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The Agreement of Clinical Evaluation and Electrodiagnostic Studies in a Modified Surgical Technique in Carpal Tunnel Syndrome Management

KHALED M. ELSHERBENY, M.D.; ADEL H. AMR, M.D. and EMAN N. MOHAMED, M.D.

The Department of Plastic, Burn and Maxillofacial Surgery, Faculty of Medicine, Ain Shams University

ABSTRACT

Background: Electrodiagnostic studies had become a routine workup in the evaluation of carpal tunnel syndrome (CTS). The presence of a relatively considerable group of patients with positive clinical findings and negative electrodiagnostic studies constitutes a problem that faces plastic surgeons. In these group pf patients, the question remains whether to take them to surgery or not? The release of median nerve is the primary objective of surgical treatment. open approach is still one of the most preferred methods of release. This includes transverse carpal ligament release as well as antebrachial fascia. This observational prospective study includes a group of patients that undergone surgery for treatment of carpal tunnel syndrome with improved technique of release resulting in symptoms relief after 1 year following surgery. The results were analysed to correlate the agreement of electrodiagnostic studies and clinical findings in CTS as well as the benefit of the improved technique in management of carpal tunnel syndrome.

Aim of Work: A refining a surgical method for carpal tunnel treatment and testing its effect on surgical outcome B-checking the agreement between electrodiagnostic studies and clinical evaluation in diagnosis of CTS.

Patients and Methods: 26 adult patients (22 females,4 males) were included in this prospective study from July 2016 to July 2020. All patients had awakening night pain with numbness in fingers suggestive of CTS. Durkan carpal compression test and electrodiagnostic studies were done. All patients underwent surgery in the form of transverse carpal ligament and antebrachial fascia release where the distance of release was measured. Data were recorded and analysed using the Statistical Package for Social Sciences (SPSS version 25).

Results: All patients didn't experience awakening night pain or numbness in fingers after one year postoperatively which constitutes 100% cure rate. The mean distance of antebrachial fascia release was (1.92±0.27) cm. There were no tender scars, hyperesthesia at wrist region or limitation of movements in fingers. preoperative findings showed that the awakening pain and numbness sensitivity is 100%, Durkan compression test sensitivity is 80.8%, the electrodiagnostic studies sensitivity is 38.5%, the agreement between the Durkan compression test and electrodiagnostic studies as regard diagnosis was 42%.

Conclusion: Antebrachial fascia release for (1.92±.27) cm resulted in complete symptom relief with no complications. The electrodiagnostic studies alone showed least sensitivity in diagnosis of CTS and poor agreement with clinical evaluation.

Key Words: *Carpal tunnel syndrome – Durkan compression test – Antebrachial fascia – Electrodiagnostic studies.*

Disclosure: No conflict of Interest.

Ethical Committee: Institutional Review Board (IRB) ethical approval and patient consents were obtained in Ain Shams University Faculty of Medicine.

INTRODUCTION

Carpal tunnel syndrome (CTS) is characterized by numbness, tingling, burning, and pain associated with localized compression of the median nerve at the wrist. It is considered as one of the most common entrapment neuropathies. Although the diagnosis and treatment of carpal tunnel syndrome (CTS) had been the subject of research for a long period of time, the American Academy of Orthopaedic Surgeons (AAOS) has stated, “high-quality evidence is not readily available for CTS diagnosis at this time” **[1]**. Electrodiagnostic studies (EDS) are used to diagnose CTS. However, these exams are prone to false positive and negative values, questioning their use as a reference standard. The gold standard clinical evaluation of CTS reveals pain and paraesthesia in the distribution of the median nerve, which includes the palmar aspect of the thumb, index and middle fingers, and radial half of the ring finger, still the probability of diagnosis of CTS clinically carries a very wide range from 25-85% **[2]**. The fact that opinions vary about the correlation between clinical evaluation and EDS makes this point an ongoing unsettled matter. The surgical technique using open carpal

Correspondence to: Dr. Eman Nagy Mohamed
E-Mail: e.nagy@hotmail.com

tunnel release forms about (73%) of cases in one of national survey done by hand surgeons in Brazil. The technique while doing that included opening of transverse carpal ligament in addition to antebrachial facia in 65% of the survey results, also flexor tendon tenolysis constitutes 13% of same survey **[3]**. The opening of antebrachial fascia was described before but on the expense of doing extended skin scar beyond wrist, also the extent of opening that fascia has not been described before, carrying a risk of complications at the wrist area and digits.

