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Phalen's test. Classic or modern?

Irakli B. Goginava¹, Sergey A. Goloborod'ko¹, Mariia V. Riezuneneko², Giorgi L. Giorgidze³

¹ Department of Pelvic Fractures Surgery, West Georgia Medical Center, Kutaisi, Georgia

² Department of Traumatology and Orthopedics, West Georgia Medical Center, Kutaisi, Georgia

³ Department of Neurology, West Georgia Medical Center, Kutaisi, Georgia

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Address for correspondence:

Irakli Borisovich Goginava,
Department of Pelvic Fractures
Surgery, West Georgia Medical
Center, Javakishvili str., 83a,
Kutaisi, 4600, Georgia, e-mail:
igoginava@evex.ge

Objective: to compare the sensitivity and specificity of the classic and modified Phalen test and to give recommendations on the expediency of using the tests in the diagnosis of carpal tunnel syndrome (CTS).

Materials and methods. The experimental group included 21 women (15 right and 14 left hands) with signs of idiopathic carpal tunnel syndrome. The control group also included 21 women (15 right and 14 left hands) without characteristic clinical manifestations of carpal tunnel syndrome. The mean age of the participants in both groups averaged 52 years.

Twenty-one women in the experimental and, respectively, in the control groups were randomized to perform both the classical and modified Phalen tests on 29 hands. In the classic Phalen test, the subject places her flexed elbows on the table so that the forearms are in a vertical position. The hands under the action of gravity are flexed as far as possible, the fingers remain in extension. When performing the modified Phalen test, the subject is asked to connect the dorsal surfaces of both hands, relax the upper limbs and, while maintaining this relaxed state, lower the elbows below the horizontal line.

Results. The sensitivity of the classic Phalen test was 93%, and that of the modified test was 96%. The specificity of the classical Phalen test was 96%, modified - 93%. The positive predictive value (PPV) of the classic Phalen test was 96%, the negative predictive value (NPV) was 93%. The PPV and NPV of the modified test were 93% and 96%, respectively.

Conclusion. The sensitivity of the classic Phalen test (93%) was slightly lower than the sensitivity of the modified test (96%), and the specificity of the classic test (96%) was higher than that of the modified test (93%). Due to high specificity and sensitivity, both tests have significant diagnostic value and can be successfully used in the diagnosis of carpal tunnel syndrome.

Keywords: carpal tunnel syndrome; classic Phalen test; modified Phalen test; sensitivity; specificity

Introduction

Carpal tunnel syndrome (CTS, G56.0) is a fairly common condition, affecting between 5-16% of the general population [1]. It is a mononeuropathy of the median nerve caused by compression of the nerve in the carpal tunnel. The primary pathophysiological mechanism of this condition is an increase of carpal tunnel pressure, leading to a disruption in the function and structure of the median nerve. The diagnosis of CTS is based on medical history and clinical examination. Electrodiagnostic and ultrasound examination are not absolutely necessary in routine cases of CTS. Instead of these instrumental examinations, only the clinical manifestations and clinical assessment tools, such as the CTS-6 diagnostic scale [2], can be used to diagnose the disease with a high degree of reliability. Electrodiagnostic studies (EDS), ultrasound, or MRI should only be performed in unclear cases and for differential diagnosis. Various provocation tests are widely used in clinical research [3]. The most well-known and popular provocation test due to its high sensitivity and specificity is the Phalen test [4, 5]. In the CTS-6

diagnostic scale, which is quite authoritative among specialists, the Phalen test has the highest diagnostic score among the six clinical diagnostic signs of CTS [6].

Scientific literature describes the use of both the classic Phalen test and its modifications [4]. The most recognized, clear, and memorable modification of the classic Phalen test involves the subject joining the back surfaces of both hands and applying pressure to create maximum flexion at the wrist joints [3, 4, 7]. The modified Phalen test differs from the classic version in its mechanism of execution. Therefore, the diagnostic value of the modified test may differ from that of the classic one. This raises the question of the appropriateness of using the modified test for the diagnosis of CTS. A review of the available literature revealed no studies directly comparing the diagnostic value of the classic and modified Phalen tests.

Objective: to compare the sensitivity and specificity of the classic and modified Phalen tests and to provide recommendations on the advisability of using these tests in the diagnosis of carpal tunnel syndrome.

