (41.1%): The operation selection rate increased with severity of the stage and the patients with Stage 5 showed the greatest preference among Stage 1-5 ($p<0.0001$). This was shown in both female and male groups in gender analysis, and in both ≤ 69 y.o. and ≥70 y.o. groups in the age analysis. There was no significant difference between female and male hands, and ≤ 69 y.o. and ≥70 y.o. hands. Among varied reasons for the decision-making process for surgical treatment in CTS, electrophysiological severity scale plays an important role as an objective tool without being influenced by subjective elements; gender and age.

INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common nerve compression disorder in upper extremities and carpal tunnel release (CTR) is a gold standard procedure to ease the symptoms. However, because of the lack of a standard indication tool for CTR, the decision to undergo surgical treatment is based on a variety of reasons. These include not only clinical symptoms that impact on quality of life but also age, gender, dominant hand, patients' levels of understanding, health condition and workers' compensation and other subjective influences (1 , 2). Furthermore, patients prefer non-operative treatment due to concern regarding the pain and discomfort of the operation (3).These elements complicate decision-making for treatment of CTS.

Electrodiagnostic examination (EDX) has the advantage of being an objective assessment strategy with numerical evaluation providing a graded initial severity as well as evaluation of postoperative recovery independently of the patient self-assessment questionnaire (4-10). Some authors recommended carrying out routine EDX preoperatively (11-13) and Lane et al. discussed the additional benefit of postoperative EDX to provide for unexpected results after CTR or medico-legal ramifications (11). The purpose of this study was to investigate the distribution of electrophysiological severity in an outpatient setting and demonstrate whether electrophysiological severity could be an objective tool for decision-making regarding choice of CTR by analyzing the selection rates of CTR in each severity stage.

MATERIALS AND METHODS

Before starting the investigation, we obtained approval from the ethics committee of our institution. A written informed consent was obtained from each patient after oral explanation on the details of the study.

This was a prospective study including 1079 hands with idiopathic CTS from January 2007 to December 2015 diagnosed by clinical symptoms; the sensory deficit, numbness and/or pain in the distribution of the median nerve area, nocturnal paresthesia and/or accompanying severe thenar muscle atrophy. There were 276 male and 803 female hands. The age of the patients averaged 64.5 years (range, 38 -80); there were 658 hands from 69 y.o and under (≤ 69 y.o.) and 421 hands from 70 y.o. and over (≥70 y.o.). We started a conservative treatment

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protocol from their first visit when CTS was diagnosed clinically and it continued for 2-8 weeks, which varied depending on the symptoms: All patients were advised to modify their activity with less use of wrists and fingers. For severe nocturnal pain or numbness, we administered oral prednisolone (5mg) for 2-8 weeks and/or wearing a night orthosis. Progress was assessed on approximately a two-weekly basis. We suggested CTR as a preferred treatment plan for those patients presenting with difficulty in pinching due to severe thenar atrophy and/or showing poor response to conservative treatment (Figure 1). However, the final decision as to a surgical or non-surgical procedure remained with the patients: They decided according to inability in their dairy life.

During conservative treatment (within 2 weeks after the diagnosis of CTS), EDX was assessed in accordance with the electrophysiological severity scale we reported previously (6), Stage 1: normal Distal motor latency (DML) and Sensory nerve conduction velocity (SCV), Stage 2: DML ≧4.5ms and normal SCV, Stage 3: DML ≧4.5ms and SCV <40.0ms, Stage 4: DML ≧4.5ms and non-measurable SCV, Stage 5: non-measurable DML and SCV, was performed on all patients by one examiner (T.K.) using a MEB 2200 (Nihon Koden, Tokyo, Japan). DML was measured after stimulating the wrist, 7cm proximal to abductor pollicis brevis. Using the same stimulation point, Anti-dromic SCV was measured at digit II with a span of 14-15cm. The skin temperature of the hand was maintained at or above 32 degrees. We provided our patients with the EDX results, although we did not indicate a treatment protocol based on severity.

The distribution of severity Stages (1-5) was examined. The ratio of the cases who chose CTR in each Stage was analyzed among Stage1-5 by chi-squared analysis using Microsoft Excel 2010 (Microsoft) ($p<0.05$).
Also, they were divided according to gender; males and females, and age differences; ≤ 69 y.o. and ≥70 y.o. The distribution of severity Stages (1-5) was also examined in each group. The CTR selection rates were compared between the female and male hands, and the ≤ 69 y.o. and ≥70 y.o. hands by chi-squared analysis using Microsoft Excel 2010 (Microsoft) ($p<0.05$).

Patients who resolved their symptoms by nonsurgical procedures or did not choose CTR at the end of the initial treatment period were excluded from this study. If they presented again at a later date (more than 6 months or with worsening symptoms), they were treated as initial CTS and the conservative protocol restarted. However, if they returned asking for CTR within 6 months and were symptomatically similar, CTR was carried out without further EDX.

