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Carpal Tunnel Syndrome: correlation between preoperative clinical findings and intraoperative findings

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Abstract

Background and objectives: Carpal tunnel syndrome is a puzzling and disabling condition which can be diagnosed on clinical bases only. The aim of this study is to find the correlation between specific clinical findings and intraoperative findings to help us define which clinical finding is the most dependable. **Methods:** Sixty five patients (72 hands) with carpal tunnel syndrome were enrolled in this study. Seven clinical findings (pain & parasthesia, touch sensation, two-point discrimination, weak thumb abduction test, Phalen test, Tinel test & Durkan test) were correlated with 3 intraoperative findings (hour-glass deformity, fibrosis & vascular interruption). **Results:** Pain and paresthesia was present in all 65(100%) of the cases, of this 47(72.3%) had hour-glass formation, while fibrosis was present in 58(89.3%) and in both conditions;their correlation was highly significant. Decreased 2 point discrimination was present in 50(76.9%) of the cases, of this 41(63.1%) had hour-glass formation and fibrosis was present in 47(72.3%) and in both conditions; their correlation was highly significant. Vascular interruption was present in 41(63.1%) and the correlation was highly significant too. **Conclusions:** Most clinical findings were associated with specific intraoperative findings. Of all; pain & parasthesia with 2-point discrimination were associated with 2 and 3 of 3 intraoperative findings respectively and regarded as the most relevant clinical findings when positive.

Key words: Carpal tunnel syndrome, Intraoperative findings, Preoperative clinical findings.

Introduction

Sir James Paget in 1854; was the first to describe Carpal Tunnel Syndrome (CTS) in a case with distal radius fracture[1-3]. It is a puzzling and disabling condition presented to orthopaedic hand surgeons frequently[1,3]. George Phalen in the 1950s popularized the diagnosis and treatment of CTS[4]. It is caused by mechanical distortion produced by a compressive force, so it is a compressive neuropathy, which is defined as a mono neuropathy or radiculopathy[1,3]. The American Academy of Orthopaedic Surgeons (AAOS) clinical guidelines on the diagnosis of CTS defines it as a symptomatic compression neuropathy of the median nerve at the level of the wrist[1,3]. Carpal Tunnel Syndrome is a very well-known and frequent form of median nerve entrapment, it comprises 90% of all entrapment neuropathies[1,3,5-7] and thought to be present in 3.8% of the population worldwide[3], and an increasingly recognised cause of work disability[1]. The overall incidence of CTS is thought to be around 0.4% per year[2]. Carpal Tunnel Syndrome is bilateral clinically in up to 87% of patients and nearly in up to 50% with neurophysiologic testing, patients are usually in their third to fifth decades at the time of diagnosis, women are involved 3 to 10 times more often as men[5], one-third of the patients need surgery[8]. Carpal Tunnel Syndrome can be diagnosed on clinical bases only[9-11], although electrodiagnostic testing is used widely. Nerve conduction studies are not perfect in the evaluation of CTS, with reported sensitivities ranging from 49% to 84% according to many studies[11]. More recently, the American Academy of Orthopaedic Surgeon's clinical practice guidelines have indicated that electrodiagnostic testing may be helpful but not required to establish the diagnosis of CTS[12]. So, without a gold standard, the clinician relies primarily on patient-reported symptoms and a number of clinical tests to diagnose this condition. Even

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the most frequently used tests for diagnosing carpal tunnel syndrome, Tinel's and Phalen's, vary widely in their reported sensitivities and specificities[9,11]. The aim of this study is to find the correlation between specific clinical findings and intraoperative findings to help us define which clinical finding is the most dependable.

Patients and methods

A case series study was performed for 65 patients and 72 hands diagnosed with carpal tunnel syndrome in Sulaymaniyah Teaching Hospital during March 2018- March 2019. Inclusion criteria; any patient diagnosed as CTS aged 18 years and above. Exclusion criteria; any patients aged below 18 years, patients with acute traumatic CTS, pregnant women, neuromuscular disorders, revision cases, mass lesions involving the carpal tunnel and operations performed under regional or general anaesthesia.

