

CUTOFF VALUE OF TWO-POINT DISCRIMINATION DISTANCES IN CARPAL TUNNEL SYNDROME

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Abstract

Background: Two-point discrimination test (2PD) represents large sensor fiber, which is more sensitive than smaller fiber to detect abnormality in carpal tunnel syndrome (CTS). Few studies have focused in 2PD to diagnose CTS.

Objective: The study aimed to establish the cutoff value of 2PD to determine CTS.

Methods: A descriptive diagnostic study was conducted at the Outpatient Department of Rehabilitation Medicine, Phramongkutklao Hospital. Participants who were suspected of having CTS were included in the study. All participants performed the 2PD test at the thumb, index finger and middle finger. The nerve conduction studies were performed and definitive diagnosis of CTS was based on the results. Data were analyzed using the receiver operation coefficient curve.

Results: Of 48 participants (total of 95 hands), CTS was diagnosed in 85 hands (89.5%). Additionally, of all CTS hands, severity was mild degree in 17 hands (28.4%), moderate degree in 31 hands (32.6%) and severe degree in 37 hands (39%). The optimum cutoff values were >4 mm having the sensitivities of 75.3, 68.2 and 68.2% while the specificities were 80, 90 and 90%, respectively, for the thumb, index finger and middle finger. The areas under curve were 0.826, 0.833 and 0.823, respectively.

Conclusion: The participants with more than 4 mm of 2PD at the thumb, index finger and middle finger had high probability of having CTS.

Keywords: Two-point discrimination test, Carpal tunnel syndrome, Sensory testing

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Introduction

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy. ^(1, 2) Classic clinical characteristics of CTS include numbness and tingling along the median sensory distribution and weakness or atrophy of the thenar muscle. Most patients reported nocturnal pain. Diagnosis of CTS involves a combination of several physical examinations and electrophysiological data obtained from nerve conduction study (NCS) of the median nerve. ⁽³⁻⁶⁾ NCS provides excellent validity and reliability and is accepted as the gold standard for diagnosing CTS. ⁽⁷⁻⁹⁾

Most patients report sensory symptoms in early stage of CTS⁽⁶⁾ Larger sensory fiber is more sensitive than smaller fiber to detect abnormality.⁽¹⁰⁾ Two-point discrimination (2PD) is the most widely-used and reliable test.^(11, 12) Despite many studies evaluating the validity and reliability of 2PD, the cutoff point to diagnose CTS using this pragmatic test remains unclear. ⁽¹³⁻¹⁸⁾ This study aimed to establish the cutoff value of the 2PD test to determine CTS.

Methods

Population

This study recruited Thai patients who were suspected of having CTS and were sent to the Rehabilitation Department, Phramongkutklo Hospital. Eligible patients aged 20 to 80 years having at least one of the following signs and symptoms were recruited in the study:⁽¹⁹⁾ 1) numbness or tingling of the hand(s) at rest, 2) numbness or tingling sensation of the hand(s)

during light activity, 3) flicking of the hand(s) that improves numbness or tingling or 4) weakness of the hand(s). Participants, receiving a diagnosis of peripheral neuropathy, experiencing altered consciousness, cervical radiculopathy or rheumatic diseases including bone fracture, steroid injection or hand(s) surgery, were excluded. Participants signed consent forms to participate in the study. The study protocol was approved by the Institutional Review Board of the *Royal Thai Army Medical Department* (IRBRTA 016/2560).

Sample size determination

The sample size was calculated based on the sensitivity and prevalence from the study of Ziswiler HR. et al, ⁽²⁰⁾ and MacDermid JC. et al. ^(16, 17) The sample size totaled 92 hands with suspected CTS to provide 5% type-I error and 10% type-II error.

