Sensitivity and Specificity of Phalen's Test and Tinel's Test in Patients with Carpal Tunnel Syndrome

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Abstract

Background: Carpal Tunnel syndrome (CTS) is the most common cause of paraesthesia in the hands and it is the most common entrapment neuropathy in the upper and lower limbs. The symptoms are variable, but episodes of burning pain or tingling in the hand are common. Diagnosis of CTS is mainly clinical based on suggestive history and Physical examination. Several physical signs are associated with carpal tunnel syndrome, including Tinel's test and Phalen's test.

Objectives: of this study are to determine the sensitivity and specificity of the Phalen´s and Tinnel´s tests in the diagnosis of Carpal Tunnel Syndrome and to analyze how such factors as patients age and duration of symptoms influence these parameters.

Patient &Methods: This is a prospective study comparing two groups (patient and control). One hundred cases (90 females and 10 males), who fulfilled the National Institute of Occupational Safety and Health **(**NIOSH) criteria for diagnosis of CTS attending physiotherapy unit in Rizgary Teaching Hospital in Erbil-Iraq .The control group included (90 females and 10 males) who were healthy asymptomatic volunteer .The duration of the study was eight months from 1st may 2011to 1st February 2012. Both groups were assessed by Phalen and Tinel tests.

Result: within patient group 78(78%)cases were having positive phalen and 66(66%) cases had positive tinel test while in the control group 6 (6%) were having positive phalen and 23(23%) controls had positive tinel test.

The resulting specificity and sensitivity of Phalen test for the patient and control groups were 94% and 78%respectively while specificity and sensitivity of Tinel test were 77% and 66% respectively.

There is also a significant association between duration of symptoms less than 6 years and Tinel test results.

Conclusion: Phalen test is more specific and sensitive than Tinel test so it is essential in the diagnosis of CTS particularly when the Nerve Conductive Study (NCS) is not available.

Keyword: Carpal Tunnel Syndrome (CTS), Phalen Tinel tests.

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Introduction

Carpal Tunnel syndrome (CTS) is the most common cause of paraesthesia in the hands. And it is the most common entrapment neuropathy in the upper and lower limbs [1,2,3,4].

Its prevalence in general population is estimated to be about 3.8%, while in persons with risk factors is about 15%. All age groups could be affected, but mostly in middle aged women with female to male ratio is 4:1 [4,5,6,7,8] .

Anatomically carpal tunnel is a passage way deep to the flexor retinaculam between the tubercles of scaphoid and trapezoid on the lateral side and psiform and hamate on the medial side. Thus any process which encroaches on the tunnel can compress the median nerve which innervates the thenar muscles which mediates flexion ,opposition and abduction of the thumb. Additionally median nerve innervates first, second lumbricals and skin of radial side of palm, thumb, second, third and radial half of forth finger [1, 6, 8, 9, 10].

The symptoms are variable, but episodes of burning pain or tingling in the hand are common. The symptoms usually occur in night which may awake the patient from sleep, the symptoms commonly affects the index and middle fingers occasionally the symptoms relieved by shaking the hands. With progression of the condition the patient may have the symptoms even during the day time, Occasionally the pain spreads above the wrist to the forearm or rarely, even above the elbow and up the arm [1,2,6,9,10,11] .

On physical examination there is decreased sensation of light touch in the distribution of median nerve, weakness and atrophy of thenar muscles. [1,4,6,7]

Also the clinical provocative tests phalen and Tinel are positive.There are many causes of Carpal Tunnel Syndrome including: Endocrine; Diabetes mellitus, hypothyroidism and acromegally. Inflamatory; Rheumatoid arthritis, gout, pseudo gout .Physiological;, edema from pregnancy . Mechanical; trauma .Infections such as tuberculosis and other inflammatory diseases of the wrist, many idiopathic cases may be due to occupational stress [1,9,10,11,12 ,13] .Dominant hands are at increased risks to develop CTS. Diagnosis of CTS is mainly clinical based on suggestive history and physical examination. Several physical signs are associated with carpal tunnel syndrome, including Tinel's test and Phalen's test [13, 14].