A research protocol was approved by research and ethical committee of the Kurdistan Higher Council of Medical Specialties(KHCMS).In each patient after taking informed consent, history was taken and clinical examination of both hands and median nerves was performed at Sulaymaniyah Teaching Hospital. Clinical examination for CTS has been carried out in the following order; fine touch sensation, 2-point discrimination, weak thumb abduction test, Phalen test, Tinel test & Durkan test. In fine touch assessmet, cotton wool was used as standard material applied over the palmar aspect of index finger and compared with the ipsilateral little finger. Weber two-point discrimination test applied using a dull-pointed eye calliper which applied in a longitudinal axis while not blanching the skin over the palmar aspect of index finger and compared with the little finger. The classification of 2 point discrimination values advocated by the American Society for Surgery of the hand was used: Normal (0–6 mm), fair (7–10 mm), poor (11–15 mm), and protective sensation (>15 mm), any measurement greater than 6mm regarded as abnormal. Thumb abduction test was positive if there was weakness of resisted thumb abduction, i.e. movement of the thumb at right angles to the palm. Phalen test was applied by flexing both wrists to 900 for 60 seconds, it was regarded as positive if reproduced the symptoms in the distribution of median nerve. Tinel test was done by tapping on the distal wrist crease over the median nerve and was regarded as positive if reproduced the symptoms in the median nerve distribution. Durkan test was applied by pressing the thumb over the palmar aspect of the wrist at the level of carpal tunnel, a positive test reproduced the symptoms in the median nerve distribution in 60 seconds. All surgical interventions were performed by one surgeon using the same technique of open carpal tunnel release under 2% plain lidocaine as a local anaesthetic with tourniquet control over the arm inflated to 150mm-Hg above systolic blood pressure without squeezing the upper limb, after sterilization with povidone iodine and appropriate drapping the carpal canal was opened through a 2 to 3 cm straight incision running distally from the distal wrist crease and lying slightly ulnar to a line continuous with the radial border of the ring finger. The flexor retinaculum was fully divided exposing the median nerve. The median nerve was inspected for the evidences of structural changes. Structural changes such as 'hour-glass' or 'pseudoneuroma' formation, fibrosis & vascular interruption were recorded according to a severity scheme. Fibrosis & Vascularisation were graded on a scale of 1–3, in which 1 is the absence of the finding , 2 is moderate, 3 is severe. Pseudoneuroma or 'hourglass' deformities were graded as either 0 or 1, the former being absence of the finding. Then the tourniquet released and again the nerve was inspected for the evidence of vascular interruption and all documented. Strict wound hemostasis conducted, the skin was sutured with nylon and a gauze and crepe bandage was applied.

We used "IBM SPSS Statistics version 25" for the analysis of the data. A p-value of ≤ 0.05 was regarded as statistically significant. In addition, Pearson Chi-Square was used to find out the significancy of association between independent and dependent variable pairs.

Results

A total of 65 patients and 72 hands with carpal tunnel syndrome were included. Mean age = 43.3±10.9 SD with a range of (29 to 65 years). Sixty cases were female (92.3%) and 5 cases were males (7.7%). Female to Male ratio (F:M = 12:1). Seven patients (10.8%); 1 male and 6 female patients had bilateral disease operated on two different occasions, Table (1).

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Table (1): Distribution of the study sample according to the demographic characteristics

Demographic feature		No.	%
Age groups (year) (Mean±SD=43.3±10.9)	26-35	25	38.5
	36-45	14	21.5
	46-55	17	26.2
	56-65	9	13.8
Gender	Female	60	92.3
	Male	5	7.7
	Female to Male ratio (F:M) = 12:1		
Hand dominance	Right handed	56	86.2
	Left handed	9	13.8
Side of CTS	Right hand	40	61.7
	Left hand	18	27.7
	Both hands	7	10.8