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Materials and methods

Experimental group

The experimental group consisted of 21 women aged between 39 to 73 years (mean age 52.5 years) (**Table 1**).

All of these women had clear clinical signs of idiopathic carpal tunnel syndrome in 29 hands (15 right and 14 left) including numbness or paresthesia in the median nerve innervation area, pain, especially at night, positive tests of Phalen (reverse), Tanzer's, the "tourniquet test", Hoffmann-Tinel, Goloborod'ko, Jungo, etc. Sixteen women underwent surgical treatment on 18 hands: 13 median nerve transpositions [8] and 5 retinaculotomies [9]. After surgery, all patients either completely lost their signs of CTS or their condition

improved over time, thereby confirming the presence of CTS in this group of patients. In five women (patients 10-14 in Table 1), the clinical diagnosis was confirmed by EDS data.

Patients presenting with signs of polyneuropathy, diabetes mellitus, hypothyroidism, cervical radiculopathy, other numerous neurological diseases, wrist contractures, or acute hand injuries were excluded from the experimental group.

Control group

The control group comprised 21 women aged 37 to 73 (average age 52.2). As in the experimental group, the study was conducted on 29 hands (15 right and 14 left) (**Table 2**).

Table 1. Phalen tests results in the experimental group

No	Gender/ Age (yr)	Hand	Classic Phalen test/ Time of response (in seconds)	Modified Phalen test / Time of response (in seconds)	Operation
1	F/51	Right	+/4	+/5	retinaculotomy
2	F/59	Left	+/21	-	retinaculotomy
3	F/51	Left	+/50	+/33	median nerve transposition
4	F/51	Left	+/7	+/13	median nerve transposition
5	F/61	Right	+/9	+/21	median nerve transposition
6	F/55	Left	+/10	+/12	median nerve transposition
7	F/65	Right	+/10	+/9	median nerve transposition
8	F/41	Right	+/8	+/11	median nerve transposition
9	F/53	Left	+/11	+/26	median nerve transposition
10	F/40	Right	-	+/56	—
11	F/39	Left	+/34	+/19	—
12	F/44	Right	+/11	+/22	—
13	F/52	Right	+/37	+/32	—
14	F/73	Right Left	- +/39	+/28 +/28	— —
15	F/50	Right Left	+/25 +/25	+/32 +/17	median nerve transposition —
16	F/41	Right Left	+/12 +/14	+/10 +/11	median nerve transposition median nerve transposition
17	F/54	Right Left	+/12 +/16	+/21 +/17	median nerve transposition —
18	F/64	Right Left	+/20 +/20	+/21 +/21	retinaculotomy retinaculotomy
19	F/47	Right Left	+/11 +/11	+/7 +/12	median nerve transposition —
20	F/60	Right Left	+/20 +/20	+/21 +/21	retinaculotomy —
21	F/51	Right Left	+/11 +/18	+/10 +/19	median nerve transposition —

Notes. F = female; + = positive provocative test; - = negative provocative test.

This article contains some figures that are displayed in color online but in black and white in the print edition.

Table 2. Phalen tests results in the control group

№	Gender/Age (yr)	Hand	Classic Phalen test/ Time of response (in seconds)	Modified Phalen test / Time of response (in seconds)
1	F/51	Right	+/30	—
2	F/59	Left	—	—
3	F/51	Left	—	—
4	F/51	Left	—	—
5	F/61	Right	—	—
6	F/57	Left	—	—
7	F/63	Right	—	—
8	F/41	Right	—	—
9	F/53	Left	—	—
10	F/40	Right	—	—
11	F/39	Left	—	—
12	F/43	Right	—	—
13	F/52	Right	—	—
14	F/73	Right Left	— —	— —
15	F/50	Right Left	— —	— —
16	F/37	Right Left	— —	+/47 —
17	F/54	Right Left	— —	— —
18	F/64	Right Left	— —	— —
19	F/47	Right Left	— —	— —
20	F/59	Right Left	— —	+/49 —
21	F/51	Right Left	— —	— —

Notes. F = female; + = positive provocative test; - = negative provocative test.

The participants in the control group were recruited from among visitors to outpatient trauma and neurology clinics. None of them had a history of clinical manifestations of CTS. This group also excluded individuals with signs of polyneuropathy, diabetes mellitus, hypothyroidism, cervical radiculopathy, other numerous neurological diseases with a clinical picture similar to CTS, as well as those with wrist joint contractures, or acute hand injuries.