Aim of work: (A) Refining a surgical method for carpal tunnel treatment and denoting its effect on surgical outcome. (B) Checking the agreement between electrodiagnostic studies and clinical evaluation in diagnosis of CTS.

PATIENTS AND METHODS

Patients:

Institutional Review Board (IRB) ethical approval and patient consents were obtained in Ain Shams University Faculty of Medicine.

26 adult patients (26 hands) 22 females and 4 males were included in this prospective study from 1st July 2016 to 1st July 2020. They presented with awakening night pain in the palmar aspect of their hands which was stinging in nature and associated with numbness. Durkan carpal compression test and electrodiagnostic study were done to all patients. All patients were diagnosed as carpal tunnel syndrome. All patients had surgery in the form of carpal tunnel release using open method with antebrachial fascia release.

Inclusion criteria:

1- Patients with awakening night pain.

2- Presence of numbness along distribution of median nerve.

Exclusion criteria:

1- Previously operated patients with carpal tunnel syndrome.

2- Thinning or wasting of muscles of hand.

3- Previous trauma to forearm.

Methods:

All included patients had:

• *History taking:*

A- Personal history.

B- Medical history.

C- Surgical history.

D- Special habits (e.g., smoking).

• *Clinical examination:*

A- General examination.

B- Vital signs.

C- Local examination of both hand.

D- Durkan carpal compression test.

• *Investigations:*

A- Preoperative investigations (e.g., blood glucose).

B- Electrodiagnostic studies (electroconductive study, electromyography).

I- Results were classified according to Bland's neurophysiological grading scale Table (1).

Table (1): Bland's neurophysiological grading scale.

0	Normal	Normal motor and sensory conduction studies
1	Very mild	CTS demonstratable only with most sensitive tests
2	Mild	Sensory nerve conduction velocity slow on finger/wrist measurement Normal motor terminal latency
3	Moderate	Sensory potential preserved Motor slowing DML to APB <6.5ms
4	Severe	Sensory potential absent Motor slowing DML to APB <6.5ms
5	Very severe	Sensory potential absent Motor slowing DML to APB >6.5ms
6	Ext severe	Sensory and motor potential effectively unrecordable Surface Motor potential from ABP <0.2mv amplitude

All patients were diagnosed as CTS and surgery (carpal tunnel release) was done where dominant hand was done first in bilateral cases.

• *Operative procedure:*

After signing consent under general anaesthesia included patients had incision just ulnar to the thenar crease and not reaching the distal wrist crease with locating the carpal ligament. Median nerve is recognized in the distal part of incision. A spatula is introduced from distal to proximal and carpal tunnel is opened. The skin proximally is retracted showing the median nerve and antebrachial fascia. The antebrachial fascia is severed, and application of little finger is done to palpate any tough edges of fascia where it is released. The distance of fascial release is measured from wrist crease. Wound Closure in layers and application of bandage with no splint is done. Fig. (1), the patient was instructed to remove bandage after a week where mobility is checked and was instructed to continue with physical medicine doctor.

Fig. (1): Operative procedure: Carpal tunnel release. (A): Had incision just ulnar to the thenar crease. (B): Locating carpal ligament. (C): Identification of median nerve. (D): Antebrachial fascia release. (E): Ensuring absence of tight bands by fingertip. (F): Measurement of distance of fascial release. (G): Incision after closure. (H): Bandage without splint.

• *Follow-up:*

Included patients were followed-up one year for:

Clinical outcome including presence of awakening night pain, numbness at volar aspect of palm and fingers, Tender scar, hyperesthesia at distal forearm and limitations of digital and wrist flexion.

