

# An evaluation of sensitivity of provocative tests used in the carpal tunnel syndrome diagnosis depending on clinical severity of the syndrome

## Ocena czułości testów prowokacyjnych stosowanych w diagnostyce zespołu kanału nadgarstka w zależności od stopnia nasilenia dolegliwości

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### Key words

carpal tunnel syndrome, diagnosis, provocative tests, sensitivity

### Abstract

**Background:** Using popular provocative tests to diagnose the carpal tunnel syndrome (CTS) facilitates referring patients for specialist treatment and is indispensable to the performance of epidemiologic studies. Patients with severe carpal tunnel syndrome (CTS) are frequently referred for surgery, whereas people with mild CTS are commonly referred for conservative therapy. Finding out which provocative tests are most effective in diagnosing mild cases can aid clinicians in making decisions about further treatment.

**Objectives:** The purpose of this study was to evaluate the sensitivity of provocative tests used for diagnosis of CTS such as Phalen's, Durkan's and Tinel's sign and to find out if the time of paresthesia occurrence during the tests depended on the severity of the syndrome assessed using Levine's Questionnaire.

**Material and methods:** The study involved 130 women and 33 men with carpal tunnel syndrome confirmed by ENG. 52 patients had bilateral symptoms so a total number of cases examined was 215. Subjects were tested using four CTS provocative tests in random order: Phalen's, Durkan's, Provocative and Tinel's sign. The examiner waited 2 – 3 minutes between each provocative test to ensure that any nerve irritation caused by previous test had abated. Severity level of CTS was assessed using Levine's Questionnaire.

**Results:** Sensitivity values were: for Phalen's Test – 85.6%, Durkan's Test – 86.5%, Provocative Test 84.6%, and Tinel's sign – 46%. Sensitivity values for Phalen's, Durkan's and Provocative tests are higher than 93,1% for moderate, severe and extreme CTS. There is a relationship between testing positive on CTS provocative tests and severity of clinical symptoms. As the severity of CTS increases, the average time of paresthesia occurrence in median nerve distribution decreases.

**Conclusions:** (1) Tinel's sign should not be recommended as a CTS diagnostic tool because of its low sensitivity. (2) If Levine's Questionnaire reveals small progression of CTS the sensitivity of the tests is insufficient to confirm CTS. (3) In the case of patients with moderate, severe or extreme CTS according to Levine's Questionnaire, the diagnosis can be confirmed using valid provocative tests such as Phalen's, Durkan's and Provocative.

### Słowa kluczowe

zespół kanału nadgarstka, diagnostyka, testy prowokacyjne, czułość

### Streszczenie

**Wstęp:** Zastosowanie testów prowokacyjnych wykrywających zespół kanału nadgarstka (ZN) ułatwia podejmowanie decyzji o skierowaniu pacjenta na leczenie specjalistyczne i jest niezbędne dla prowadzenia badań epidemiologicznych. Pacjenci z nasilonym ZKN często kwalifikowani są do leczenia operacyjnego, podczas gdy osoby z łagodnymi objawami choroby kierowani są do leczenia zachowawczego. Sprawdzenie, które testy prowokacyjne są najbardziej skuteczne w rozpoznawaniu lekkiego ZKN może pomóc terapeutom w podejmowaniu decyzji o sposobie dalszego postępowania.

**Cel:** Ocena czułości testów: Phalena, Tinela, Durkana i Provocative oraz sprawdzenie czy czułość testów oraz czas pojawienia się parestezji w czasie ich wykonywania uzależniony jest od ciężkości choroby ocenianej z pomocą kwestionariusza według Levina.

**Materiał i metoda:** Zbadano 130 kobiet i 33 mężczyzn leczonych z powodu ZKN, który potwierdzony był badaniem ENG. U 52 chorych występujące objawy miały charakter obustronny, tak więc łączna ilość wszystkich zbadanych przypadków wyniosła 215. Wszystkim pacjentom wykonano w losowej kolejności 4 testy prowokacyjne: Phalena, Durkana, Provocative i Tinela. Pomiędzy

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The letters indicate the authors' contribution to the paper: A – research project; B – data collection; C – statistical analysis; D – data interpretation; E – work on the manuscript; F – literature search; G – funds procurement

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testami występowały 2 – 3 minutowe przerwy pozwalające na powrót nerwu do poprzedniego stanu. Do oceny ciężkości ZKN wykorzystano kwestionariusz według Levina.