All participants in both the experimental and control groups signed a voluntary informed consent form for clinical and EDS examination and, in indicated cases, for surgery. The participants were not familiar with the purpose of the study, the presumptive diagnosis, or the test techniques.

Twenty-one women in the experimental and control groups, respectively, underwent both classic

and modified Phalen tests on 29 hands (15 right and 14 left) in a randomized order. A time interval of 2-3 minutes was observed between tests. The procedures were performed and evaluated by certified orthopedic traumatologists and a neurologist.

The technique for performing the classic Phalen test was as follows. The subject was asked to place their flexed elbow joints on the table so that their forearms were in a vertical position. Under the influence of gravity, the hands were flexed maximally, with the fingers remaining extended (**Fig. 1**). This position was maintained for 1 minute. If signs of median nerve compression (numbness, paresthesia, pain in all 3.5 radial fingers or in some of them) appear during this time, the test was considered positive. In the absence of any clinical manifestations of CTS, the test was considered negative [10].

The modified test is performed as follows. The subject is asked to join the back surfaces of both hands, relax the upper limbs, and, in this relaxed state, lower the elbow joints below the horizontal line [7]. This technique of lowering the elbow joints actively increases the angle of flexion in the wrist joints. The fingers should be extended during the test (**Fig. 2**). If the characteristic signs of CTS are reproduced within one minute, the test is considered positive. If these symptoms are not present, the result is considered negative.

In patients in the experimental group with positive classic and modified Phalen tests, the time during which CTS symptoms appeared while performing these tests was recorded.

Results

The results of the tests in the experimental and control groups are presented in Tables 1 and 2. In the experimental group, a negative classic Phalen provocation test was observed in two patients on both right hands. Moreover, in one patient, the test was negative on the right hand and positive on the left hand. It should also be noted that a negative response was observed in patients who did not undergo surgery. In all other 19 patients on 27 hands, the classic Phalen test was positive. In the same experimental group, the modified Phalen test was negative in one patient on the left hand. In all other 20 subjects (28 hands), the test was positive. In the control group, one participant exhibited



Fig. 1. Classic Phalen test



Fig. 2. Modified Phalen test

a positive classic Phalen test on the right hand. On all other 28 hands, it was negative. The modified Phalen test was positive on two right hands in two participants, while in the remaining 27 hands, the test was negative. The sensitivity, specificity, and positive and negative predictive value results were determined using the generally accepted method [11].

The sensitivity of the classic Phalen test was 93%, and that of the modified test was 96%. The specificity of the classic Phalen test was 96%, and that of the modified test was 93%. The PPV of the classic Phalen test was 96%, and the negative predictive value was 93%. The PPV of the modified Phalen test was 93%, and the negative predictive value was 96%.

The time to a positive response to the classic Phalen test on 27 hands in 19 patients ranged from 4 to 50 seconds (average 18 seconds). The time to a positive response to the modified Phalen test on 28 hands in 20 patients ranged from 5 to 56 seconds (average 20 seconds).

Discussion

CTS is a compression-ischemic neuropathy of the median nerve. The median nerve is compressed due to increased carpal tunnel pressure. The diagnosis of CTS is based on medical history and clinical signs of pathology. Instrumental examination methods (EDS, ultrasound, MRI) serve as supplementary tools, used mainly for differential diagnosis. In clinical examination, great importance is attached to the use of various provocation tests. One of the most well-known and popular tests is the Phalen test [5].

According to a recent meta-analysis, the sensitivity of the Phalen test is 70% and its specificity is 80% [12]. Therefore, in the modern CTS-6 diagnostic scoring scale, the Phalen test is assigned the highest diagnostic value score of 5 points.