Of all clinical findings, pain and paresthesia was present in all 65(100%) of the cases, of this 47(72.3%) had hour-glass formation and their correlation was significant, while fibrosis was present in 58(89.3%) and their correlation was significant. Decreased 2 point discrimination was present in 50 (76.9%) of the cases, of this 41(63.1%) had hour-glass formation and their correlation was significant, while fibrosis was present in 47(72.3%) and their correlation was significant, and vascular interruption was present in 41(63.1%) and their correlation was significant. Weak thumb abduction was positive in 55 (84.6%) of the cases, of this 52(80%) had fibrosis and their correlation was significant. Tinel test was positive in 56 (86.2%) of the cases, of this; 50 (76.9%) had vascular interruption and their correlation was significant. Durkan test was positive in 60 (92.3%) of the cases, of this 47(72.3%) had vascular interruption and their correlation was significant, Table (2), Table (3) & Table (4).

Table (2): Association between clinical findings & hour-glass deformity .

Clinical findings	Frequency & Percentage		Hour-glass deformity		
			Absent	Present	p-value
			18(27.7%)	47(72.3%)	
Pain & Parasthesia	Intermittent	32 (49.2%)	17(26.2%)	15(23.1%)	<0.001
	Constant	33 (50.8%)	1(1.5%)	32(49.2%)	
Touch sensation	Normal	13 (20%)	4(6.2%)	9(13.8%)	0.78
	Decreased	52 (80%)	14(21.5%)	38(58.5%)	
2 point discrimination	Normal	15 (23.1%)	9(13.8%)	6(9.2%)	0.001
	Decreased	50 (76.9%)	9(13.8%)	41(63.1%)	
Weak thumb abduction test	Absent	10 (15.4%)	5(7.7%)	5(7.7%)	0.087
	Present	55 (84.6%)	13(20.0%)	42(64.6%)	
Phalen test	Negative	3 (4.6%)	0(0.0%)	3(4.6%)	0.27
	Positive	62 (95.4%)	18(27.7%)	44(67.7%)	
Tinel test	Negative	9 (13.8%)	1(1.5%)	8(12.3%)	0.23
	Positive	56 (86.2%)	17(26.2%)	39(60.0%)	
Durkan test	Negative	5 (7.7%)	0(0.0%)	5(7.7%)	0.15
	Positive	60 (92.3%)	18(27.7%)	42(64.6%)	

Table (3): Association between clinical findings & fibrosis .

Clinical findings	Frequency & Percentage		Fibrosis			
			Nill	Moderate	Severe	p-value
			7(10.8%)	15(23.1%)	43(66.2%)	
Pain & Parasthesia	Intermittent	32 (49.2%)	6(9.2%)	12(18.5%)	14(21.5%)	0.001
	Constant	33 (50.8%)	1(1.5%)	3(4.6%)	29(44.6%)	
Touch sensation	Normal	13 (20%)	3(4.6%)	4(6.2%)	6(9.2%)	0.16
	Decreased	52 (80%)	4(6.2%)	11(16.9%)	37(56.9%)	
2 point discrimination	Normal	15 (23.1%)	4(6.2%)	8(12.3%)	3(4.6%)	<0.001
	Decreased	50 (76.9%)	3(4.6%)	7(10.8%)	40(61.5%)	
Weak thumb abduction test	Absent	10 (15.4%)	4(6.2%)	5(7.7%)	1(1.5%)	<0.001
	Present	55 (84.6%)	3(4.6%)	10(15.4%)	42(64.6%)	
Phalen test	Negative	3 (4.6%)	0(0.0%)	0(0.0%)	3(4.6%)	0.45
	Positive	62 (95.4%)	7(10.8%)	15(23.1%)	40(61.5%)	
Tinel test	Negative	9 (13.8%)	1(1.5%)	3(4.6%)	5(7.7%)	0.72
	Positive	56 (86.2%)	6(9.2%)	12(18.5%)	38(58.5%)	
Durkan test	Negative	5 (7.7%)	0(0.0%)	0(0.0%)	5(7.7%)	0.25
	Positive	60 (92.3%)	7(10.8%)	15(23.1%)	38(58.5%)	

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Table (4): Association between clinical findings & vascular interruption .