**Wyniki:** Czulości testów wynosiły: Phalena – 85.6%, Durkana – 86.5%, Provocative – 84.6%, Tinela – 46%. Czulość testu Phalena, Durkana i Provocative osiąga wartość powyżej 93.1% dla umiarkowanego, ciężkiego i ekstremalnego ZKN. Istnieje związek pomiędzy uzyskiwaniem pozytywnych wyników testów prowokacyjnych a ciężkością objawów klinicznych. Wraz ze wzrostem ciężkości ZKN skraca się średni czas wystąpienia parestezji w obszarze unerwienia nerwu pośrodkowego.

**Wnioski:** (1) Test Tinela nie powinien być rekomendowany jako narzędzie diagnostyczne ZN, ponieważ charakteryzują go niska czulość. (2) Jeżeli kwestionariusz według Levina wskazuje na małe zaawansowanie choroby, to czulość testów prowokacyjnych jest niewystarczająca do potwierdzenia ZN. (3) W przypadku pacjentów, u których stopień nasilenia objawów oceniany za pomocą kwestionariusza Levina wskazuje na umiarkowane, ciężkie lub ekstremalne nasilenie choroby, to rozpoznanie można potwierdzić za pomocą wartościowych testów prowokacyjnych, a za takie można uznać test Phalena, Durkana i Provocative.

## Introduction

Diagnosis of upper limb compression neuropathies still remains controversial despite such an obvious clinical picture. In 1998, an interdisciplinary team of clinicians headed by Rempel stated that no clinical symptom or ancillary examination is sensitive or specific enough to confirm the diagnosis. The authors used the term constellation of symptoms to highlight the complex nature of CTS<sup>1</sup>.

Incorrect diagnosis is one of the most common causes of CTS treatment failure. According to the latest reports, the diagnosis should be based both on clinical symptoms and electrodiagnostic tests<sup>2</sup>. Diagnostic tests are generally required to confirm the diagnosis, choose appropriate treatment and determine CTS cause and etiology. Their greatest advantage is facility of administration<sup>2,3,4</sup>. Finding out which provocative tests are the most appropriate for diagnosing mild or severe CTS can help therapists to make correct diagnosis and choose proper treatment procedure<sup>5</sup>.

The purpose of this study was to evaluate the sensitivity of provocative tests used for diagnosis of CTS such as Phalen's, Tinel's sign, Durkan's and Provocative and to find out if the time of paresthesia occurrence during the tests depended on the severity of the syndrome assessed using Levine's Questionnaire.

## Material and methods

The study involved 163 patients: 130 females and 33 males treated for CTS at the outpatient department and

Department of Neurosurgery of St Luke's Hospital in Tarnow between December 2006 and December 2008. 52 patients had bilateral symptoms so the hands examined totalled 215. The patients' age ranged between 25 to 81 years, mean age was 54.74 years. The criterion for inclusion in the study was CTS confirmed by an ENG examination (considered a gold standard) performed as a first diagnostic test outside the provocative tests evaluation centre.

Subsequently, the following provocative tests were administered:

- 1) Phalen's test: the patient placed the elbow on the table holding the forearm in vertical position while the weight of the hand made the wrist flex and stay fully flexed for one minute<sup>6</sup>;
- 2) Durkan's test: the patient bent the tested limb at the elbow at an angle of 0-30°, with the forearm in supination and the wrist and hand in the neutral position; the therapist placed the thumbs on the proximal bend line of the wrist (above proximal edge of the transverse carpal ligament) over the median nerve and pressed evenly for 60 seconds<sup>6</sup>;
- 3) Provocative test: the patient's forearm was pronated; the wrist was in the neutral position or slightly extended; the tested limb was relaxed; the therapist placed 'partially bent' 2nd and 3rd fingers of one hand on the patient's palm on the distal half of the first metacarpal; the index and middle fingers of the therapist's other hand were placed on the pisotriquetral complex while one thumb was placed on the other and pressed the dorsal

part of the hand in the lunate area (it is in line with the middle finger); the therapist pressed dorsally with the second and third fingers (of both hands) while exerting volar pressure on the lunate with the thumbs (He 'tried to open the carpal tunnel or extend transverse carpal ligament'); the constant even pressure lasted 60 seconds<sup>6,7</sup>;

4) Tinel's sign: the elbow joint of the tested limb was flexed at an angle of 0-30°, forearm in supination, the patient's wrist in the neutral position; the examiner tapped gently the carpal tunnel area with the tip of the index or middle fingers along the course of the median nerve between the flexor carpi radialis tendon and the long palmar muscle in the carpal fold area<sup>6</sup>.

