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Lin-Yi Wang

Jyun-Ying Li

Yu-Chi Huang

Mei-Yun Liaw

Tsung-Hsun Yang

*See next page for additional authors*

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# The Utility of Semmes-Weinstein Monofilament Test in Detecting Carpal Tunnel Syndrome with Clinical Stage, Nerve Conduction Study, and Sonography Correlations

## Authors

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# The Utility of Semmes-Weinstein Monofilament Test in Detecting Carpal Tunnel Syndrome with Clinical Stage, Nerve Conduction Study, and Sonography Correlations

Lin-Yi Wang<sup>1,2</sup>, Jyun-Ying Li<sup>1</sup>, Yu-Chi Huang<sup>1,3</sup>, Mei-Yun Liaw<sup>1,3</sup>, Tsung-Hsun Yang<sup>1</sup>,  
Yi-Jung Hsin<sup>1</sup>, Willie Lee<sup>1</sup>, Jui-Kun Chang<sup>1,4</sup>, Ya-Ping Pong<sup>1,3</sup>

<sup>1</sup>Department of Physical Medicine and Rehabilitation, Kaohsiung Chang Gung Memorial Hospital, Kaohsiung; <sup>2</sup>Medical Mechatronic Engineering Program, Cheng Shiu University, Kaohsiung; <sup>3</sup>College of Medicine Chang Gung University, Taoyuan; <sup>4</sup>Department of Occupational Therapy, Kaohsiung Medical University, Kaohsiung.

**Background and purpose:** Nerve conduction study (NCS) and ultrasonography (US) are used to support the diagnosis of carpal tunnel syndrome (CTS). The ability of the Semmes-Weinstein monofilament test (SWMT), a sensibility threshold test, to detect CTS, and its relationship to clinical severity, NCS, and US, remain controversial. We conducted this study to address this controversy.

**Method:** Thirty-three patients presenting with typical symptoms and signs of CTS and 20 normal subjects were enrolled. SWMT on the index finger, NCS, and US of the cross-sectional area of the median nerve at the pisiform level (PCSA) were performed. Receiver operating characteristic (ROC) curves of SWMT, variables of NCS, and PCSA were plotted to analyze their discriminative utilities. The diagnostic agreement for CTS among SWMT, NCS, and PCSA were analyzed by kappa statistics. Sensitivities, specificities, positive predictive values (PPV), negative predictive values (NPV), and accuracies, as well as the correlation coefficients among SWMT, NCS measures, and PCSA, were calculated.

**Results:** The areas under the ROC curve (AUC) for SWMT and PCSA were 0.852 and 0.71, respectively. AUCs for three NCS variables ranged from 0.822 to 0.902. All these variables were discriminative for CTS and were not significantly different in their discriminative power. SWMT yielded sensitivity, specificity, PPV, NPV, and accuracy of 82%, 70%, 82%, 70%, and 77%, respectively. There is significant agreement in detection of CTS using SWMT and NCS ( $\kappa = 0.575$ ,  $p < 0.001$ ). The kappas between SWMT and PCSA, as well as NCS and PCSA, were 0.305 and 0.427, respectively ( $p = 0.025$  and  $0.002$ ). SWMT significantly correlates with not only clinical stage, but also NCS measures and PCSA ( $r$  ranged from 0.381 to 0.581,  $p < 0.01$ ).

**Conclusion:** SWMT shows discriminative power similar to NCS and US for detection of CTS. SWMT also has a moderate correlation with clinical stage, NCS measures, and PCSA on US. As a painless, convenient, and inexpensive modality, SWMT may have the ability to diagnose CTS, but further research is needed. (Tw J Phys Med Rehabil 2015; 43(1): 9 - 18)

**Key Words:** Semmes-Weinstein monofilament test, carpal tunnel syndrome, nerve conduction study, sonography, correlation.

