RESEARCH ARTICLE

Value of Modified Duran's Test in Clinical Diagnosis of Carpal Tunnel Syndrome

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ABSTRACT

Background: Carpal tunnel syndrome (CTS) is a medical condition, the most common, most important, and best defined, and the most carefully studied of all nerve entrapment syndromes. **Objective:** Our study aims to evaluate clinical tests in the diagnosis of CTS with special reference to modified Duran's test regarding specificity and sensitivity. **Patients and Methods:** A prospective study carried out on 300 hands in 240 patients with symptomatic CTS was taken, from August 2015 to February 2017, at Erbil Teaching hospital (Orthopedic department). History, clinical examination, and Electrophysiological by Electromyography and Nerve conduction study and 250 persons without symptoms on 300 hands were taken as a controlling group. We applied the five clinical provocative tests on each group, Phalen's test, Tinel's test, original Duran's test, arm Tourniquet test, and Reversed Phalen's test. In this research, we compared former tests by our test modification (Duran's test), considering specificity, accuracy, and sensitivity. **Results:** Findings show that the modified Duran's test was the most specific (94%), accurate (94%), and sensitive (94%) in comparison with the other provocative tests. The modified Duran test had the highest positivity rate, according to the cases in less than 1-month history of symptoms it reached: 81.8% which was higher than the result of the previous tests in comparison to the previous clinical tests. Its mean time was 11.5 s. **Conclusions:** Modified Duran's test was simple, noninvasive, most sensitive, and most specific in comparison to other clinical tests. Furthermore, the reaction time of Modified Duran's test was the shortest,

Keywords: Carpal tunnel syndrome; Diagnosis; Provoking test

INTRODUCTION

Carpal tunnel syndrome (CTS) is a hand and wrist condition. It is the most important, most common of all entrapment nerve syndromes (Douglas et al., 1981). In most cases can be diagnosed only by clinical history and physical examination (Trumble et al., 2002; Parisdm, 2005). More than 80% of the patients are over the age of 40 years and women are more affected than men, 50% of the cases are bilateral and the dominant hand is usually affected first and severely involved (De-La-Llave-Rincón et al., 2012). It is defining as a compressive neuropathy of the median nerve where it passes through the carpal tunnel which is created by the transverse carpal ligament and carpal bones, producing paresthesia and pain in the median nerve distribution in the hand.

These are described as causal factors: Endocrinology, infection, rheumatologic, trauma, tumoral lesions, and pregnancy or may be idiopathic (Wanitwattanarumlug and Varavithya, 2012).

CTS is mainly diagnosed on a clinical basis, and the diagnosis is made after careful history and examination, including known provocative tests of varying effectiveness and reliability. (Douglas et al., 1981) Provocative tests have

a very important role in the diagnosis of CTS especially in early cases (Kuschner, 1999) which includes the Phalen's test, Tinel's test, Arm sphygmomanometer test, and Duran's carpal compression test.

CTS can result from ischemia and mechanical compression of the median nerve. In Duran's carpal compression test – transient reversible ischemia of the median nerve is induced by direct pressure on an already ischemic nerve by high pressure within the carpal tunnel and acute conduction block (Durkan, 1991). In Phalen's wrist flexion test-the size of the carpal tunnel is reduced which compresses the median nerve more than it was already compressed in the neutral position. In Tinel's percussion test-median nerve conduction is blocked by sharp tapping upon the nerve (Phalen, 1972; Gellman et al., 1986). Ischemic nerve becomes more sensitive to the tapping in its ischemic part. Finally, in Arm sphygmomanometer test-venous congestion is induced in the hand, wrist, and forearm which reduces the size of the carpal tunnel and compresses the median nerve (Boland and Adams, 1999).

Electrodiagnostic studies are used to confirm the diagnosis and some studies discourage its use as an exclusive tool, (Louis and Hankin, 1987) but other studies had refined

the technique and data analysis to establish a dependable and reliable diagnosis (Werner and Andary, 2011). Over recent years, the use of ultrasonography, to demonstrate the usefulness of this method as an aid to diagnosing CTS, in cases which compatible symptoms are present together with normal physical and electroneurography examination result (Kang et al., 2012; Rahmani et al., 2011).

The Aim of the Study

The aim of the study was to evaluate the modified Duran's test in the clinical diagnosis of CTS and compared it to the other valuable clinical test.