The results of Phalen's, Durkan's and Provocative tests were considered positive when there occurred paresthesia in the median nerve area or when it worsened (in patients suffering from constant numbness). Tinel's sign test was considered positive when there occurred tingling (or electric shock) in one or more fingers innervated by the median nerve.

During provocative tests administration, the time of paresthesia occurrence in the tested limbs was also monitored. The patient was asked to watch for discomforts every ten seconds.

According to the method suggested by Prignac and Henry<sup>5</sup> the tests were administered in random order for all the patients. The therapist waited for 2-3 minutes between each test to ensure that any median nerve irritation caused by previous test had abated.

Following provocative tests administration, the therapist and the patient filled in Levine's questionnaire (Boston Carpal Tunnel Questionnaire – BCTQ). On the basis of the mean value of Symptom Severity Scale (SSS) and the whole questionnaire – Symptom Severity Scale + Functional Status Scale (SSS+FSS) the patients were categorized by CTS severity as shown in Table 1.

Only one patient failed to fill in the questionnaire because he found the questions incomprehensible. Therefore the number of the analyzed cases was 214.

The questionnaire refers to the most common symptoms and disorders typical of CTS patients and makes possible an evaluation of the symptoms severity and functional status of the hand on a 5-grade scale. The tested patient fills in two parts of the form:

- Symptom Severity Scale (SSS) – comprising 11 questions with 5 possible answers each, scoring from 1 to 5<sup>5,8</sup>,
- Functional Status Scale (FSS) – listing 8 simple daily activities and asking the patient to choose the number that best describes their ability to do a particular activity starting with no difficulty (1 point score) through total inability (5 point score)<sup>5,8</sup>.

The questionnaire is a reliable and valid diagnostic tool. It is highly reproducible, sensitive with regard to identifying changes and internally coherent. Higher SSS and FSS scores are correlated with greater damage to the median nerve.

90% of the patients needed less than 10 minutes to fill in the questionnaire<sup>5,8,9,10,11,12</sup>.

**Results**

The results presented in Table 2 demonstrate high sensitivity of Phalen's, Durkan's and Provocative tests. The tests can be recommended as diagnostic tools. Tinel's sign, on the other hand, proved disappointing since its sensitivity was a mere 46%.

Table 3 shows provocative tests sensitivity to increase as CTS severity increases. Tinel's sign has the lowest values and its sensitivity ranges between 37.0 and 66.7 %. The

**Table 1**

CTS severity based on average Symptom Severity Scale result and Levine's Questionnaire (SSS + FSS) – the author's findings		
Impairment degree	Average value on SSS	Average value SSS + FSS
5 extreme	4.51 – 5.0	4.51 – 5.0
4 severe	4.01 – 4.5	4.01 – 4.5
3 moderate	3.01 – 4.0	3.01 – 4.0
2 mild	2.01 – 3.0	2.01 – 3.0
1 slight	1 – 2.0	1 – 2.0

**Table 2**

Test sensitivity values and average time of paresthesia occurrence in 215 cases of CTS						
Test sensitivity [%]				Average time of symptom occurrence during positive tests [s] (mean, standard deviation)		
Phalen's	Durkan's	Provocative	Tinel's sign	Phalen's	Durkan's	Provocative
85,6	86,5	84,6	46	24,4 ±12.96	22,6 ±11.83	23,8 ±11.92

values are too low for the test to be recommended as a sensitive and reliable diagnostic tool regardless of symptoms severity. The results obtained using Phalen's Durkan's and Provocative tests are similar. The lowest sensitivity values of provocative tests are characteristic of slight CTS: Phalen's test – 63%, Durkan's 66.7% and Provocative – 59.3%. Results characterizing sensitivity for mild CTS show slightly higher values: Phalen's – 78.7%, Durkan's – 82%, Provocative – 80%. Test sensitivities typical of moderate, severe and extreme CTS show the highest values in the following ranges: Phalen's - above 97.3% , Durkan's – above 93.1% and provocative - above 92%. The results allow the three tests to be considered very sensitive tools in diagnosing, moderate, severe and extreme CTS.