## INTRODUCTION

Carpal tunnel syndrome (CTS) is usually diagnosed based on clinical manifestations, and is supported by nerve conduction study (NCS), which discloses prolonged latency and/or slowed conduction velocity of the median nerve across the wrist.<sup>[1]</sup> NCS is a laboratory-based test and is inconvenient in the community or workplace. Moreover, some patients may refuse NCS due to pain and fear of electric stimulation. Ultrasonography (US) is a painless, convenient, and portable modality for imaging of the carpal tunnel when there is a concern for a space-occupying lesion.<sup>[2-4]</sup> The image associated with CTS is swelling of the median nerve proximal to the carpal tunnel.<sup>[2, 4-6]</sup> A cross-sectional area of the median nerve proximal to the carpal tunnel greater than 9.5 to 10.5 mm<sup>2</sup> on US is thought to be abnormal.<sup>[5]</sup> Analysis of pooled data revealed that diagnosing CTS by US yields sensitivity of 84% and specificity of 78%.<sup>[5]</sup>

The Semmes-Weinstein Monofilament Test (SWMT) is another painless, inexpensive, and convenient threshold test for sensibility and is used widely to evaluate peripheral nerve injury, diabetic neuropathy, and CTS.<sup>[7-12]</sup> Several studies recommended SWMT 2.83 as the upper limit of normality in the upper extremity, which corresponds to 0.068 g of force.<sup>[8, 13, 14]</sup> Few studies have evaluated the role of SWMT in supporting the diagnosis of CTS, and controversies persist.<sup>[7, 8, 15-18]</sup> However, the usefulness of SWMT for postoperative evaluation of the median nerve in patients with CTS, and as a prognostic factor of median nerve injury, have been reported.<sup>[11, 12]</sup> To our knowledge, no study has compared the detective utilities of SWMT, NCS, and US for CTS.

Many studies have reported a significant correlation between NCS and US in CTS.<sup>[3, 19-24]</sup> However, disagreement persisted in the correlation between SWMT and NCS,<sup>[14, 17, 25]</sup> as well as the correlation of SWMT with clinical severity.<sup>[14, 15, 25]</sup> Moreover, no research has reported the correlation of SWMT with US. Therefore, this study was conducted to test the utility of SWMT in supporting the diagnosis of CTS, and to determine its correlation with clinical severity, NCS, and US.

## MATERIALS AND METHOD

### Participants

This study was approved by the institutional review board of the medical center. Written informed consent was obtained from each participant, and their rights were protected. From November 2010 to May 2012, a total of 33 consecutive patients presenting with CTS symptoms were recruited from a rehabilitation clinic at a medical center that receives patients referred from local hospitals and clinics, and is open to the public. Twenty healthy persons without a history of trauma or disease of the upper extremity, and without symptoms or functional impairment of the hands, were enrolled from the hospital and community as the control group. Inclusion criteria were: (a) age 18 to 80 years; (b) symptoms suggestive of CTS (pain, numbness, and/or paresthesia in at least 2 of the radial 4 digits, accompanied by at least two of the following: 1) nocturnal pain, 2) pain exacerbated by grasping, 3) Phalen's sign, 4) Tinel's sign over the carpal tunnel); and (c) symptoms for more than 1 month. The exclusion criteria were as follows: (a) history of systemic disease associated with peripheral neuropathy, such as diabetes mellitus, chronic renal failure, gout, rheumatoid arthritis, and hypothyroidism; (b) history of trauma or paralysis of the upper extremity; (c) history of ulnar neuropathy, cervical radiculopathy, or polyneuropathy; (d) previous carpal tunnel release surgery; (e) pregnancy or lactation; (f) history of inability to tolerate NCS; (g) inability to express hand sensation; (h) receiving analgesics in 7 days before screening; (i) radiating pain or paresthesia from the neck to the arm, forearm, or hand.

### Procedures

The screening process began with an interview to review demographic data, and medical and surgical history. Age, sex, body height, and weight were recorded for each participant. All participants received SWMT on the index finger, along with NCS and US of the median nerve. The index finger was chosen for SWMT because we recorded the sensory response on the index finger in NCS. The clinical stage of CTS for each participant was classified according to their symptoms and signs.<sup>[26]</sup> The examiners who carried out SWMT, NCS, and US were blind to the participant's history, laboratory data, and the

test results among themselves. The three examinations were undertaken within 7 days.

