

## AGREEMENT BETWEEN ULTRASONOGRAPHY AND NERVE CONDUCTION STUDIES IN ASSESMENT OF SEVERITY OF CARPAL TUNNEL SYNDROME

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### ABSTRACT

**Objective:** To determine the agreement between ultrasonography and nerve conduction studies in the assessment of severity of carpal tunnel syndrome.

**Study Design:** Cross sectional descriptive study.

**Place and Duration of Study:** Conducted at Radiology Department Combined Military Hospital Lahore, from Aug 2014 to Feb 2015.

**Material and Methods:** Cases were selected from the Rehabilitation Medicine OPD of Combined Military Hospital Lahore. Total 130 cases of NCS positive carpal tunnel syndrome were included in the study selected on non probability convenience sampling technique. Ultrasound of wrist was conducted and results compared with nerve conduction study findings. Measurements were taken for the median nerve at the carpal tunnel inlet proximally. Patients were distributed in mild, moderate and severe grades according to ultrasound and nerve conduction studies. Agreement was determined using statistical analysis. Data entry and analysis was done by using SPSS version 20.

**Results:** The average percentage of agreement between Ultrasound wrist and nerve conduction studies for assessment of severity of carpal tunnel syndrome is 63.4%.

**Conclusion:** Ultrasound is an additional noninvasive modality for assessment of severity of carpal tunnel syndrome having results comparable to nerve conduction studies.

**Keywords:** Carpal tunnel syndrome, Median nerve, Nerve conduction study, Ultrasound wrist.

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### INTRODUCTION

Carpal tunnel syndrome (CTS) is symptomatic compression neuropathy of the median nerve at the level of the wrist characterized physiologically by evidence of increased pressure in the carpal tunnel and decreased function of the nerve at that level<sup>1</sup>. It has a prevalence of 2.7 to 5.8% in adult population<sup>2</sup> and is more common among adult women (9%) than men (0.6%)<sup>3</sup>. Although CTS can be diagnosed on the basis of history and electrodiagnostic tests like nerve conduction studies (NCS) are used to confirm the diagnosis. NCS have a sensitivity of 86% and specificity of 95%<sup>2,3</sup>. In recent years the imaging techniques like ultrasonography (USG) has gained interest as an alternative diagnostic test for CTS<sup>1</sup>. The cross-

sectional area of the median nerve at the inlet of the carpal tunnel (at the level of the pisiform bone) is the most sensitive and specific ultrasound finding in patients with CTS<sup>1</sup>. Ultrasound has sensitivity of 94% and specificity of 98% in one study<sup>1,4</sup>. Recent advances in ultrasound (USG) equipment have improved the quality of US images for clearer evaluation of soft tissue<sup>3</sup>. In comparison with NCS, ultrasonography has many advantages such as: availability, lower cost, non-invasiveness and shorter examination time<sup>3</sup>. There is significant agreement between ultrasound and NCS findings in diagnosing CTS. In one study the agreement between Ultrasound and NCS was 61.9%<sup>7</sup>. The aim of this study is to calculate the agreement between ultrasonography and nerve conduction studies in assessment of severity of carpal tunnel syndrome. The results could be used to evaluate CTS using ultrasonography only, especially in our health care facilities where the facility of NCS is not readily

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available, thus providing prompt diagnosis, early treatment and reducing patient's morbidity. In addition to CTS diagnosis, sonographic measurement of cross sectional area (CSA) could also give additional information about severity of median nerve involvement. Use of ultrasound will also cost-effectively reduce the number of NCS in patients with suspected CTS.

## **MATERIAL AND METHODS**

This cross-sectional descriptive study was conducted after approval from the Hospital ethical committee and all the data was collected after informed written consent of all patients. Sample size of 130 cases is calculated with 95% confidence level, 8.5% margin of error and taking expected percentage of agreement between USG and NCS in the diagnosis of severity of CTS i.e. 61.9%<sup>7</sup>. Non probability consecutive sampling technique was used. Patients referred by clinicians with clinical diagnosis of carpal tunnel syndrome. Patients of any sex willing to undergo the tests were included. Patients below 12 over 65 years of age were excluded from the study because of short caliber of Median nerve as compared to adults in children and arthritic changes in elderly. Patients with traumatic or congenital wrist deformities because it will impair the accurate measurement of median nerve at the wrist by Ultrasonography were also excluded. Hospital registration numbers of all patients included in the study were be recorded. All patients with clinical diagnosis of carpal tunnel syndrome underwent NCS in the Rehabilitation department CMH Lahore by consultant specialist in Rehabilitation Medicine using neurowork system and then underwent ultrasonography by me in Radiology Dept CMH Lahore using medison sonoace accuvix V20. The sonographic examination was performed with the patient seated in a comfortable position facing the radiologist, with the forearm resting on the table and the palm facing up in the neutral position. Measurements were taken for the median nerve at the carpal tunnel inlet proximally. The mean cross-sectional area of the median nerve was measured by tracing with

electronic calipers around the margin of the nerve at the time of sonography (direct tracing). Medison sonoace accuvix V20 was used for all patients with a 7.5 MHz high frequency linear array transducer. All the relevant details were recorded separately for each patient along with the I.D number and other information on performa. Bias if any was controlled by involving same specialists in conduction and reporting of NCS and USG. All data collected was analyzed using SPSS version 20. Mean, Median & Standard deviation were calculated using the quantitative variable like age and cross sectional diameter of median nerve, whereas frequency was calculated for qualitative variables like gender, severity grades of CTS on ultrasonography and NCS. The agreement between NCS and USG in showing CTS severity (Mild, Moderate and Severe) was calculated with Cohen's kappa coefficient. A *p*-value of less than 0.05 was considered significant.