In 1915, Jules Tinel, a French neurologist, described a "tingling sensation" is produced by slight percussion of a nerve trunk one time after an injury. [15, 16]. In 1957, Phalen also proposed a diagnostic test, a wrist flexion test (i.e., Phalen's maneuver), and the appropriate anatomic distribution of paresthesia elicited by both examinations. [15-17]

Although Phalen´s test and Tinel´s tests are classically associated with carpal Tunnel Syndrome, the clinical usefulness of clinical provocative tests including Phalen´s and Tinel´s tests varies depending on their sensitivity and specificity, various studies had been done on these tests, the sensitivity of Phalen ´s test ranges from 42% to 91% and of Tinel´s tests ranges from 38% to 100%, while specificity had various values being from 55% to 98% for Phalen ´s test and from 55% to 80 for Tinel´s tests[7,8].

Both tests have been used for many years for the purpose of diagnosing CTS, and they also have been relied upon surveillance and research studies into the epidemiology of carpal Tunnel syndrome.

It is Postulated that CTS can be an intermittent problem, may be due in part to

small un myelinated fibers that the test cannot detect, or that in the early stages of the disease the test is normal. Usually confirmation of diagnosis is by electrodiagnostic study which correlates closely but not perfectly [16,20,24, 25] .

Current recommendations of the National Institute of Occupational Safety and Health (NIOSH) for diagnosis of carpal tunnel syndrome include two or more of the following criteria (one or more symptoms and one or more objective findings) [8] .

1. One or more of the following symptoms affecting at least part of the median nerve distribution of the hand: pain ،tingling or numbness.
2. One or more of the following objective findings: physical findings of mediannerve compression including a positive Tinel test or a positive Phalen test.
3. Electrodiagnostic findings indicative of median nerve dysfunction across the carpal tunnel.

Although the criteria above were developed are appropriate for clinical practice as well, whether work -related or not [17].

There are non-surgical and surgical options in the management of CTS, the non-surgical one includes treatment of underlying causes of CTS,using night splint, avoidance of activities and postures that aggravate the symptoms and short course of oral glucocorticoids or local injection into the carpal tunnel. When conservative treatment fails, surgical decompression of the tunnel by release of the transverse carpal ligament and removal of tissue compressing the median nerve .Even with surgery, however, symptoms may sometimes recur [9,15,17,26-30 ,31-37].

This study aims to determine the validity of the Phalen´s and Tinel´s tests in the diagnosis of Carpal Tunnel Syndrome by detecting their sensitivity and specificity, and analyze how such factors as patients age,sex,BMI and duration of symptoms influence these tests.

Patients and Method

The study was conducted prospectively as case – control study ,the period of data collection was 9 months (from 1st May 2011 to 1st February 2012) in physiotherapy unit in Rizgary Teaching Hospital in Erbil city. One hundred patients with CTS fulfilling NIOSH criteria for diagnosis of CTS and one hundred controls who were collected among asymptomatic volunteers who had no hand symptoms were included.

History of wrist surgery, carpal tunnel injection or fracture, cervical rib, clinical or electrophysiological evidence of an accompanying condition that mimics CTS or interferes with its evaluation, such as cervical radiculopathy has been excluded. The verbal consent was taken from all the participants. The study form includes Aquestionnaire.

A detailed history was taken and clinical examination was done for both groups including Phalen's test &Tinel's test.

Nerve conduction study performed for all patients in the Neuro-physiological Unit in Erbil Teaching Hospital.NCS were performed by Nicolet BIOMEDICAL machine, the nerve conduction studies included the sensory and motor conduction velocities of median and ulnar nerves were recorded. In addition, comparative test was performed in the fourth digit for ulnar-median nerve stimulation in wrist. According to American Association of Electro-diagnostic Medicine (AAEM) two of the following criteria for abnormal values were accepted to identify the patients with CTS:

1. Antidromic sensory conduction velocity for the wrist-second digit segment less than 48.2 m/s,
2. The difference between median and ulnar sensory nerve distal latencies with recording from the fourth digit (recording-stimulation distance was kept 14 cm) exceeding 0.5 ms.
3. Distal motor latency to abductor pollicis brevis muscle greater than 4.2 ms. (25).

A form was designed to record name, age, gender, occupation, residence of the patients, side of hand, numbness, tingling, burning pain, wasting of hand muscle, phalen's test, Tinel's test, NCS. The BMI was calculated as weight by kg over height by squared meter and reported as kg/m2. Obesity was defined as BMI > 29.9 kg/m2 [38,39,40].

Statistical term and analysis

Data, concerning different variables, were analyzed by entering data into Microsoft Excel program and analysis was done by (SPSS version 16) and p-value ≤ 0.05 considered as significant. Descriptive statistics included the mean and standard deviation for numerical variables, comparison between categorical variables was carried out by the Chi-square test.