Two-Point Discrimination

Basic characteristic data were obtained. Patients were asked to sit relaxed and place the affected hand on the bed. After closing their eyes, the Touch Test® Two-point discriminator (**Figure 1**) was used set perpendicular to the tip of the thumb, index and middle fingers. The examiner started with 2 mm and increased by 1 mm until patients discriminated 2 points and recorded the distance.⁽²¹⁾ An intraining physiatrist resident obtained all basic characteristic data and the 2PD test. The 2PD test was conducted before performing the nerve conduction study.

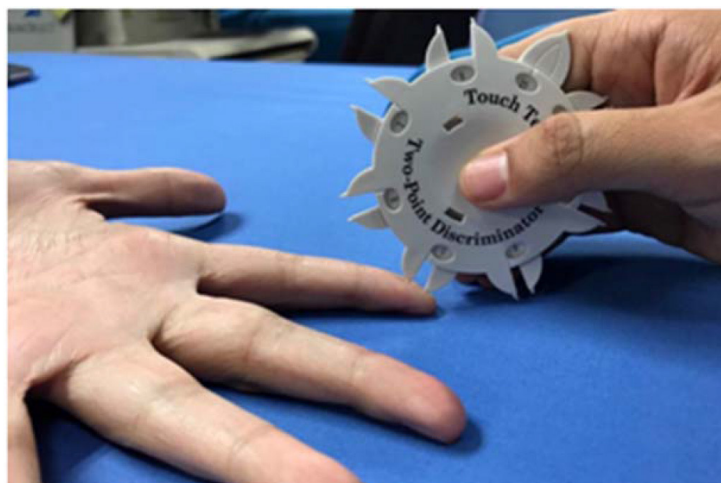


Figure 1. Touch Test® Two-point discriminator

Table 1. Electrodiagnosis classification of CTS

	no CTS	Mild CTS	Moderate CTS	Severe CTS
sensory latency	normal	prolonged	prolonged	prolonged or absent
sensory amplitude	normal	normal	normal	low or absent
motor latency	normal	normal	prolonged	prolonged or absent
motor amplitude	normal	normal	normal	low or absent

Table 2. Sensitivity, specificity, and predictive value of each cutoff value of the thumb

Criterion (mm)	Sensitivity	95% CI	Specificity	95% CI	PPV	NPV
Thumb						
>2	97.65	91.8 - 99.7	10	0.3 - 44.5	90.2	33
>3	89.41	80.8 - 95.0	30	6.7 - 65.2	91.6	25
>4	75.29	64.7 - 84.0	80	44.4 - 97.5	97	27
>5	55.29	44.1 - 66.1	100	69.2 - 100.0	100	20.8
>13	0	0.0 - 4.2	100	69.2 - 100.0		10.5
Index finger						
> 2	96.47	90.0 - 99.3	10	0.3 - 44.5	90.1	25
> 3	83.53	73.9 - 90.7	70	34.8 - 93.3	95.9	33
> 4	68.24	57.2 - 77.9	90	55.5 - 99.7	98.3	25
> 5	51.76	40.7 - 62.7	90	55.5 - 99.7	97.8	18
> 6	36.47	26.3 - 47.6	100	69.2 - 100.0	100.0	15.6
>13	0	0.0 - 4.2	100	69.2 - 100.0		10.5
Middle finger						
> 2	95.29	88.4 - 98.7	0	0.0 - 30.8	89	0
> 3	83.53	73.9 - 90.7	60	26.2 - 87.8	94.7	30
> 4	68.24	57.2 - 77.9	90	55.5 - 99.7	98.3	25
> 5	52.94	41.8 - 63.9	100	69.2 - 100.0	100.0	20
> 14	0	0.0 - 4.2	100	69.2 - 100.0		10.5