Clinical findings	Frequency & Percentage		Vascular interruption			
			Nill	Moderate	Severe	p-value
			13(20%)	26(40%)	26(40%)	
Pain & Parasthesia	Intermittent	32 (49.2%)	9(13.8%)	12(18.5%)	11(16.9%)	0.26
	Constant	33 (50.8%)	4(6.2%)	14(21.5%)	15(23.1%)	
Touch sensation	Normal	13 (20%)	3(4.6%)	8(12.3%)	2(3.1%)	0.11
	Decreased	52 (80%)	10(15.4%)	18(27.7%)	24(36.9%)	
2 point discrimination	Normal	15 (23.1%)	4(6.2%)	11(16.9%)	0(0.0%)	0.001
	Decreased	50 (76.9%)	9(13.8%)	15(23.1%)	26(40.0%)	
Weak thumb abduction test	Absent	10 (15.4%)	4(6.2%)	5(7.7%)	1(1.5%)	0.07
	Present	55 (84.6%)	9(13.8%)	21(32.3%)	25(38.5%)	
Phalen test	Negative	3 (4.6%)	0(0.0%)	3(4.6%)	0(0.0%)	0.095
	Positive	62 (95.4%)	13(20.0%)	23(35.4%)	26(40.0%)	
Tinel test	Negative	9 (13.8%)	7(10.8%)	2(3.1%)	0(0.0%)	<0.001
	Positive	56 (86.2%)	6(9.2%)	24(36.9%)	26(40.0%)	
Durkan test	Negative	5 (7.7%)	0(0.0%)	5(7.7%)	0(0.0%)	0.017
	Positive	60 (92.3%)	13(20.0%)	21(32.3%)	26(40.0%)	

Discussion

Clarification of the diagnostic utility of clinical tests for CTS has been tried through systematic reviews of the literature, but the widespread difference in research methodology and incomplete reporting has led to inconclusive recommendations[11]. Several tests which help in the diagnosis of CTS have been explained. None of these tests are of diagnostic values on their own but they are most useful when applied in a cluster. Usually symptoms, signs and diagnostic tests should be combined when the diagnosis of CTS is made[7].

The importance of electrodiagnostic testing as an essential tool for the preoperative workup continues to be argued, despite its common use to confirm the diagnosis of CTS. Supplemental electrodiagnostic testing has been described to add little in increasing the diagnostic probability of CTS, so some providers have suggested that the routine ordering of electrodiagnostic testing for clinically diagnosed CTS is unneeded, and suggested that it is an irrelevant study that accomplishes little to change surgical treatment strategy[12,13]. Guidelines for healthcare commissioning by the British Society for Surgery of the Hand, the British Orthopaedic Association, and the Royal College of Surgeons recommend that electrophysiological testing should be reserved for conditions where there is diagnostic uncertainty, complex cases, or where there are recurrent symptoms after primary surgery, and that testing is best applied in a specialist centre[14]. Literature data related to grading the severity of clinical and intraoperative gross structural changes that occur in an affected median nerve in CTS is generally diffuse, narrative in nature and usually far from being illustrative[10,15]. Britz et al compared clinical, electrodiagnostic, MRI, intraoperative structural changes and postoperative results, they emphasized on the significance of MRI findings without any clarification about specific clinical tests and the intraoperative structural changes and they classified each patient's finding in to a severity score which is mostly subjective and non- practical[10]. Nau et al compared preoperative clinical assessment, electrophysiological testing, intraoperative finding and postoperative follow up. They didn't mention any correlation between clinical findings and intraoperative morphological changes, and the intraoperative changes such as vascularity, fibrosis and oedema were mentioned but without much details16. In a review article conducted by Leblanc et al., the condition was classified according to different parameters like duration, two point discrimination, weakness, atrophy, electromyography and nerve conduction study, but there was no sharp difference between the stages of the disease[17].