Sensitivity — The number of patients with a positive test who have a disease divided by all patients who have the disease. A test with high sensitivity will not miss many patients who have the disease (ie, few false negative results). [50].

Specificity — the number of patients who have a negative test and do not have the disease divided by the number of patients who do not have the disease. A test with high specificity will infrequently identify patients as having a disease when they do not (i.e., few false positive results). [50].

Predictive values — In addition to sensitivity and specificity, the predictive values of a diagnostic test must be considered when interpreting the results of a test. The positive predictive value of a test represents the likelihood that a patient with a positive test has the disease. Conversely, the negative predictive value represents the likelihood that a patient who has a negative test is free of the disease [50].

Results

1. Age frequency distribution:

The sample enrolled 100 patients and 100 healthy controls. The majority of the patients (60) 60% of them are in the age between (30-49) years while the majority of the controls (64) 64% are in the age between (30-49)years.Table 1

2. Severity of Carpal Tunnel Syndrome according to NCS: Among one hundred patients with CTS 44 (44%) had mild CTS ,24(24%) cases had moderate CTS and only 32(32%) cases had severe CTS.Figure 1

3.Sensitivity, Specificity ,Positive Predictive Value and Negative Predictive value of Phalen´s and Tinel´s tests . From one hundred patients and one hundred healthy controls, the highest specificity was from Phalen´s test which was 94% ,its sensitivity was 78%, its positive predivtive value was 92%, and its negative predictive value was 81%, but for Tinel ´s test specificity was 77%, sensitivity was 66%, its positive predictive value was 74% and its negative predictive value was 69% .Table 2

4. Frequency distribution of gender ,occupation and address among CTS patients: Among 100 cases (90%) were females and only (10%) cases were males, majority of the cases were housewives which were (76%) and (16%) cases were computer worker, (68%) cases were from rural areas and (32%) cases from urban areas. Table 3

5. Frequency distribution of symptoms (numbness, nocturnal tingling and pain) among studied patients: Majority of

patient's cases (96%) had numbness, (87%) cases had nocturnal tingling and only cases (43%) had pain. Table 4

6.Frequency distribution of hand involvement among studied patients: Among 100 cases , 72% had Right hands involvement, 13% had Left hands involvement and only 15% cases had bilateral hand involvement. Figure 2

7. Frequency distribution of Phalen´s, Tinel´s tets and Muscle wasting among CTS patients. Among the cases of CTS, 78% cases had positive Phalen´s test, and 66% cases had positive Tinel´s test, while only 8% cases had thenar muscle wasting of hand.Table 5

8. Association between phalen´s and tinel´s with duration of symptoms: Association between mean duration of symptoms of (35±29) months among patients with positive Tinel`s test was significantly higher than the mean duration of symptoms (21±23) among patients with negative Tinel`s test, while there is no statistically significant association between Phalen´s test and duration of symptoms. Table 6

9.Association between phalen´s and tinel´s tests with age of patient: Among patients with CTS, there is no statistically significant association between Phalen´s test and mean age of (43.0±11.1) yr with (p-value =0.391), and also there is no statistically significant association between Tinel´s test with mean age of (43.1±10.3)yr with (p-value =0.487).Table 7

10. Association between severities of CTS according to NCS with sex of patient.

Among 90 females, 40% of them had mild CTS, 21% had moderate CTS while 29% cases had severe CTS for them (p value=0.733) which is not statistically significant, 4% male cases had mildCTS, 3% male cases had moderate CTS, 3% male cases had severe CTS with (p value=0.733) which is statistically not significant .Table 8

11. Association between phalen ´s and tinel´s tests with sex of patient

Among 100 patients with CTS in whom 90% cases were female s,58% of them had positive Tinel´s test (p-value=0.434) which is not statistically significant and 7% male cases had positive Tinel´s test (p-value=0.434) which is also not statistically significant while 70% females had positive Phalen´s test(p-value=0.98)which is not statistically significant and 7% males had positive phalen´s test (p-value=0.98) which is not statistically significant.Table 9

12. Association between phalen ´s and tinel´s tests with BMI of patients

Among patients with CTS with their BMI shown in the table below there is no significant association between phalen´s test and tinel ´s test with BMI.Table 1

Table (1): Distribution of patients according to their age range in years.