PATIENTS AND METHODS

240 patients (300 hands) were studied prospectively in a certain period (from August 2015 to February 2017), at Erbil Teaching hospital. All the patients had symptoms of CTS and have definite abnormalities of electromyography (EMG) and nerve conduction study (NCS). This group of patients was considered as the positive group, among these 240 patients, 216 were female, and 24 were male (female/male ratio are 9/1). The symptom in 132 patients was on their right hands, and in 28 patients was on their left hand. While in 80 patients, it was found bilateral. The ages of the patient were ranged between 26 and 54years (the average was 39 years old).

One hundred and seventy patients were housewives, 35 typists, 30 clerical workers, and five dentists. CTS was suspected by a history of pain and paresthesia in the median nerve distribution of the hand. The hand was tested electrophysiologically by EMG and NCS and by positive findings that have CTS by positive findings. The criteria for abnormal EMG can be identified when the distal motor nerve conduction velocity over the carpal tunnel is more than 4.5 ms, or 1 ms more than ulnar nerve on the same side or the opposite (asymptomatic) median nerve side in unilateral cases, while for abnormal NCS when the sensory velocity is more than 3.5 ms or is 1 ms more than ulnar nerve on the same side or the opposite (asymptomatic) median nerve side in a unilateral case.

The control group was 250 patients (300) hands. None of them had any history and symptom of CTS, and as a negative group, they consisted of 200 female and 50 males (female/male ratio are 4/1). Among them, 160 were right-handed patients, 50 of them are bilateral, and 40 only left-handed. The range of their ages was 28 to 60 years (average age 40 years).

The clinical tests were carried out on the two groups as follows:

a. Original Duran's test

It consists of a device that is created by a link of an aneroid pressure manometer in a rubber atomizer-bulb from a sphygmomanometer producing direct pressure on the median nerve under the flexor retinaculum by a pressure of (150) mmHg during 30 s. A timer recorded the interval from the application of compression to the onset of symptoms in the median nerve distribution on the hand

b. Modified Duran's test

Consists of a firm plastic board (7×11 cm) with central round edge rectangular pieces ($3 \text{ cm} \times 6 \text{ cm}$) which is enough to cover the volar aspect of an adult wrist and apply pressure upon the median nerve running under the flexor retinaculum. This board was incorporated into a blood pressure cuff. Linked to a manometer from a mercurial sphygmomanometer is shown in [Figure 1]. A pressure of 150 mmHg was applied for 30 s. The timer reported the interval from compression applied to the onset of symptoms in the hand's median nerve distribution.

c. Phalen's test

d. Tinal's test

e. Reversed Phalen's test

f. Tourniquet test.

Statistical Analysis

Data were translated into the codes by employing a particularly coding sheet and then the data transformed into computerized data. Statistical analyses SPSS version 23 (Statistical Package for the Social Science) which is a computer software were used to analyze the data.

The significance of statistically analyzed data in the different groups in a mean of the confirm finding variable in quantitative method (like pressure needed to achieve a positive test) between two groups was estimated by *t*-test. The statistical importance of the association among two

Figure 1: Modified Duran's a device

variables groups (like duration of symptoms and positivity rate of the test) was evaluated by the Chi-square test. $P < 0.05$ level of significance was estimated as statistically important.

Test performance characteristics (Sorlie, 1995). The performance characteristics of a test or criteria, sometimes called test operating characteristics include, among others: Specificity, sensitivity, negative predictive value, and positive predictive value the used formulas in the calculation are:

$$\text{Sensitivity} = \frac{\text{No.of true positives}}{\text{No.of diseased person}}$$

$$\text{Specificity} = \frac{\text{No.of true negatives}}{\text{No. of non - diseased person}}$$

$$\text{PPV} = \frac{\text{No. of true positives}}{\text{No. of positive test results}}$$

$$\text{NPV} = \frac{\text{No. of true negatives}}{\text{No. of negative test results}}$$

$$\text{Accuracy} = \frac{\text{No. of (true positives + true negatives)}}{\text{Total No.}}$$

RESULTS

The results of the clinical tests for the diseased positive group (300 hands) are as follows:

Modified Duran's Test

It was positive in 282 hands (94%) with a mean time of 11.5 s from the application of the pressure to the onset of symptoms (range 9–19 s). The pressure which was applied to induce symptoms is 150 mmHg for patients with normal blood pressure and 165 mmHg (range 160–180 mmHg) for hypertensive patients with mean systolic blood pressure (160 mmHg) (range 150–180 mmHg) and mean diastolic blood pressure (102 mmHg) (range 95–110 mmHg).