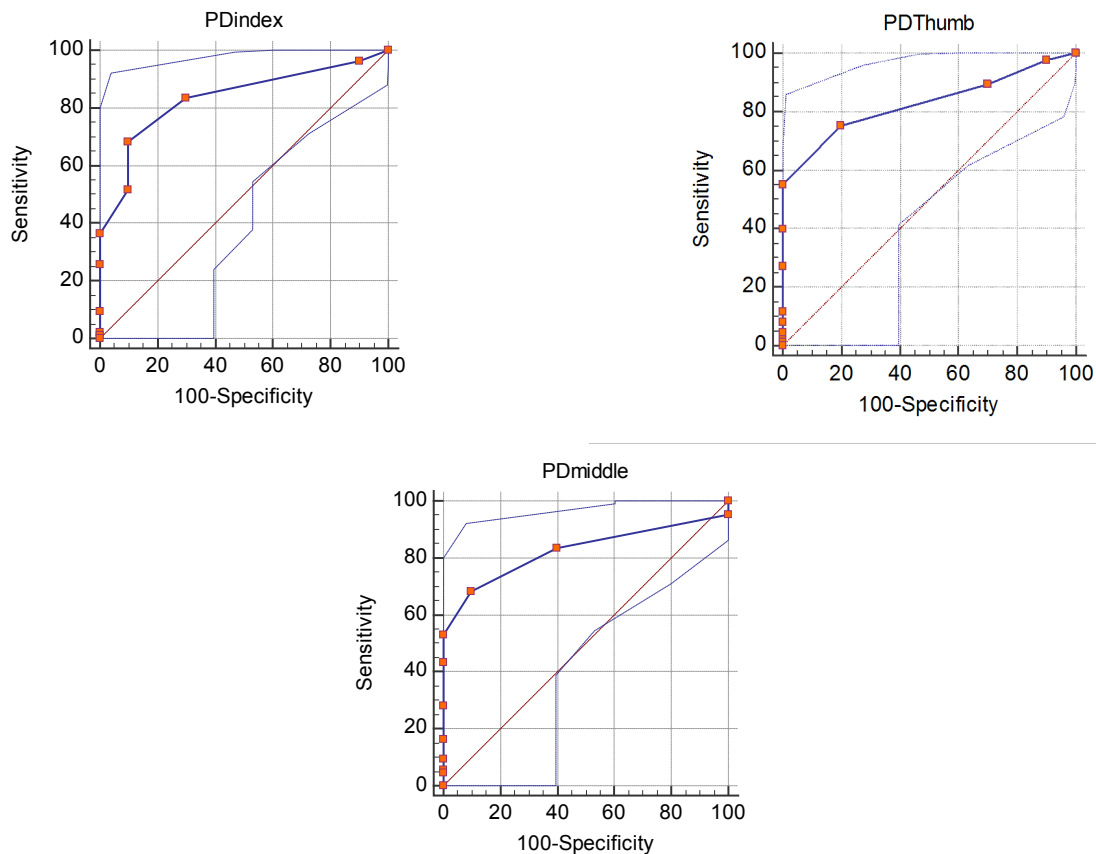


Figure 2. Receiver Operation Coefficient (ROC) curve of the 2PD test of each finger

Nerve conduction studies

A single physiatrist who was blinded to the 2PD results performed NCS on the same day of 2PD. A standard electrodiagnosis machine (Medelec Synergy T5EP model, Oxford Instruments, Oxfordshire, UK) was used. Sensory NCS was performed at the 14-cm antidromic sensory median and ulnar nerve^(22, 23) for peak latency and amplitude. Normal values for the median nerve were 3.6 ms and 10 μ V, respectively. Motor NCS was performed at 8-cm orthodromic median and ulnar nerve to determine distal motor latencies, amplitude and nerve conduction velocity. Normal values were 4.2 ms and 5 mV, respectively. The NCS results were classified in four groups: none, mild, moderate and severe CTS.⁽²⁴⁾

Statistical analysis

The overall diagnostic value of 2PD was evaluated by the area under the receiver operator characteristics (ROC) curve using MedCalc Statistic Software, Version 18.2.1. The data was analyzed for sensitivity, specificity, positive predictive value (PPV), and negative predictive

value (NPV) across a range of the 2PD from 2 mm in 1 mm incrementation. Spearman's rank correlation coefficient was used to assess the relationship between 2PD and CTS severity.