Variables	Status	
	Case N (%)	Control N (%)
Age (Years)		
< 20	Zero	Zero
20-29	10(10%)	28(28%)
30-39	20 (20%)	30(30%)
40-49	40(40%)	34(34%)
50-59	30(30%)	8(8%)
>60	zero	zero
total	100.0	100.0

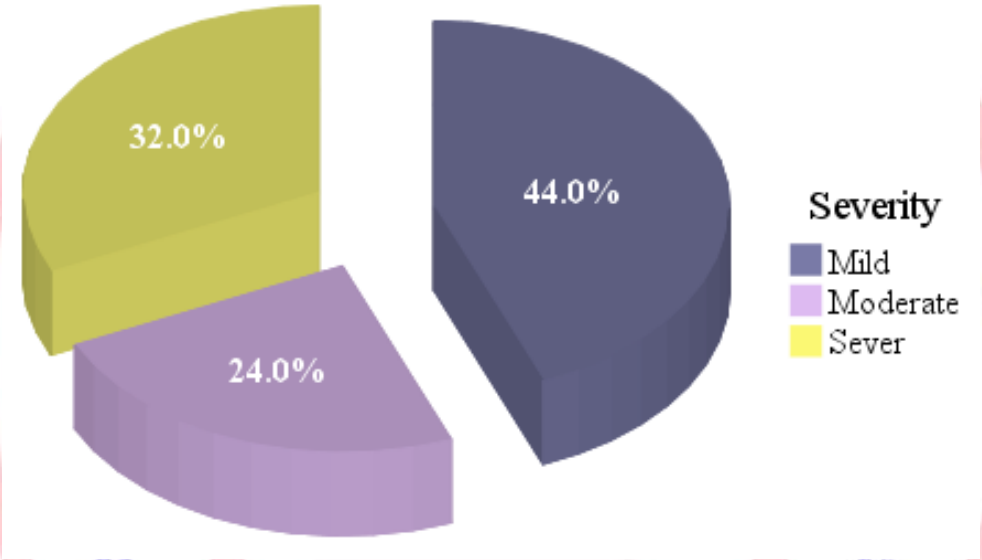

Figure (1): frequency of severity of carpal Tunnel Syndrome among cases.

Table (2): Sensitivity, Specificity, Positive Predictive Value and Negative Predictive value of Phalen´s and Tinel ´s tests.

Phalen`s test

Disease	Present	Absent	Total
Positive Test	78%	6%	84
Negative Test	22%	94%	116
	100	100	200

Tinel`s test

Disease	Present	absent	Total
Positive test	66%	23%	89
Negative test	34%	77%	113
	100	100	200

Table (3): Frequency distribution of gender, occupation and address among CTS patients.

Variables	Frequencies	Percentages
Sex		
Male	10	10.0
Female	90	90.0
Total	100	100.0
Variables	**Frequencies**	**Percentages**
Occupation		
House wife	76	76.0
Computer worker	16	16.0
Manual worker	8	8.0
Total	100	100.0
Variables	**Frequencies**	**Percentages**
address		
Urban	32	32.0
Rural	68	68.0
Total	100	100.0

Table (4): Frequency distribution of symptoms (numbness, nocturnal tingling and pain) among CTS patient.

Variables	Frequencies	Percentages
Numbness		
Positive	96	96.0
Negative	4	4.0
Total	100	100.0
Variables	**Frequencies**	**Percentages**
Noct.Tingl.		
Negative	13	13.0
positive	87	87.0
Total	100	100.0
Variables	**Frequencies**	**Percentages**
Pain		
Positive	43	43.0
Negative	57	57.0
Total	100	100.0