### Clinical stage of CTS.<sup>[26]</sup>

Four stages were classified according to symptoms and signs. Stage 0 is asymptomatic. Stage 1 is symptomatic during the night. Stage 2 is also symptomatic during the day; weakness in the hand may be present, but there is no thenar eminence atrophy. Stage 3 shows thenar eminence atrophy; sensory symptoms may diminish.<sup>[26]</sup>

### Semmes-Weinstein Monofilament Test (SWMT)<sup>[27]</sup>

The full SWMT kit (Touch-Test<sup>TM</sup> Sensory Evaluator 20 piece Kit, Stoelting Co., Wood Dale, IL, USA) was used in this study. The kit contains 20 calibrated monofilaments ranging in size from 1.65 to 6.65. This number represents the logarithm to the base 10 of the force in tenths of milligrams required to bow the monofilament. The formula is: marking number =  $\log_{10}$  Force (0.1 mg).<sup>[28]</sup> Specifically, the force in the formula is expressed by multiples of 0.1 mg.

A licensed occupational therapist was trained in the use of the fiber to ensure a consistent and proper technique prior to administering the SWMT, following the instructions of the kit and the literature.<sup>[27]</sup> The intraclass correlation coefficient for intra-rater reliability (time interval within 24 hours) was 0.872. The SWMT was performed on the index fingertip pulps of both hands, with the participant's vision occluded, and the hand resting comfortably in supine position on a pillow. The monofilament was applied perpendicular to the skin until it began to bend, and was held in place for approximately 1.5 seconds. Testing began with the largest filament in the normal category (2.83). If the participant failed to accurately identify the touch of this filament, the therapist progressively applied each next larger monofilament until touch pressure could be identified. If the participant accurately identified the touch of the 2.83 filament, the therapist progressively applied each next smaller monofilament until touch pressure could not be identified. Filaments marked 1.65 through 4.08 were applied three times to the same spot consecutively. One correct response to the three trials was considered an affirmative response. All larger filaments 4.17 through 6.65 were

applied only once per trial. The size of the smallest diameter filament that could be perceived by the participant was recorded. SWMT >2.83 was considered abnormal.<sup>[8, 13]</sup>

### Nerve Conduction Study (NCS)

NCS was performed by a licensed physiatrist using Viking Quest Electrodiagnostic System (Nicolet Biomedical, WI, USA), and followed the guideline of NCS for CTS.<sup>[1]</sup> The temperatures of tested limbs were kept at 32° or higher. Median compound motor action potential was recorded at the abductor pollicis brevis with stimulation at the wrist and a distance of 6 cm, and motor distal latency of the median nerve (MDL) was obtained at the takeoff of the potential. The median sensory nerve action potential was recorded at the index finger with stimulation at the wrist and a distance of 13 cm, and sensory distal latency of the median nerve (SDL) was obtained at the peak of the potential. With a distance of 12 cm, a median-ulnar sensory comparison study recording on the 4th digit was also carried out, and the latency difference of median-ulnar 4th digit comparison ( $\Delta$ MUD4) was obtained. In addition, routine ulnar motor and sensory studies and electromyography for selective cases were done to exclude possible ulnar neuropathy, polyneuropathy, or cervical radiculopathy. In our electrophysiological laboratory, CTS was confirmed if any one of these criteria were met: MDL >4.1 ms; SDL >3.5 ms; or  $\Delta$ MUD4 >0.4 ms. These diagnostic criteria were derived from the data of 20 healthy subjects, and the limits for the values were defined from the mean values plus 2 standard deviations.<sup>[2]</sup>