The cases in which opponens plasty was performed with CTR or the decisions for CTR were from referring primary care physicians were excluded in this study.

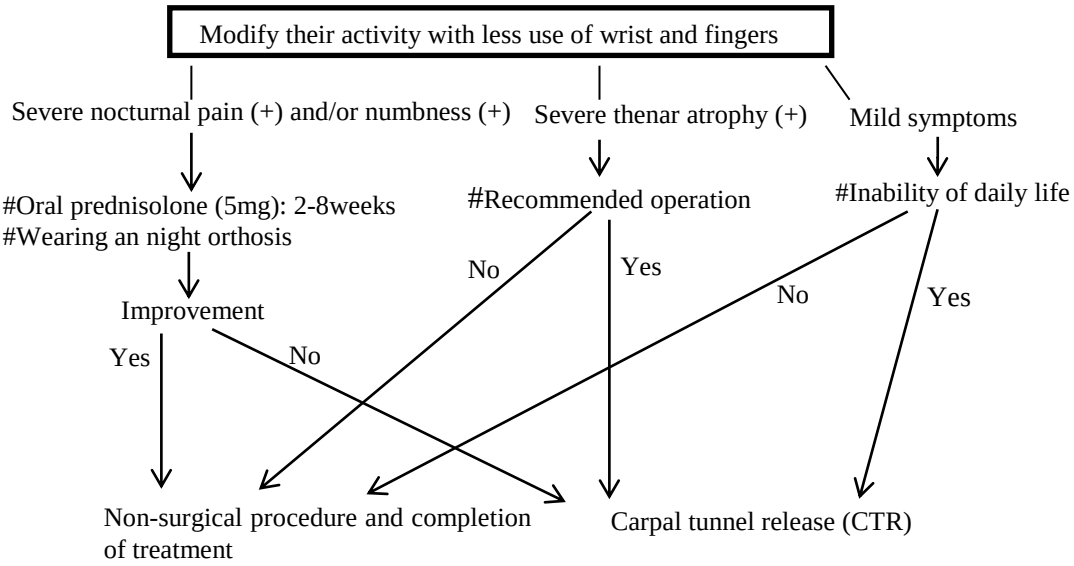

Figure 1. Flow of treatment in 2-8 weeks after diagnosed idiopathic CTS. The final decision as to a surgical or non-surgical procedure remained with the patients.

RESULTS

Analysis in total hands

The distribution of severity stages was shown in Table I, where Stage 4 was the most common. Two hands were not classifiable (0.19%). Four hundred and forty three of 1077 hands (41%) selected surgery. The two unclassifiable hands did not select CTR. Patients with a more severe Stage chose surgery over conservative treatment. CTR selection ratio was the highest in Stage 5 group among all stages (Table I) ($p<0.0001$).

Table I. The distribution of severity Stages and selection of CTR** in Total hands.

Group (hands)	Stage	hands	%	selection of CTR**	%	p value
Total (1077)	1	50	5	5	10	
	2	201	19	24	12	
	3	235	22	65	28	
	4	364	34	188	52	
	5	227	21	161	71	p<0.0001

**carpal tunnel release

Analysis in gender difference

In the female and male hands, Stage 4 was the most common (Table II). In the 803 female hands, 318 of 803 hands (39.6%) selected surgery. In the 276 male hands, 125 of 276 hands (45.3%) selected surgery. There was no significant difference in the selection rates of CTR between female and male hands. There were two unclassified hands in female hands (2.5%) and these cases did not select CTR. For both female and male patients, those with a more severe stage chose surgery over conservative treatment, and the patients with Stage 5 selected CTR significantly more frequently among Stage 1-5 each ($p<0.0001$) (Table II).

Table II. The distribution of severity Stages and selection of CTR** in female and male hands.

Group (hands)	Stage	hands	%	selection of CTR**	%	p value
Females (801)	1	40	5	4	10	
	2	148	18.4	19	12.8	
	3	180	22.4	43	23.9	
	4	254	31.6	129	50.1	
	5	179	22.3	123	68.7	p<0.0001
Males (276)	1	10	3.6	1	10	
	2	53	19.2	5	9.4	
	3	55	19.9	22	40	
	4	110	40	59	53.6	
	5	48	17.4	38	79.2	p<0.0001

**carpal tunnel release

Analysis by age; ≤ 69 y.o and ≥70 y.o.

In the ≤69 y.o. and ≥70 y.o. hands, Stage 4 was the most common (Table III). In ≤69 y.o. hands, 267 of 656 hands (40.7%) selected surgery compared to 176 of 421 hands (41.8%) in ≥70 y.o. hands, which did not show a significant difference. The two unclassified hands were included in the ≤69 y.o. group and did not select CTR. Both ≤69 y.o. and ≥70 y.o. hands showed that patients with a more severe stage chose surgery over conservative treatment, and the patients with Stage 5 selected CTR significantly more frequently among Stage 1-5 each ($p<0.0001$) (Table III).