As CTS severity increases it takes less time for paresthesias to occur during test administration.. In slight CTS they occur after 40 seconds, 30 seconds and 36 seconds of Phalen's, Durkan's and provocative tests respectively. In mild, moderate, severe and extreme CTS, mean time of paresthesias occurrence was 26-27.1 seconds, 20.3-21.5, seconds 17.5-

20.4 seconds and 12.2-13.3 seconds, respectively.

The results presented in Table 4, like the ones in Table 3, show the provocative tests sensitivity to grow as CTS severity increases. Tinel's sign test has the lowest values and its sensitivity ranges between 36.4 and 100% for extreme CTS. The results of Phalen's, Durkan's and Provocative tests are similar. The lowest sensitivity values of provocative tests are characteristic of slight CTS: Phalen's– 60.6%, Durkan's- 69.7 and Provocative – 60.6%. Sensitivity results characteristic of mild CTS have higher value – 83,5%. Test sensitivity results characteristic of moderate, severe and extreme CTS fall within the range of over 93%: Phalen's – 96% ,Durkan's – 93.4% ,Provocative – 93.7%.

As CTS severity increases it takes less time for paresthesias to occur during test administration. In slight CTS they occur after 41 seconds, 30 seconds and 35,5 seconds of Phalen's , Durkan's and Provocative tests, respectively. In mild, moderate, severe and extreme CTS, mean time of paresthesias occurrence was 25.5-26.0 seconds,18.9-21.2 seconds,17.5-18.7 seconds and 10.0-12.5 seconds, respectively.

**Table 3****Results of provocative tests sensitivity evaluation and average time of paresthesia occurrence in relation to SSS-based CTS severity**

CTS severity	No of cases	Test sensitivity [%]				Average time of symptoms occurrence during positive tests [s] (mean, standard deviation)		
		Phalen's	Durkan's	Provocative	Tinel's sign	Phalen's	Durkan's	Provocative
slight	27	63	66.7	59.3	37	40 ±13.7	30 ±9.7	36.2 ±12.6
mild	80	78.7	82.5	80	36.2	27.1 ±13.1	26 ±11.9	26.7 ±11.7
moderate	73	97.3	93.1	97.3	52	21.5 ±10.2	20.3 ±11.8	21.3 ±10.2
severe	25	100	96	92	64	20.4 ±11.3	17.5 ±8.5	19.1 ±10.4
extreme	9	100	100	100	66.7	12.2 ±4.4	13.3 ±7.1	13.3 ±5

**Table 4****Provocative tests sensitivity values and average time of paresthesia occurrence in relation to Levine's Questionnaire-based CTS severity (SSS + FSS)**

CTS severity	No of cases	Test sensitivity [%]				Average time of symptoms occurrence during positive tests [s] (mean, standard deviation)		
		Phalen's	Durkan's	Provocative	Tinel's sign	Phalen's	Durkan's	Provocative
slight	33	60.6	69.7	60.6	36.4	41 ±12.1	30 ±9	35.5 ±11.9
mild	85	83.5	83.5	83.5	38.8	25.5 ±12.5	25.5 ±12.3	26 ±11.8
moderate	76	96	93.4	94.7	56.6	21.2 ±10.9	18.9 ±11	20.3 ±10
severe	16	100	100	93.7	43.7	17.5 ±5.8	18.1 ±9.1	18.7 ±11.2
extreme	4	100	100	100	100	10 ±0	12.5 ±5	12.5 ±5

**Discussion**

A look at the results obtained allows Phalen's, Durkan's and Provocative tests to be recommended as valuable diagnostic tools because of the sufficiently high sensitivity values. Similar results are reported by the majority of authors dealing with CTS diagnosis<sup>6</sup>. Tinel's sign test with its sensitivity value of 43% performs poorly. The result is not good enough for the test to be treated as sufficiently sensitive. The results reported by other authors also suggest that Tinel's sign sensitivity is decisively lower than that of the other three provocative tests<sup>6</sup>.

Mean sensitivity values of provocative tests reported by MacDermid et al<sup>13</sup> show Tinel's sign test to have lower values (50% - 2640 CTS cases assessed) in comparison with Phalen's (68% - 3218 CTS cases assessed) and Durkan's (64% - 1985 CTS cases assessed).