Original Duran's Test

It was positive in 258 hands (86%) with a mean time of 23.5 s (range 17–30 s). The pressure which was applied to include CTS symptoms is 150 mmHg for patients with normal blood pressure and 180 mmHg range 165–190 mmHg for hypertensive patients with mean arterial systolic blood pressure 160 mmHg and mean diastolic blood pressure (103 mmHg).

Phalen's Test

Two hundred and thirty-six hands were positive (78.7%) with a mean time of 44.7 s (range 33–60 s).

Reversed Phalen's Test

It was positive in 225 hands (75%) with a mean time of 47.2 s (range 32–60 s).

Tinel's Test

It was positive in 209 hands (69.7%). In 159 hands (53 %), the Tourniquet test was positive.

The results of 300 hands clinical tests are shown in the control group as shown in Table 1.

Original Duran's Test

It was positive in 19 hands (6.3%) with a mean time of 24 s (range 19–28 s).

Modified Duran's Test

It was positive in 18 hands (6%) with a mean time of 20 s (range 13–28 s).

Phalen's Test

It was positive in 48 hands (16%) with a mean time of 40 s (range 35–60 s).

Reversed Phalen's Test

It was positive in 53 hands (17.7%) with a mean time of 44.5 s (range 39–60 s).

Tinel's Test

It was positive in 36 hands (12%).

Tourniquet Test

It was positive in 69 hands (23%).

The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of Modified Duran's test, Duran's test, and other tests were the highest specificity was from Modified Duran's test which was 94%, its sensitivity was 94%, its positive predictive value was 94%, and its negative predictive value was 94%, and was 94% with the result of others tests is shown in Table 2.

Modified Duran's test was positive in cases with a short duration of history <1 month with an 80% positivity rate; which increases with the duration of symptoms reaching as high as 97% in more than 6 months' duration of symptoms. This means that modified Duran's test remains higher in its positivity rates than other tests along with all the duration of symptoms, this was statistically significant in Chi-square $P = 0.02$ [Table 3].

Table 1: The cases–control difference in means of certain criteria

???	Number		Mean		SD (Standard Deviation)		P (t-test)
	Positive	Negative	Positive	Negative	Positive	Negative	
Pressure needed to have positive Duran's test	258	19	160	150	10.37	0	0.003
Pressure needed to have positive Modified Duran's test	282	18	158	150	9.11	0	0.002
Time Interval (Seconds) Needed to have a positive Duran's test	258	19	23.5	24	3.91	2.80	0.02
Time Interval (Seconds) Needed to have a positive Modified Duran's test	282	18	11.5	20	2.65	4.70	< 0.001
Time Interval (Seconds) Needed to have a positive Phalen's test	236	48	44.70	47.00	8.38	8.06	0.008
Time Interval (Seconds) Needed to have a positive Reversed Phalen's test	225	53	47.2	44.5	8.74	5.50	0.03

Table 2: Validity parameters (sensitivity and specificity, positive predictive value, negative predictive value, and accuracy) of six different tests to detect and diagnose CTS

Test	Final diagnosis of CTS						
	Positive group	Negative group	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Duran's test							
Positive	258	19	86	93.7	93	87	89
Negative	42	281					
Modified Duran's test							
Positive	282	18	94	94	94	94	94
Negative	18	94					
Phalen's test							
Positive	236	48	78.7	84	90.8	88.7	81.3
Negative	64	252					
Revered Phalen's test							
Positive	225	53	75	82	80.9	76.7	78.7
Negative	75	247					
Tinel's test							
Positive	209	36	69.7	88	85.3	70.1	76
Negative	91	264					
Tourniquet test							
Positive	159	69	53	77	69.7	62.1	65
Negative	141	231					

CTS: Carpal tunnel syndrome

Table 3: Positivity rate (sensitivity) of the different tests about the duration of the symptoms

Duration of symptoms in months	Duran's test		Modified Duran's test		Phalen's test		Revered Phalen's test		Tinel's test		Tourniquet test	
	n	%	n	%	n	%	n	%	n	%	n	%
<1 (n=22)	13	59.1	18	81.8	10	45.4	10	45.4	13	59.1	15	68.2
1–3 months (n=84)	63	75.0	76	90.4	51	60.7	50	59.5	43	51.2	30	35.7
4–5 months (n=126)	118	93.7	124	98.4	113	89.7	103	81.7	98	77.8	70	55.5
More than 6 month (n=68)	64	94.11	64	94.1	62	91.1	62	91.2	55	80.9	44	64.7
P (t-test)	0.02		<0.001		<0.001		<0.001		0.003		0.06(NS)	

DISCUSSION

Provocative tests are broadly required for confirmation of the diagnosis, treatment selection, and determination of the cause and etiology of CTS. Although electrodiagnostic studies are considered to be the gold standard (abnormal test result is an objective prove of CTS) (Szabo et al., 1999; Gellman et al., 1986).