### Ultrasonography (US)

US was performed by another licensed physiatrist using a portable machine (t3000, Terason, Burlington, VT, USA) with a multi-frequency 5-10 MHz linear-array transducer. The patients were examined while sitting upright with elbow flexion around 120 degrees, and palm up with wrist at neutral position, fingers semiflexed. The carpal tunnel was scanned on the axial plane, and the transducer was kept with minimal pressure on the skin and perpendicular to the nerve, to obtain the highest echo level and minimize anisotropy; therefore, the cross-section of the median nerve presented as a honey-

comb appearance, with hypoechoic fascicles surrounded by hyperechoic fibroadipose tissue.<sup>[2]</sup> Cross-sectional areas of the median nerve were acquired by using a direct trace method at the level of the pisiform bone (PCSA represents the inlet of the carpal tunnel, and is the best measure for diagnosis of CTS).<sup>[2]</sup> According to Wang's study, the intraclass correlation coefficient of PCSA is 0.814, and the diagnostic criterion for CTS is PCSA  $\geq 9.9$  mm<sup>2</sup>.<sup>[2]</sup> The sonographer in this study is the same as in Wang's study.<sup>[2]</sup>

## Statistics

For independence of data, only the more symptomatic hands in patients with bilateral symptoms, and the dominant hands in normal subjects, were analyzed. The normality of numeric variables was tested by using the Kolmogorov-Smirnov test. Demographic variables were compared by using chi-square tests and two-sided independent *t* tests. For SWMT, variables of NCS, and PCSA on US, the comparison between two groups was made by using the Mann-Whitney U test, because they are not normally distributed. Receiver operating characteristic (ROC) curves of the aforementioned variables were plotted to analyze their discriminative utilities. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of SWMT, NCS, and PCSA on US for diagnosis of CTS were calculated.

The diagnostic agreements among various examinations were tested by kappa statistics. Correlation coefficients among SWMT, NCS measures, and PCSA were calculated using Spearman's correlation. A *p* < 0.05 is considered significant.

## RESULTS

Of 102 patients screened, a total of 61 were excluded. Eight patients refused to participate in this study. (Figure) Therefore, 33 patients (26 women and 7 men) and 20 normal subjects (15 women and 5 men) were enrolled. No significant difference in gender proportions was observed between both groups. Demographic data and variables of the median nerve in the patient and control groups are shown in Table 1. There was no statistically significant difference in mean age, mean body weight, and body mass index between the patient and control groups. However, the mean height of the patient group was significantly lower than that of the control group. The median of symptom duration in the patient group was 12 months. There were 20 participants with clinical stage 0 (the control group), 6 with stage 1, 22 with stage 2, and 5 with stage 3. The SWMT, MDL, SDL,  $\Delta$ MUD4, and PCSA on US in the patient group were significantly greater than in the control group. All hands had detectable motor and sensory responses on NCS.

**Table 1.** Demographic data and variables of the median nerve in the patient and the control groups

Variables	Patients	Controls	<i>p</i>
Age	45.2 (11.1)	41.4 (12.3)	0.252
Body Height (cm)	159.2 (5.8)	163.8 (5.6)	0.006
Body Weight (Kg)	62.9 (12.1)	63.2 (11.6)	0.937
Body mass index	23.5 (4.3)	24.8 (3.7)	0.261
Semmes-Weinstein monofilament test	3.22 (0.39)	2.83 (0.78)	<0.001
Motor distal latency (ms)	3.8 (1.8)	3.2 (0.6)	<0.001
Sensory distal latency (ms)	3.5 (1.3)	2.7 (0.3)	<0.001
Latency difference of median-ulnar 4 <sup>th</sup> digit comparison (ms)	0.6 (1.2)	0.2 (0.2)	<0.001
CSA at the level of pisiform bone (mm <sup>2</sup> )	11.7 (3.3)	9.4 (1.9)	0.002

CSA, cross-sectional area of the median nerve.

Numbers represent mean (standard deviation) for age, body height, body weight, and body mass index. Numbers represent median (inter-quartile range) for other variables.

**Table 2.** Areas under the receiver operating characteristic curves of Semmes-Weinstein Monofilament Test, variables of nerve conduction study, and sonography.