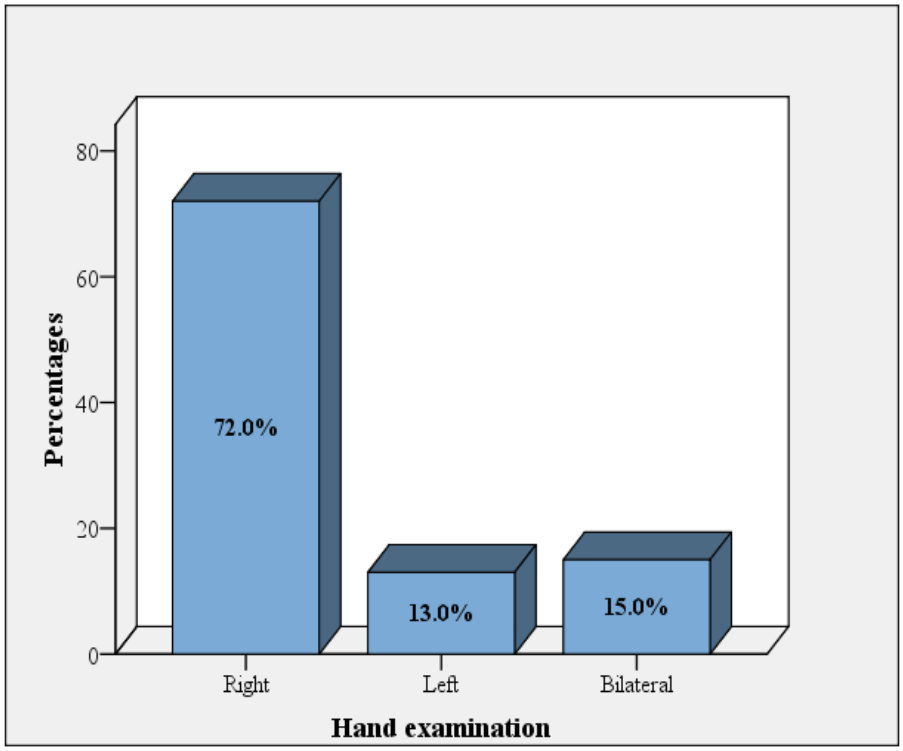

Figure (2): Frequency distribution of hand involvement among studied patients.

Table (5): Frequency distribution of Phalen, Tinel tets and Muscle wasting among CTS patients.

Test	Frequencies	Percentages
phalen		
Positive	78	78.0
Negative	22	22.0
Total	100	100.0
Test	**Frequencies**	**Percentages**
Tinel		
Positive	66	66.0
Negative	34	34.0
Total	100	100.0
Variables	**Frequencies**	**Percentages**
Muscle wasting		
Positive	8	8.0
Negative	92	92.0
Total	100	100.0

Table (6): association between phalen´stest, tinel´s test and duration of symptom.

Tests Among Cases	Duration(Months) Mean± S.D	P Value
Phalen´s test Positive	33±28	0.152
Negative	22±28	
Tinel´s test Positive	35±29	0.021
Negative	21±23	

Table (7): Association between phalen and tinel tests with age of patient**.**

Tests Among Cases	Age (Years) Mean± S.D	P Value
Phalen ´s test Positive	43.0±11.1	0.391
Negative	40.8±9.0	
Tinel ´s test Positive	43.1±10.3	0.487
Negative	41.5±11.3	

Table (8): Association between severity of CTS according to NCS with sex of patient.

Variables	Sex		P value
	Male N (%)	Female N (%)	
severity Mild	4(4%)	40(40%)	0.825
Moderate	3(3%)	21(21%)	
Severe	3(3%)	29(29%)	
Total	10(10%)	90(90%)	

Table (9): Association between phalen´s and tinel´s tests with sex of patient**.**

Variables	Sex		P value
	Male N (%)	Female N (%)	
Tinel´s test Positive	7(7%)	58(58%)	0.434
Negative	3(3%)	32(32%)	
phalen´s test Positive	7(7%)	70(70%)	0.692
Negative	3(3%)	20(20%)	

Table (10): Association between phalen´s and tinel´s tests with BMI of patients**.**

Tests	BMI Mean± S.D	P value
Phalen ´s test Positive	24.2±2.2	0.132
Negative	23.4±2.3	
Tinel ´s test Positive	24.2±2.1	0.450
Negative	23.8±2.4	

Discussion

Provocative tests including Phalen test and Tinel test which are broadly required for confirming the diagnosis of Carpal Tunnel Syndrome despite that the Elect-rodiagnostic studies are considered to be gold standard . However a positive result of Nerve Conduction Study can not confirm the diagnosis of CTS when there are no symptoms. The current study shows that most of patients with CTS are in age groups from 20-69 years with 60% of them in the range of 30-49 years. This result agrees with results of studies which described that CTS occur at any age but with its peak in forth decade of life [17-20,28,33].

This study shows that 90% cases were females while only 10% cases were males which indicate that the female to male ratio F:M is equal to 9:1 which is similar to result of Susan, *et a l*(2000) [12]. This female predominance could be explained by hormonal effect [12].

Regarding the sensitivity and specificity of Phalen ´s and Tinel´s test, our study shows that the highest specificity was for Phalen´s test which was 94% is nearly similar to the result of Desmet ,*et al (*1995) [16],while sensitivity of phalen`s test which was 78% is higher than the result of prakaush *et al* (2009), which was 59% [22].