However, a positive result cannot confirm the diagnosis of CTS when there are no symptoms (Szabo et al., 1999).

Some patients with characteristic CTS signs may be qualified as candidates for surgical intervention and thus avoid costs and time associated with electrodiagnostic study (Durkan, 1991). The fact that clinical tests are an available and easy-to-use diagnostic method constitutes their greatest advantage (Szabo et al., 1999). The majority of authors agree that a positive result of high sensitivity and specificity provocative tests is an indication for further studies verifying the diagnosis, while a negative result does not exclude CTS (Bozek and Gaździk, 2001). Tests with high sensitivity should be used to differentiate patients with

symptoms similar to CTS, while tests with high specificity can serve to eliminate falsely positive results and are thus especially useful in cases when surgical intervention is considered (Szabo et al., 1999; MacDermid and Wessel, 2004).

This study shows that 90% of cases were females while only 10% of cases were males which indicate that the female to male ratio is equal to 9:1 which is similar to the result of (Susan Ferry and Mariawarasky, 2000) This female predominance could be explained by the hormonal effect (Susan Ferry and Mariawarasky, 2000).

In this study, a combination of the test was used to diagnosis of CTS and confirmed by positive NCS, these hand the sensitivity of modified Duran's test was (94%), and the specificity was (94%), for CTS diagnosis with 18 hands false positive. While the sensitivity original Duran's test was (86%), and specificity was (93.7). with 19 hands false-positive. The result is close enough to the result of (Al-Mukhtar, 2004). The sensitivity modified Duran's test was 94.7% and specificity (94.7) (Al-Mukhtar, 2004).

From our study, we conclude that the modified Duran's test is a better diagnostic test than the other tests in the diagnosis of CTS due to more sensitivity and specificity than the other tests.

In modified Duran's test, the applied pressure was sustained and precise (stoppage valve) by a firm device (the physical advantage of the firm substance allows a better pressure transmission than a soft one, this was utilized in designing the modified Duran's device) on the median nerve running under the flexor retinaculum to induce transient reversible ischemia and direct pressure nerve conduction block in short duration using the mercurial sphygmomanometer which is documented to be more precise and accurate than aneroid type (Andrews, 1972).

While in the original Duran's test, the applied pressure was through a soft rubber atomizing bulb, which is difficult to maintain the standard pressure for the appropriate time because there is no Valve to stop the pressure on the recommended level.

There have been few published studies on the highest specificity and sensitivity of the original Duran's test as compared to other provocative tests in the diagnosis of CTS, as follows

There have been few published studies on the highest specificity and sensitivity of the original Duran's test as compared to other provocative tests in the diagnosis of carpal tunnel syndrome, as follows: Kuschner SH

(Kuschner, 1999) duran's test sensitivity was (89 %) and specificity (93 %), while Phalen test sensitivity was 83% and specificity 82%. Richter M (Rickter M, 1999) duran's test sensitivity was (87 %) and specificity 96% while Phalen test sensitivity was (64%) and specificity (87 %). Joh Duran (Durkan, 1991) duran's test sensitivity was (87%) and sensitivity (90%). While Phalen test sensitivity was (70%) and sensitivity (84%).

The sample size of this study considered as largest if compared to other published researches such as (Durkan, 1991), (Williams et al., 1992), (Tetro et al., 1998), (Al-Mukhtar, 2004) which adds to the accuracy of these studied tests.

CONCLUSION

To make a test useful for diagnosing a disease, it should be highly sensitive and specific for the disease being studied.

1. Modified Duran's test was the most sensitive (94%) and most specific (94%), with the highest positive predictive value and negative predictive value compared to other clinical tests
2. It is the most helpful test for diagnosis and screening of CTS in patients with a typical history
3. It is a very helpful simple, noninvasive, and inexpensive test
4. Test to pare form in the painful wrist or stiffness wrist
5. Modified Duran's test was found to have the least reaction time to be positive and it can detect early cases of CTS.

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