Variables	Area under curve	95% confidence interval
Semmes-Weinstein monofilament test	0.852	0.75-0.953
Motor distal latency	0.822	0.712-0.932
Sensory distal latency	0.902	0.820-0.983
Latency difference of median-ulnar 4 <sup>th</sup> digit comparison	0.849	0.741-0.958
CSA at the level of pisiform bone	0.71	0.542-0.848

CSA, cross sectional area.

All *p* for each area under curve are <0.001, except *p*=0.011 for CSA at the level of pisiform bone.

**Table 3.** Diagnostic accuracies for carpal tunnel syndrome of Semmes-Weinstein Monofilament Test, nerve conduction study, and sonography

Test	Diagnostic Criterion	Sensitivity	Specificity	PPV	NPV	Accuracy
SWMT	> 2.83	82%	70%	82%	70%	77%
NCS	MDL > 4.1ms, or SDL > 3.5ms, or ΔMUD4 > 0.4ms	82%	85%	90%	74%	83%
PCSA	≥ 9.9mm <sup>2</sup>	67%	65%	76%	54%	66%

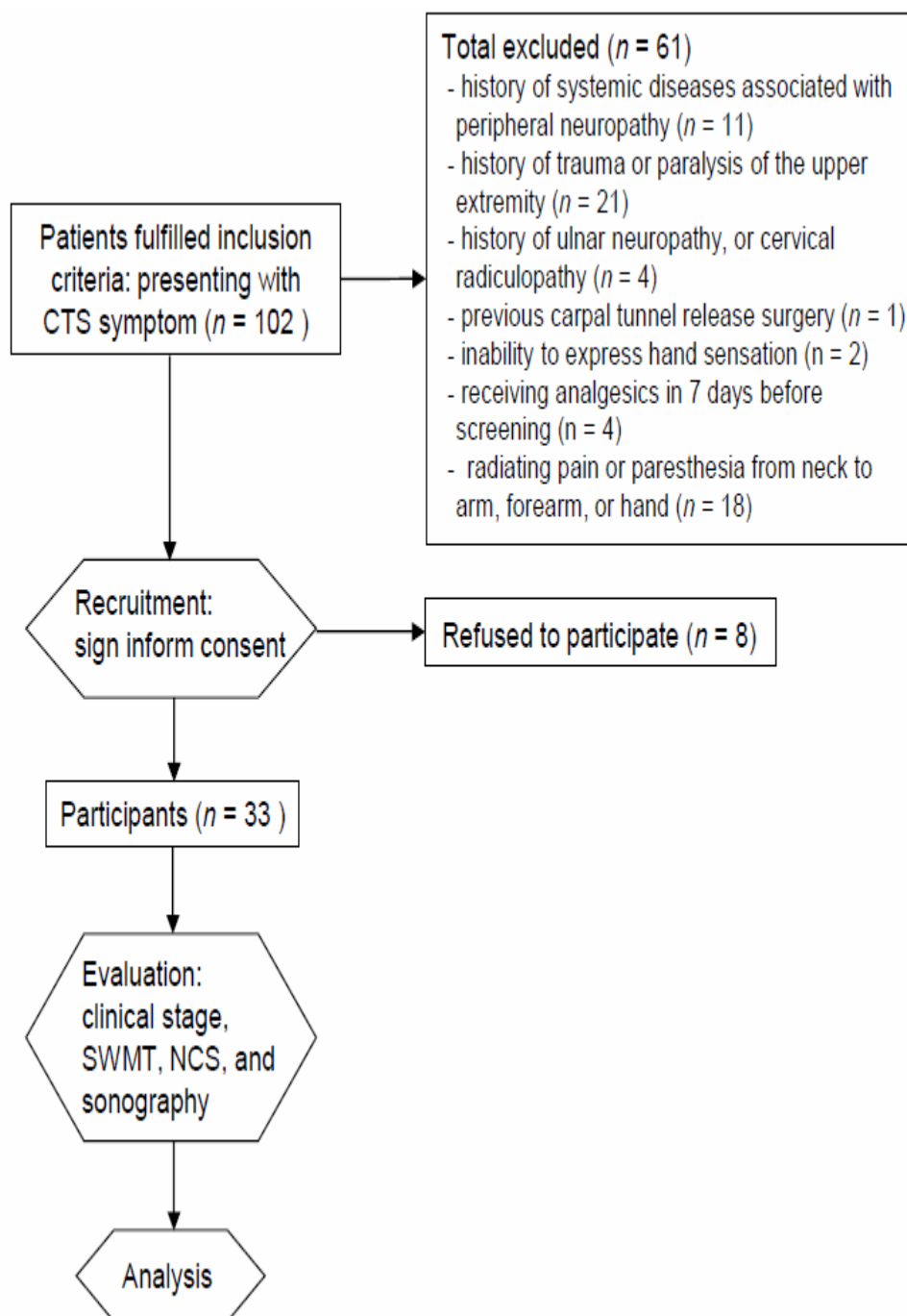
PPV, positive predictive value. NPV, negative predictive value. SWMT, Semmes-Weinstein monofilament test. NCS, nerve conduction study. MDL, motor distal latency of median nerve. SDL, sensory distal latency of median nerve. ΔMUD4, latency difference of median-ulnar 4<sup>th</sup> digit comparison. PCSA, crosssectional area of median nerve at the pisiform level.