Table III. The distribution of severity Stages and selection of CTR** in ≤ 69 y.o. and ≥70 y.o. hands.

Group (hands)	Stage	hands	%	selection of CTR**	%	p value
≤ 69 y.o.(656)	1	44	6.7	5	11.4	
	2	133	20.2	18	13.5	
	3	168	25.6	53	31.5	
	4	207	31.6	112	54.1	
	5	104	15.9	79	76	p<0.0001
≥70 y.o.(421)	1	6	1.4	0	0	
	2	68	16.2	6	8.8	
	3	67	15.9	12	17.9	
	4	157	37.3	76	48.4	
	5	123	29.2	82	66.7	p<0.0001

**carpal tunnel release

DISCUSSION

The use of EDX for CTS is still controversial; some strongly support its use and some weakly support it, however, after the release of Clinical Practice Guidelines for diagnosis of CTS (14), the vast majority of survey respondents of the American Society for Surgery of the Hand members use EDX when they diagnose CTS and/or recommend CTR (11-13). In addition, EDX can show objective evidence after CTR if there are unexpected results or medico legal ramifications (11). Maggard et al. included EDX evaluation in the operative indication scenario to avoid overuse of inappropriate care, where CTR was not recommended if cases showed normal EDX (12).

Use of EDX decreased CTR indication ratio significantly (83% versus 79%) because some cases exhibited normal or less severe EDX results than expected (15). Interestingly, in their severe EDX cases with non-recordable DSL (equivalent to Stage 4 or 5 in our scale), they found only one out of 32 patients (4%) declined CTR. Compared to their report, we noted our patients with severe Stage (Stage 4 or 5) selected lower rates of surgery. This might be explained by the difference in the number of patients or by the process of decision making used. We consider their patients were more reliant on their surgeons' advice than our patients because they preferred the treatment plan that the surgeon recommended to them prior to accounting for the patients' preferences. On the other hand, we provided our patients with the EDX results and did not indicate a treatment protocol based on severity, but instead explained their meaning and let them decide. This was the aim of our study: to investigate the objective role of EDX.

Severity of symptoms and function loss are the main determinants in the choice of surgical over nonsurgical treatment for CTS. However, there are a variety of other reasons for patients' choice including age, gender, dominant/ non-dominant hands, patients' perception of the efficacy of the surgery, patients' education level, presence of comorbidities, work compensation (1, 2) and the process of decision-making of surgery is complex. Patients tend to choose conservative treatment due to a perception that it will be less painful (3), however, we consider that conservative treatment should not be repeated unless a practical response is obtained, otherwise, the need for continuing conservative treatments was an indicator of progression to surgery (16). For this reason, we designed the conservative treatment protocol as a single course for 2-8 weeks, when patients were required to make a decision as to surgery during or at the end of the protocol. Performing EDX within the 2 weeks following the diagnosis of CTS was mandatory to avoid interruption to the protocol by delays of EDX performance (17).
The earliest change is abnormal DML in our severity scale and Vahdatpour et al. reported a similar trend to ours that terminal latency index on median nerve motor fiber is more sensitive than SCV in early stage of CTS (18). In contrast, there are several established neurophysiological severity scales for CTS (5, 9), where SCV becomes abnormal before abnormal DML. This reason might be explained by the differences of the boundary for abnormality. The normal value of DML and SCV were set; DML<4ms and SCV>40-44m/s by Padua (9) and DML<4.5ms and SCV >40 m/s by Bland (5). Our criteria are similar to Bland's, where there was a possibility of the difference of the span between the stimulation point and the electrodes. In our method, DML was measured after stimulating the wrist which is 7cm proximal to the electrode on the abductor pollicis brevis and the same stimulation point was used for Anti-dromic SCV measured at digit II. In this process, the span between the stimulation point and the electrodes at digit II becomes 14-15cm. Bland described "from index finger to wrist" only and did not present the span (5). To obtain precise SCV with minimum calculation error, a longer span would be favorable.

There were limitations in this study. Firstly, the average age of the patients was 64.5 y.o and this was high compared to the previous reports; 51.4 y.o. (9) 56 y.o. (10) 56 y.o. (15) and 57 y.o. (17), which might have skewed toward the more severe grades (Stage 4 or 5) because CTS has higher incidence in older people who tend to have more severe neurophysiological changes (19). Secondly, the conservative treatment regimens used by the other researchers and us were not uniform. Therefore, there was a possibility that this could vary the outcome.

In conclusion, electrophysiological severity scale might help decision-making for surgical treatment, especially for the patients with CTS who showed severe Stages with an advantage of objectivity without being influenced by subjective reasons including gender and age.

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