Different sensitivity of provocative tests may be due to different technique of the test administration<sup>14</sup>, the examiner's experience and different criteria for regarding the test as positive – eg. we regarded Tinel's sign test as positive when there occurred 'electric shock' in one or several fingers innervated by the median nerve. Some authors<sup>9</sup> consider the test positive when there occurs discomfort or pain in the wrist (below the flexor retinaculum) or when the pain radiates distally along the course of the nerve. The low sensitivity values of Tinel's sign test can also result from the fact that in our test the median nerve was tapped using the index or middle fingers and not a reflex hammer. Our action might have been too delicate.

Incorrect diagnosis is one of the most common reasons for CTS treatment failure. According to the latest reports, the diagnosis should be based on both the clinical symptoms and

electrodiagnostic tests<sup>2</sup>. According to the guidelines of the American Association of Electrodiagnostic Medicine a clinical diagnosis of CTS can only be confirmed by a complete electrophysiological examination<sup>15</sup>. However, it is necessary to remember that an electrophysiological examination is not entirely free from errors and CTS should be confirmed also by other diagnostic methods especially when operative treatment is considered<sup>16,17</sup>.

Our results demonstrate the sensitivity of provocative tests (Phalen's, Durkan's and Provocative) to be insufficient in the case of patients with ENG-confirmed CTS which is slight or mild as assessed by Levine's questionnaire (1-3). For such patients, conservative treatment should be considered in the first place because the ENG test can be false positive.

In the case of patients with ENG-confirmed CTS which is moderate,

severe or extreme according to Levine's questionnaire (3,01-5), CTS should absolutely be confirmed by means of valid provocative tests such as Phalen's, Durkan's and Provocative. It seems that people with moderate or higher symptoms progression who test positive on provocative tests and have an ENG-confirmed diagnosis of CTS should be considered for operative treatment.

The results reported by Kaul et al<sup>18</sup> show Durkan's test sensitivity to remain stable as CTS severity assessed on the basis of Katz–Stirrat Hand Diagram grows and to be: possible – 32%, probable – 29%, classic – 38%.

Dakowicz et al.<sup>19</sup> report Tinel's sign test sensitivity to increase as CTS symptoms severity increases (according to Withley and Mc Donel). Phalen's test sensitivity was a constant 100% regardless of symptoms severity (Table 5). The obvious drawback of the study described is a small number of CTS patients in particular groups (subsequently): 10 – slight, 16 – moderate, 4 – severe.

Of the three provocative tests evaluated, only Phalen's test sensitivity was confirmed by Prignac et al<sup>5</sup> (Table 6) to increase with an increase in CTS symptoms severity assessed by means of an ENG examination. Durkan's test sensitivity does not increase when the severity of the disease increases. There is a slight increase in the sensitivity of Tinel's sign test as CTS severity increases but the values are too low for the test to be recommended to therapists as a diagnostic tool.

Our results show the sensitivity of Phalen's, Durkan's and Provocative tests to be over 93.1% for moderate, severe and extreme CTS. The values are similar regardless of the patients' division into groups by CTS severity assessed using only the SSS part of Levine's questionnaire or its whole (SSS+FSS). Therefore asking patients to fill in only the symptom part of the questionnaire can save time without affecting the reliability of the results.

### Conclusions

1. If Levine's Questionnaire reveals small progression of CTS the sensitivity of provocative tests is insufficient to confirm CTS .

**Table 5**

**Sensitivity values of Phalen's and Tinel's sign tests in relation to CTS severity (acc.to Withley and Mc Donel) – based on the results by Dakowicz et al.<sup>19</sup>**

Test	CTS severity		
	mild	moderate	severe
Phalen's	100%	100%	100%
Tinel's sign	20%	87%	100%

**Table 6**

**Provocative tests sensitivity values in relation to ENG-based CTS severity according to Prignac et al.<sup>5</sup>**

CTS severity	Number of cases	Sensitivity [%]		
		Phalen;s test	Durkan's test	Tinel's sign test
Mild	55	65	60	18
moderate	23	78	74	30
Severe	17	88	65	35

2. In the case of patients with moderate, severe or extreme CTS according to Levine's Questionnaire, the diagnosis should be confirmed using valid provocative tests such as Phalen's, Durkan's and Provocative.

3. Tinel's sign test is not recommended as a CTS diagnostic tool because of its low sensitivity.

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