**Table 4.** The correlation coefficients among clinical stage, Semmes-Weinstein Monofilament Test, variables of nerve conduction study, and sonography

	Clinical Stage	SWMT	MDL	SDL	ΔMUD4	PCSA
Clinical Stage	1					
SWMT	0.686	1				
MDL	0.606	0.539	1			
SDL	0.682	0.581	0.875	1		
ΔMUD4	0.661	0.556	0.707	0.804	1	
PCSA	0.445	0.381	0.468	0.542	0.501	1

SWMT, Semmes-Weinstein monofilament test. MDL, motor distal latency of median nerve. SDL, sensory distal latency of median nerve. ΔMUD4, latency difference of median-ulnar 4<sup>th</sup> digit comparison. PCSA, cross sectional area of median nerve at the level of pisiform bone.

All *p*<0.01.



**Figure.** Flow of participants. CTS, carpal tunnel syndrome. SWMT, Semmes-Weinstein monofilament test. NCS, nerve conduction study.

The area under the ROC curve (AUC) for SWMT was 0.852. The AUC of individual variables on NCS and US ranged from 0.71 to 0.902 (Table 2). All of these variables were discriminative for CTS. Furthermore, there was no significant difference in discriminative power between SWMT, NCS, and US variables, according to the

overlapped 95% confidence intervals of the AUCs. On the basis of the ROC curve of SWMT, the best cutoff was 2.83.

The sensitivities, specificities, PPV, NPV, and accuracy of SWMT, NCS, and US for diagnosis of CTS, based on symptoms and signs, are shown in Table 3.



When SWMT  $>2.83$  was classified as CTS, the sensitivity was 82%, with specificity 70%, and the PPV, NPV, and accuracy were 82%, 70%, and 77% respectively. If we diagnosed CTS when any of the three NCS criteria used in our practice were met, the sensitivity was 82%, with specificity 85%. The agreement (kappa) to discriminate CTS between SWMT and NCS was 0.571 ( $p < 0.001$ ). The kappas between SWMT and PCSA, as well as NCS and PCSA, were 0.305 and 0.427, respectively ( $p = 0.025$  and  $0.002$ ).

The correlations among clinical stage, SWMT, measures of NCS, and PCSA on US are shown in Table 4. SWMT correlated with clinical stage, measures of NCS, and US ( $r$  ranged from 0.381 to 0.581,  $p < 0.01$ ). Meanwhile, all the measures in NCS and PCSA on US correlated with clinical stage ( $r$  ranged from 0.445 to 0.682,  $p < 0.01$ ). In addition, NCS measures correlated with PCSA ( $r$  ranged from 0.468 to 0.542,  $p < 0.01$ ). Regression analysis was not undertaken due to a small sample size.