• *Statistical data:*

Statistical analysis:

Data were analysed using the Statistical Package for Social Sciences (SPSS version 25). Descriptive analyses were performed to obtain the means, and deviations for quantitative data, and Numbers and frequencies for qualitative data.

Different types of graphs were used according to the type and distribution of data (bar, pie and error bars).

Bivariate analyses were performed using the independent samples "*t*" test, the Analysis of Variance (ANOVA) test, and the chi-squared test for categorical variables. *p*-value <0.05 was considered significant.

RESULTS

26 patients (26 hands) 22 female (84.6%) 4 male (15.4%) were diagnosed as CTS, the age of patients was from29-50 years with Mean ± SD 40±5, the duration of pain was from 1 to 4 month with Mean ± SD 3±1,16 Patient (65.4%) were right-handed, 2 patients (7.70%) were left-handed and 4 patients (26.90%) were bilateral. Table (2), Fig. (2). The relationship between age, sex and duration of pain showed no statistical significance. The comparison between gender and clinical data and electrodiagnostic studies showed no statistical significance except in Duran compression test showed significant *p*-value in females Table (3).

Table (2): Patient's demographic and clinical data (N=26).

Age	Mean ± SD	40±5
	Min - Max	29-50
Duration of	Mean	3±1
the disease (month)	Min - Max	1-4
Gender	Male	4 (15.4%)
	Female	22 (84.6%)

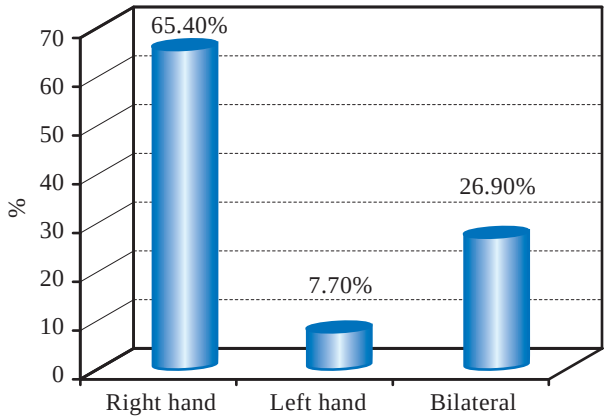

Fig. (2): Shows the frequency of affected sides among the study group (N=26).

Table (3): Comparison between gender, clinical data and electrodiagnostic studies.

	Sex				Chi-square test	*p*-value
	Female		Male			
	N	%	N	%		
Hand side:						
Rt hand	16	72.7	1	25.0	5.60	0.06
Lt hand	2	9.1	0	0.0		
Bilateral	4	18.2	3	75.0		
Durkan compression test:						
Negative	2	9.1	3	75.0	9.96	0.002*
Positive	20	90.9	1	25.0		
Electrodiagnosistic:						
Negative	14	63.6	2	50.0	0.266	0.606
Positive	8	36.4	2	50.0		
Degree of ENG:						
Negative	14	63.6	2	50.0	1.67	0.643
Mild	3	13.6	0	0.0		
Moderate	2	9.1	1	25.0		
Severe	3	13.6	1	25.0		

Preoperatively all patients had awakening pain at night with numbness along the volar aspect of digits with a 100% statistical value, the Durkan compression test was positive in 80% of cases, the electrodiagnostic tests was positive in 38.5% of cases, the chance that the Durkan compression test or the electrodiagnostic test is positive is 57.6%, the chance that both are positive is 30.8%. Table (4), Fig. (3). The agreement between electrodiagnostic studies and clinical evaluation (Durkan compression test) is 42% Table (5). All patients had done surgery where the mean distance of antebrachial fascia release was from 1-2cm with a Mean ± SD of 1.92±0.27, Table (6). All patients

did not experience awakening night pain, numbness at volar aspect of palm and fingers, Tender scar, hyperesthesia at distal forearm and limitations of digital and wrist flexion 1y postoperative (100%). Fig. (4) (video supplement).

Table (4): Frequency of clinical data, investigation and outcome among the study group (N=26).