The only study which demonstrated the intraoperative structural changes was done by Tuncali et al[15]. They graded the clinical and intraoperative findings in to a severity score, and correlated with each other. They observed no correlation between electrodiagnostic severity and intraoperative changes, similarly comparison of clinical and electrodiagnostic severity revealed no statistical correlation[15]. So in our study we didn't rely on electrodiagnostic testing for the diagnosis of CTS, and we didn't apply any severity scoring, instead we depended on patient reported symptoms and several clinical examinations, and we compared with specific intraoperative structural changes to find out their significance in practical life. The intraop-

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erative grading criteria used in this study are not new[18-20]. In a series of 34 wrists explored for recurrent CTS, fibrous proliferation was a leading cause in 22 and represented the most frequent surgical finding[21] which is comparable to our study (89.3%). Although Rhoades et al18, could not show a correlation between the degree of fibrosis and preoperative symptoms, it was highly correlated in our series. Fibrosis was highly correlated with pain and parasthesia, decreased 2-point discrimination and weakness of thumb abduction test, which is comparable with a study done by Tuncali et al[15]. The 'hour-glass' formation (pseudoneuroma or 'false' neuroma) was first demonstrated by Marie and Foix in 1913, the swelling is usually considered to be due to oedema formation related to local vascular stasis[15]. Phalen, did not assign pseudoneuroma to be a specific cause in the pathogenesis of CTS but rather an outcome of the pathology, he also pointed to its rare occurrence in patients with severe thenar atrophy[19], which is comparable to our findings, in which atrophy of thenar muscles was present in 6 hands (8.3%), of this none had hour-glass deformity and correlation of hour-glass deformity with weakness of thumb abduction showed no statistical significance.

The pathophysiology of CTS includes a mixture of mechanical trauma, increased pressure and ischemic insult to the median nerve within the carpal tunnel[3]. Prolonged nerve compression may result in fibrotic proliferation creating further mechanical pressure and narrowing of the nerve[6]. It is believed that increased pressure in the carpal tunnel results in chronic ischemia in the median nerve and followed by demyelination[6]. Phalen, has obviously explained the abrupt disappearance of the vasa nervorum of many median nerves at the proximal edge of the transverse carpal ligament[19]. After release of the tourniquet, engorgement of the nerve would develop but this would stop abruptly at the level of the proximal edge where the major site of compression was usually found[15]. In our study, vascular interruption was correlated with decreased 2-point discrimination, Tinel test and Durkan test which is comparable to the study done by Tuncali et al[15]. In a systematic review by D'Arcy et al[13], several classical findings of CTS have little or no diagnostic value, including nocturnal parasthesia, Phalen and Tinel signs, thenar atrophy, 2 point discrimination, vibratory, and monofilament sensory testings, but sensory abnormality was a useful finding in their review[13]. In contrary, our study showed that pain and parasthesia, 2-point discrimination test, weakness of thumb abduction test, Tinel and Durkan tests were of diagnostic value, while Phalen test and sensory abnormality were not of clinical significance. Several studies addressed the diagnostic accuracy of combined clinical findings, but no combination consistently proved significantly more helpful than the individual findings themselves[9,13]. Tinel, is the least accurate test according to Mondelli et al., who did not find a combination of signs more useful than a single sign alone[7], this is in contrast to our study in which Tinel test was associated with vascular interruption but Phalen test and touch sensation were not associated with any intraoperative findings, and are not dependable. Open carpal tunnel release is the classical option and still the recommended method of surgical treatment for idiopathic CTS, it was first performed by Herbert Galloway in 1924, though since then several transformations have been made to improve it[7]. Carpal tunnel release is most commonly performed as a day case procedure using local anesthesia and a tourniquet in many other centers as well as ours[2]. Carpal tunnel decompression has been applied even in patients with advanced thenar atrophy and sensory deficits as they get benefit from it[5,7,15].

Women are considerably more prone to CTS in a ratio of 3:1 to about 10:1[5], in our study the ratio was higher than that 12:1. One weakness of our study is that we depended on an array of intraoperative structural changes which are subjective and liable to interobserver bias, so some degree of observer experience is still needed for an intraoperative evaluation. Further prospective comparative studies are needed in order to prove the value of this correlation.

Conclusions

Most clinical findings were associated with specific intraoperative findings, of all pain & parasthesia with 2-point discrimination were associated with 2 and 3 of 3 intraoperative findings respectively and regarded as the most relevant clinical finding when positive.

Conflict of interest

Nothing to declare.

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