## DISCUSSION

In the present study, we found that SWMT has the ability to detect CTS as effectively as NCS and US, and has moderate agreement when compared with NCS. Moreover, SWMT correlates with clinical stage, NCS, and US measures. Some studies reported that SWMT is a good diagnostic tool for CTS,<sup>[7,8]</sup> but others did not.<sup>[16-18]</sup> The disagreement might be related to different methods when applying SWMT and the definition of CTS. Gellman et al. and MacDermid et al. reported sensitivities of 81-91% and specificities of 57-86%, by using a criterion of SWMT  $>2.83$  to confirm CTS.<sup>[7,8]</sup> However, in a study by Buch-Jaeger, only 61% of patients with a typical presentation of CTS have positive results on NCS; this is suggestive of milder severity, and reduces the detective feasibility of SWMT.<sup>[18]</sup> Pagel et al. used typical symptoms and abnormal cross-wrist nerve conduction as the gold standard to test the detective feasibility of SWMT, and concluded that SWMT is not a good single diagnostic tool for CTS.<sup>[16]</sup> Pagel's study showed high sensitivity, 98%, but low specificity, 15%, while defining a positive test as SWMT  $>2.83$  on any one of the three radial digits. However, there was low sensitivity, 13%, but high specificity, 88%, while defining a positive test as SWMT  $>2.83$

on the middle finger and SWMT  $\leq 2.83$  on the little finger.<sup>[16]</sup> In the current study, both the sensitivity and specificity of SWMT on the index finger were fairly good, and suggested that it is a useful diagnostic tool. A study by Amirfeyz defined SWMT  $>3.61$  as CTS.<sup>[17]</sup> Therefore, it is not surprising that our study shows different results, because we defined SWMT  $>2.83$  as CTS.

The sensitivity and specificity of PCSA on US were 67% and 65%, respectively, in this study, which are lower than the results in a meta-analysis.<sup>[5]</sup> This may be related to the definition of CTS in our study, with typical symptoms and signs. The definition of CTS in studies analyzed by Descatha is based on typical symptoms plus abnormal NCS.<sup>[5]</sup> On the other hand, there is fair to moderate agreement among SWMT, NCS, and US in our study. This may be due to the different nature of the three modalities: SWMT determines sensibility threshold, NCS calculates nerve conduction velocity, and US demonstrates nerve swelling.

Argument persists about the correlations among SWMT, clinical severity, NCS, and US. Gelberman et al. recruited healthy volunteers, and externally compressed the median nerve with gradually increasing pressure. They found that SWMT correlates well with sensory amplitude, paresthesia, and vibratory testing.<sup>[14]</sup> Braun et al. also reported that SWMT correlates with pain and hand volume change.<sup>[15]</sup> Conversely, other researchers reported no correlation between SWMT and clinical severity of CTS.<sup>[25]</sup> In addition, previous studies revealed no correlation between SWMT and NCS in patients with CTS.<sup>[17, 25]</sup> In the present study, significant correlations were found among SWMT, clinical stage, measures of NCS, and US. More levels of SWMT by using a 20-piece kit in this study might contribute to significant correlations, in contrast to studies by Elfar and Amirfeyz, in which a 5-piece SWMT kit was used. The 5-piece kit consists of 2.83, 3.61, 4.31, 4.56, and 6.65 monofilaments. However, only 3 hands in our series perceived monofilaments equal to or greater than 4.31. This suggested that the severity of our patients was different from those of Elfar and Amirfeyz.