		N	%
Awaking pain at night	Yes	26	100.0
Durkan compression test	Negative	5	19.2
	Positive	21	80.8
Electrodiagnosistic test	Negative	16	61.5
	Positive	10	38.5
At least one positive	Negative	11	42.3
	Positive	15	57.6
Both test positive	Negative	18	69.2
	Positive	8	30.8
Surgical treatment	Yes	26	100
	No	0	0
Improvement of symptoms after surgery	Negative	0	0
	Positive	26	100

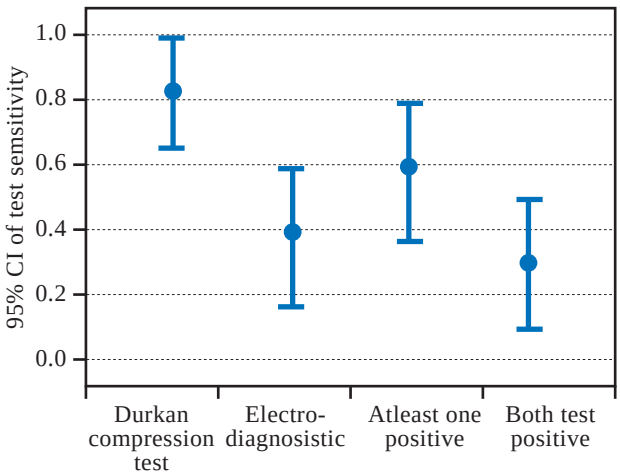

Fig. (3): Shows sensitivities (95%CI) of different diagnostic tests (N=26).

Table (5): The agreement between tests results.

	Durkan compression test		Total
	Negative	Positive	
Electrodiagnosistic:			
Negative	3	13	16
Positive	2	8	10
Total	5	21	26

The percentage of agreement between the two test results = 42%. Cohen's Kappa = 0.01 (*p*-value = 0.937).

Table (6): Relationship between antebrachial fascia release and postoperative results.

	Durkan compression test		Total
	Negative	Positive	
Electrodiagnostic:			
Negative	3	13	16
Positive	2	8	10
Total	5	21	26

The percentage of agreement between the two test results = 42%. Cohen's Kappa = 0.01 (*p*-value = 0.937).

Fig. (4): Video recording showing full function recovery with no limitation of finger movement.

DISCUSSION

The use of electrodiagnostic studies in diagnosis of CTS had become more like a routine. Some doctors depend on these studies without recognizing the main limitations of electrodiagnostic test in diagnosis of the disease. The fact that some patients with evident clinical picture of CTS and normal electrodiagnostic studies would not receive the proper treatment at the proper time constitutes a problem. The further tests used to confirm an obvious clinical diagnosis can be viewed as waste of time, medical resources, and money. This fact had triggered us to evaluate and measure the agreement between electrodiagnostic studies and clinical evaluation.

In the current study, the mean age of the patients was 40±5, more common in females (84.6%) bilateral in (26%) of cases with a mean duration of 3±1 month. Several studies confine with this demographic data and prevalence **[4,5]**. The comparison between gender and clinical data and electrodiagnostic studies reveal no statistical difference except in Durkan compression tests in females which was statistically significant, and we attribute that to statistical error type 1 due to small sample size.

The clinical symptoms in the form of pain and numbness along the median nerve distribution in hand was present in 100% of cases (sensitivity 100%). The type of pain was stinging in nature enough to wake the patient at night more than one

time, this pain was relieved temporary by anti-inflammatory medicine. Jennifer **[6]** described the sensitivity of night pain to be 70% which indicates a reliable symptom of CTS. In this study Since all patients had relief of such symptoms after carpal tunnel release indicating that this type of awakening pain with numbness is pathognomonic to carpal tunnel syndrome to a degree that necessitate surgery. Numerous signs and provocation tests have been described for clinical evaluation of carpal tunnel syndrome as Phalen test, Tinel sign, scratch collapse test and Durkan compression test **[7,8,9,10]**. The Durkan carpal compression test is a test where the assessor presses over the carpal tunnel with his or her thumbs and generates numbness/tingling in the median nerve distribution within 30 seconds **[9,17]**. It is Considered the most sensitive and specific provocative test for diagnosing CTS (Sensitivity 87%, Specificity 90%). It is a simple, fast, and very reliable provocative test. This test is also an appropriate manoeuvre in wrists with limited range of motion or pain **[8]**. In this study the test revealed a sensitivity of 80.8% which is comparable to finding of several authors that indicated that the test is 70% and 90% sensitive consequitivly **[6,11]**.