Regarding Tinel´s test, its sensitivity in our study is 66% which is close to result of Bruske, *et al(* 2002), they found sensitivity of Tinel´s test to be 67% [15]. while specificity of Tinel´s test in current study is 77% which is nearly similar to result of Frank L *(l*2004) which was seventy 70% [36]. *Eta.*

There are various studies had been done which determined different values for specificity and sensitivity of provocative tests including phalen´s and Tinel´s tests O gradagl, *et al, (*2000) who found out sensitivity of Phalen´s and Tinel´s tests 85% and 38% respectively [21]. But Gonzalez *et al (*2008) found specificity of Phalen´s test and Tinel´s test to be 78% and 85%respectively [17].

The reasons behind these differences in results of sensitivity and specificity of assessed provocative tests in patients with CTS are explained by non-homogenous characters of examined groups of patients. Different degree in progression of the condition [15] as well as other influencing factors like:

Methods of performing these tests seem to play a significant role specially the percussion Tinel´s test; some using their fingertips, while other using neurological hammer. Additionally difference in the forces applied for percussion and the number of percussions, regarding the controls, some regarded a symptomatic

volunteer as a control group While other taking contra lateral hand of the cases as control but other consider symptomatic persons with negative NCS as a control) [15,35,49].

Our study shows 96% of case had numbness which is near to result of Gonzalez , *et al,* (2008), which was 93% . In our study among one hundred cases 78% of them had shown positive result for Phalen´s test which agrees with result of Gonzalez ,et *al,(* 2008). Which found 73% of cases to be positive for phalen´s test [17]. The current study indicated that 15% among CTS cases had bilateral involvement of the hands which is in contrast to study of Norat ,*et al,* which determined bilaterality in seventy 70% of cases of their study the cause of this variation in bilaterality could be explained by difference in the sample size[31] .

The results of current study shows that 76% among the cases were housewives which is in agree with result of Prakaush ,*et al* ,(2009), which was 81%. These being near in results might be due to the fact that the CTS is recognized as an occupational disease [22]. Philip, *et al, (*2011). Regarding the influencing factors such as:age of patients on the results of provocative tests. The current study shows that there is no significant association between them ,this association between age of patient and its influence on [47]. result of both Phalen´s and Tinel´s tests is in agree with that of Bruske ,*et al,(* 2002) which found out that analysis of selected factors as age of patients did not reveal significant influence on the results of both Phalen´s and Tinel ´s tests[15].

Our study found out that there is a significant association between duration of Symptoms and positive results of Tinel ´s test (p-value =0.021), this observation is near to result of Duldey Porras ,*et al* , [41],which was also significant (p value=0.031), while there is no significant association between Phalen´s test and duration of symptoms and this agrees with Bruske, *et al,* (2002) [15].

In present study we confirmed the diagnosis of CTS by Nerve Conduction Study which regarded as gold standard for diagnosis of CTS [2].With its Sensitivity, and specificity of 84% and 99% respectively [43-45]. In a way that our result shows that 44% among one hundred cases had mild, 32% severe and 24% had moderate CTS, while S.AWright (2003) [34] : Said that the diagnosis of CTS can be based on suggestive symptoms and physical signs including Phalen´s and Tinel´s test so NCS did not add to Diagnosis because of false negativity .

The current study indicated that only 8% of cases had thenar muscle wasting which is close to result of Gonzalez R, *et al.* [17] , which was 10% and in contrast to study of Phalen CM [46], which was 41% .The present study shows that there is no significant association(p-value=0.73)between gender of patients with severity of CTS by elecrodiagnostic study which is in agreement with result of Becker *et al* [42].The result in table (2.10) : shows no significant association between Tinel´s test and Phalen ´s test with gender of patient, this near to that of Alexis D *etal* [35].The result in our study shows that there is no significant association between neither Phalen´s nor Tinel´s tests with gender of cases which near to result of Laura. *et al* [24].

These provocative tests (Phalen ´s and Tinel´s tests) may serve as a tool to assess treatment result of both surgical and conventional therapy in a way that Nawrot *et al*), Showed that after median nerve

decompression the incidence of the both clinical tests Phalen´s and Tinel ´s tests results become decreased [31]. While Scazbo *et al* found out that as these clinical tests are available and easy to use diagnostic method constitute s their greatest advantage [30].

Conclusion

1. Phalen´s test is more specific and sensitive than Tinel´s test so it is essential for diagnosis of CTS particularly when NCS is not available.
2. There is significant association between duration of symptoms and positive result of Tinel´s test.
3. There is no significant association between age of patients and results of both Phalen´s and Tinel ´s tests

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