Results

The 2PD was positively correlated with severity of CTS with $r = 0.48$, $r = 0.51$, $r = 0.49$ in the thumb, index, and middle fingers, respectively. Of the 95 hands (48 participants), most were female (77.1%) with mean age of 57.8 ± 12.2 years. The number of patients presenting bilateral, left hand and right hand symptoms were 52.1, 29.9 and 25.0%, respectively. Diabetes Mellitus was noted in 16.7%, and CTS was diagnosed in 85 hands (89.47%). Of all 85 hands with CTS 28.4 (17 hands), 32.6 (31 hands) and 38.9% (37 hands) were documented as mild, moderate, and severe CTS, respectively. According to the ROC curve, a >4 mm 2PD could be used as the best cutoff value between the sensitivity and specificity for the thumb (75.3%, 80%), index (68.2%, 90%), and middle (68.2%, 90%) fingers. In addition, 4 mm cutoff value showed PPV 97 to 98.3% and NPV 25 to 27%. (**Table 2 and Figure 2**)

Discussion

The 2PD test and CTS severity exhibited moderate positive correlation. This result correlated with a related study by Elfar et al.⁽²²⁾ who reported $r = 0.48$. This is the first study to determine the cutoff value of 2PD in diagnosing CTS. However, the cutoff value in this prospective study differed from related studies^(18, 25). Elfar et al. evaluated 2PD in 40 CTS hands and reported a mean 2PD value of the middle finger as 6.07 mm. Diagnostic value and cutoff point from ROC were not reported in that study. However, race and nationality may have affected the 2PD test result. Regarding nerve injury of the upper extremity, Vorawanthanachai et al. recommended >4 mm to diagnose ulnar neuropathy at the elbow.⁽²⁶⁾ The cutoff value in this study was similar to that of Wolny et al.⁽²⁷⁾, reporting mean 2PD in the index and middle fingers as 4.75 ± 1.33 and 3.83 ± 0.85 , respectively.

The 2PD test has high sensitivity and specificity. Using 4 mm cutoff point provided the highest sensitivity (75.3%) in the thumb and the greatest specificity in the index and middle fingers (90%). These results resembled those of a study of other provocative tests in Thailand. Khanittanuphong reported the modified phalen test had a sensitivity of 70%, and the carpal compression test had a specificity of 85% to diagnose CTS.⁽²⁸⁾

The 2PD test could be used in addition to standard physical examination to diagnose CTS because this test did not provoke uncomfortable symptoms in patients. However, the 2PD test was unable to grade severity of CTS.

Interestingly, the 2PD at the index finger increased the sensitivity to 83.5% but the specificity reduced to 70% when the cutoff point changed to 3 mm. The sensitivity and specificity of 3 mm had more power to rule out CTS.

A review article published by Macdermid et al. reported low sensitivity (24%) and high specificity (95%) of the 2PD at the cutoff value of 5 mm.⁽²⁹⁾ The cutoff value was equal to the present study while the diagnostic values differed. However, among those published articles from 1984 to 1992, the gold standard of diagnosis and electrodiagnosis machine differed from that of the present.

In this study, 2PD and NCS were conducted on the same day. The physical examiner and electromyographer were blinded to each other's results. This study evaluated patients suspected

of having CTS with few nonCTS patients for comparison. Thus, selection bias also affected NPV and PPV in this study. Additionally, a lack of test-retest reliability and interpersonal reliability might have posed an important limitation. The force of testing 2PD by single examiner might have been unstable.

Conclusion

Patients with symptoms of CTS, having 2PD test result >4 mm of the first 3 digits had a high probability of CTS. The severity of CTS might not be determined by 2PD test.

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