Electrodiagnostic studies have a sensitivity of 56% to 85% for CTS **[5]**. In this study the sensitivity of electrodiagnostic studies is 38.5%. This can be explained by the limitation of the test as the measurement of nerve latency indicates the conduction of the best myelinated fibres rather than the most severely affected axons, and normal latency may still be present even when many nerve fibres are affected. This confines with the fact that in all cases patients were suffering clinically from awakening night pain and numbness carried by unmyelinated fibres which are first to be affected by compression.

Electromyography assesses pathologic changes in the muscles innervated by the median nerve, typically the abductor pollicis brevis muscle **[4]**. Motor nerve involvement according to electrodiagnostic studies showed muscle affection in 27% of cases (moderate and severe cases) while clinically there was no clinical evidence based on patient complaint or clinical examination. Although EMG is generally normal until the end of the disease, the use of surface electrodes may not give the accurate results and needle EMG are more accurate which was not the case in this study also this type of test is somehow operator dependant.

The sensitivity of combining of the two tests (the Durkan compression test and electrodiagnostic studies) for diagnosis of CTS versus using one of these tests alone has changed the sensitivity from 57.6% to 30.8%. This is explained by the low sensitivity of electrodiagnostic studies. The agreement between the electrodiagnostic studies and Durkan compression tests was 42%. The fact that the electrodiagnostic studies sensitivity was 38.5% and its agreement about 42% in the studied patients who had CTS that was relieved by surgery indicates that using Durkan compression test alone is far better in diagnosis of CTS that needed surgery.

A lot of surgical techniques for carpal tunnel release have been described that include open technique, small incision, and endoscopic release **[12-15]**. The results as regard the release of transverse carpal ligament were not quite different, yet limitations as median nerve neurolysis and tenolysis are present in endoscopic approach. In this study neither median nerve neurolysis or tenolysis was done due to the risk of median nerve injury and adding adhesions with no added value from our perspective. All patients (100%) in this study had complete relief of awakening pain and numbness with only transverse carpal tunnel and antebrachial fascia release. The value of opening the antebrachial fascia was based on the importance of the complete incision of all distal extension of the roof of the carpal tunnel and also of the proximal fascia to the transverse carpus ligament as the proximal and distal aspects of the fascia are important sources of carpal tunnel syndrome **[16]**. The transition area between the forearm fascia and the transverse carpal ligament is the most likely site of flexion-induced deformation of the median nerve and constitute one of the aetiology for compression **[11]**. In techniques where release of the antebrachial fascia is done, the skin incision is extended proximally in a zigzag pattern across the wrist in an ulnar direction. This extension adds a scar which is not appreciated by patients specially females, the possibility of injury to palmar cutaneous branch is there, adding dissection along planes may increase the possibility of adhesions along flexor tendons at this area. In this study no extension of incision had been made where the incision ends before wrist crease and skin retraction was done and antebrachial fascia was released with completion of procedure by blunt dissection (fingertip) for any remnant tight bands that exists. The distance of fascial release from wrist crease was measured with a resultant value1.92±0.27cm. This modification had shortened the scar by 2cm which was appreciated specially in females. There were complete relief of awakening pain and numbness up to 1 year postoperative, no recurrence. In the meantime, there were no complications recorded as hyperesthesia in wrist area due to possible partial

nerve injury or limitation of movements due to possible adhesions.

Conclusions:

Electrodiagnostic studies has the least sensitivity in diagnosis of CTS and 42% agreement with clinical evaluation which makes it far less reliable method for diagnosis. The presence of awakening pain and numbness with positive Durkan compression test even without electrodiagnostic studies can confirm diagnosis of CTS.

The distance of release of antebrachial fascia for a 1-2cm is a reliable modification with no recorded complications.

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