There were several limitations in our study. First, we defined CTS by typical clinical presentation. As a result, we included more cases with milder severity than the studies in which CTS was defined by symptoms plus

NCS. In the present study, no hand had undetectable motor or sensory responses that suggested milder severity. Second, we excluded patients with conditions commonly confused with CTS, such as C6/7 radiculopathy, ulnar neuropathy, or polyneuropathy. This limits the use of SWMT to discriminate CTS from the aforementioned diseases. Comparing SWMT on the index and little fingers may help discriminate CTS from ulnar neuropathy or polyneuropathy, and deserves further study. Third, we recruited normal subjects as the control group, instead of patients sharing similar symptoms of CTS. This may increase spectrum bias and overestimate the diagnostic utility of the index test (SWMT). Fourth, this is a hospital-based study, and the relatively small sample size limits the generalizability of the results.

## CONCLUSION

SWMT has discriminative power similar to NCS and US for detection of CTS. SWMT also has moderate correlations with clinical stage, NCS measures, and PCSA on US. As a painless, convenient, and inexpensive modality, SWMT may have utility in support of the diagnosis of CTS, but further research is needed.

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# Semmes-Weinstein 氏單絲測試在偵知腕隧道症候群的使用途及與臨床分期、神經傳導檢查、及超音波之相關

王琳毅<sup>1,2</sup> 李俊瑩<sup>1</sup> 黃郁琦<sup>1,3</sup> 廖美雲<sup>1,3</sup> 楊宗勳<sup>1</sup> 辛宜蓉<sup>1</sup> 李炎諭<sup>1</sup>  
張瑞昆<sup>1,4</sup> 彭亞蘋<sup>1,3</sup>

高雄長庚紀念醫院復健科<sup>1</sup> 正修科技大學醫學工程學程<sup>2</sup>  
長庚大學醫學院<sup>3</sup> 高雄醫學大學職能治療學系<sup>4</sup>

**背景與目的：**神經傳導檢查(nerve conduction study, NCS)與超音波可支持腕隧道症候群(carpal tunnel syndrome, CTS)的診斷。Semmes-Weinstein 單絲測試(Semmes-Weinstein monofilament test、SWMT)，一種感覺閾值檢查，用於偵測 CTS、及與臨床嚴重度、NCS、與超音波的關係仍有爭議。為釐清爭議而進行研究。

**方法：**納入 33 位有典型 CTS 症狀與徵象的病人與 20 位正常人。我們執行食指的 SWMT、NCS、及以超音波量測正中神經在豆狀骨平面上的截面積(cross-sectional area of the median nerve at pisiform level, PCSA)。畫出 SWMT、NCS 變數、與 PCSA 的接收者操作特徵(receiver operating characteristic, ROC)曲線以分析辨別力。以 kappa 統計分析以 SWMT、NCS、及 PCSA 診斷 CTS 的一致性。並計算其敏感性、特异性、陽性預測率、陰性預測率、精確性，與其之間的相關係數。

**結果：**SWMT 與 PCSA 之 ROC 曲線下面積分別是 0.852 和 0.71。三種 NCS 變數之曲線下面積為 0.822 至 0.902。這些變數皆可辨別 CTS 且辨別力並無差別。SWMT 之敏感性、特异性、陽性預測率、陰性預測率、精確性分別為 82%、70%、82%、70%與 77%；且在偵測 CTS，與 NCS 有顯著的一致性(kappa = 0.575, p<0.001)。SWMT 與 PCSA 間、以及 NCS 與 PCSA 間的 kappa 分別為 0.305 及 0.427 (p=0.025 與 0.002)。SWMT 與臨床分期、NCS、和 PCSA 皆有顯著相關(r 0.381-0.581, p<0.01)。

**結論：**在偵測 CTS，SWMT 有與 NCS 及超音波相似的辨別力，與臨床分期、NCS、和超音波上 PCSA 皆有中度相關。SWMT 是方便無痛又便宜的檢查，可能在診斷 CTS 有其用途，需再研究。(台灣復健醫誌 2015；43(1)：9 - 18)

**關鍵詞：**Semmes-Weinstein 氏單絲測試(Semmes-Weinstein monofilament test)，腕隧道症候群(carpal tunnel syndrome)，神經傳導檢查(nerve conduction study)，超音波(sonography)，相關(correlation)。