In the 1950s, American hand surgeon Phalen GS published scientific papers on the diagnosis and treatment of carpal tunnel syndrome [13]. These scientific papers described a new diagnostic provocative test, known as the wrist flexion test. The essence of the test was that when the wrist was flexed for 60 seconds, patients with CTS experienced numbness, paresthesia, or pain in all or some of the 3.5 radial fingers, i.e., the clinical picture of carpal tunnel syndrome was reproduced. Phalen explained the mechanism of the test by the fact that when the wrist was flexed, the median nerve was bent over the flexor retinaculum and subjected to compression from the proximal edge of the flexor retinaculum on the palmar surface and from the flexor tendons of the fingers on the dorsal surface. There is another reason for the compression of the median nerve. Although the carpal tunnel is anatomically an open system, it behaves like a closed space in which a certain carpal tunnel pressure is created [14]. In healthy people in a neutral hand position, the carpal tunnel pressure ranges from 2.5 to 13 mm Hg [14], whereas in patients with signs of CTS, it averages 32 mm Hg [15]. During active flexion of the wrist in patients with CTS, the carpal tunnel pressure increases to 94 mm Hg [15]. If the carpal tunnel pressure exceeds 30 mm Hg, axoplasmic transport is disrupted, causing mild paresthesia in healthy subjects. In individuals with carpal tunnel syndrome this level is 32 mm Hg. If the carpal tunnel pressure exceeds the

above level, a mechanism of pathological changes in the function and even structure of the median nerve is triggered (impaired epineural blood circulation, epineural edema, blockage of axoplasmic transport, etc.), which clinically manifests itself in symptoms characteristic of CTS [14]. Therefore, if during the Phalen test in a patient with CTS the carpal tunnel pressure exceeds the critical level by more than 3 times, it becomes clear why the clinical picture of CTS is reproduced within such a short period of time (within the first 60 seconds). It should also be emphasized that during the Phalen test, the already pathologically altered structures of the median nerve are compressed. Notably, even healthy people may experience numbness, paresthesia, and pain when carpal tunnel pressure increases during forced flexion of the wrist in the Phalen test. However, the symptoms will only appear after 10 minutes or more, rather than within the first 60 seconds, as in patients with CTS [10].

Since the description of the classic Phalen test, several modifications of this test have appeared. Technically, these modifications differ from the classic test in certain aspects. It is not entirely clear how much the modified tests differ in a positive or negative way in terms of diagnosing CTS. Therefore, we decided to compare the classic Phalen test and one of the most common and memorable modified version. The classic Phalen test differs from the modified one in certain aspects. For example, when performing the classic test, the forearms are in a vertical position, and the hands are much higher than the heart. In other words, in this case, the flexion test is combined to some extent with the elevation component, which can have a positive effect on the sensitivity and specificity of the test. When performing the modified test, the forearms are almost horizontal, and the hands are at heart level. Thus, there is virtually no combination with the elevation test. Another important distinction relates to the manner of wrist flexion. More than 40 years after first describing his test, Phalen confirmed that when performing the test, the hands should be only flexed under the action of gravity, without touching each other, and most importantly, neither the patient nor the doctor should actively bend the hands: only passive flexing due to gravity [10]. If either the patient or the physician actively bends the wrist, the difference between flexion of the wrist under the influence of gravity and flexion with external force can be as much as 20 degrees. The significance of this difference in bending angles on the test result is still unknown [16]. Therefore, considering the above differences between the classic and modified tests, we decided to compare the effectiveness of the two diagnostic tests in the same group of patients with CTS and determine the legitimacy of using either the classic or modified test.

The results of this study showed that the sensitivity of the classic Phalen test (93%) was lower than that of the modified version (96%). The specificity of the classic Phalen test (96%) was higher than that of the modified one (93%). The PPV of the classic Phalen test (96%) was higher than that of a PPV of the modified test (93%). The negative predictive value of the classic test (93%) was lower than that of a negative predictive value of the modified Phalen version (96%).

According to MacDermid JC and Wessel J [4], if the sensitivity or specificity of clinical provocation tests

is greater than 50%, such tests can be classified as “potentially useful for the diagnosis of CTS.” In our study, the classic and modified Phalen tests significantly exceeded the 50% threshold for both sensitivity and specificity. Therefore, based on the data we have presented, we can confidently conclude that both the classic and modified Phalen tests can be successfully and legitimately used to diagnose CTS.

Conclusion

The sensitivity of the classic Phalen test (93%) was slightly lower than that of the modified version (96%), while its specificity (96%) was higher than that of the modified test (93%). Due to their high specificity and sensitivity, both tests have significant diagnostic value and can be successfully used in clinical practice for diagnosing CTS.

Disclosure

Conflict of interest statement

The authors declare no conflict of interest.

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