## **RESULTS**

A sum total of 130 cases were included in the study over a period of 06 months and all the patients met the above mentioned criteria. All the patients first underwent NCS at the rehabilitation medicine department CMH Lahore by the same person in same room and under similar conditions to exclude environmental effects like temperature and humidity. These patients then underwent USG in the radiology department CMH Lahore by me. Out of 130 patients examined, 91 were females (70%) and 39 were males (30%). The minimum age was 18 years and maximum age was 63 years; mean age 40.5 years and SD  $\pm$  22.5. Most of the patients were between 27-52 years. In 85% cases (111 out of 130) CTS was idiopathic and no etiology was found. However in remaining 15% an underlying cause was identified, 4 patients had degenerative changes at the wrist, 5 patients had hypothyroidism and in 10 cases it was pregnancy related. In 23 cases the disease was bilateral involving both wrist joints (table-I). Most of the female patients were housewives and most of the male patients were manual workers. Out of the 130 cases  $54 \pm 14$  (41.5%) were categorized as

mild, 55 ± 12 (42.3%) as moderate and 21 ± 4 (16.2%) as severe cases according to USG findings. Out of the 130 cases 48 ± 8 (36.9%) were categorized as mild, 57 ± 14 (43.8%) as moderate and 25 ± 8 (19.2%) as severe cases according to NCS findings. The findings on both investigations for the assessment of severity of CTS grades were analyzed and then subjected to correlation and Cohen’s kappa agreement

disease on USG (table-II). These findings suggested a significant correlation between NCS and USG for the assessment of CTS. According to Pearson’s R and spearman statistics there was about 0.696 correlation between the two investigations which is statistically significant (table-III). Cohen’s Kappa coefficient was also applied to determine the agreement between the two parameters. The data revealed a Cohen’s

**Table-I: Baseline characteristics of the patients.**

Variable	Value
Age (years)	40.5 ± 22.5
Sex (males: females)	39 : 91 (30% : 70%)
No. of patients/wrists examined	107/130
Duration of symptoms (months)	12 ± 6
<b>Side affected</b>	
Right	67 (51.5%)
Left	17 (13%)
Bilateral	46 (35.3%)

Except where indicated otherwise, the data are presented as mean ± SD or n (%) values.

**Table-II: Cross sectional area on USG \* Severity grades on nerve conduction studies crosstabulation.**

		Severity Grades on Nerve Conduction Studies			Total
		16-20 uV	5-15 uV	<5 uV	
Cross sectional Area on USG	10.80	40	11	3	54
	11.4	7	43	5	55
	12.0	1	3	17	21
<b>Total</b>		48	57	25	130

**Table-III: Symmetric measures.**

		Value	Asymp. Std. Errora	Approx. Tb
Interval by Interval	Pearson's R	0.696	0.064	10.964
Ordinal by Ordinal	Spearman Correlation	0.689	0.063	10.742
Measure of Agreement	Kappa	0.634	0.059	9.804
N of Valid Cases		130		

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

statistics and results were observed. 40 (30.7%) cases were diagnosed as having mild disease both on NCS and USG. While 8 (6%) cases were wrongly diagnosed as having either moderate or severe disease on USG. 43 (33%) cases were diagnosed as having moderate disease both on NCS and USG. While 14 (10.7%) cases were wrongly diagnosed as having either mild or severe disease on USG. 17 (13%) cases were diagnosed as having severe disease both on NCS and USG. While 8 (6%) cases were wrongly diagnosed as having either mild or moderate

kappa coefficient of 0.634 which represents substantial agreement between these two investigations in the assessment of severity of CTS (table-III). Cohen's kappa (κ) can range from -1 to +1. Based on the guidelines from Altman (1999), and adapted from Landis & Koch (1977), a kappa (κ) of 0.634 represents a substantial agreement.

**DISCUSSION**

Carpal tunnel syndrome (CTS) is the most common form of peripheral nerve entrapment

and is particularly prevalent in middle-aged women. In most of the cases it leads to symptoms complex, and the cause is usually uncertain. In most cases carpal tunnel syndrome can be readily identified by the examining clinician, and the clinical findings alone may be sufficient for diagnosis. In our study we incorporated patients which are diagnosed as having carpal tunnel syndrome in Rehabilitation Medicine OPD, CMH Lahore on NCS. These patients were then referred to Radiology department where ultrasound wrist was carried out after having informed consent. My research protocol shows that most of the patients suffering from carpal tunnel syndrome were females (70%) general age range falls between 27-52 years. It was observed that mostly middle aged females were affected by this disease. Ajeena *et al*<sup>14</sup> also reported similar findings in her study. Various studies carried out so far have used different measurements for the diagnosis of CTS. The most accurate sonographic finding appreciated was the increased cross sectional diameter of median nerve<sup>10</sup>. The median nerve cross sectional area was measured by direct (area trace) method, the method used in various other studies as well. Karadag *et al*<sup>7</sup> studied the relationship between USG and NCS in the assessment of severity of CTS and he found significant correlation between these two investigations. According to his study USG and NCS showed 61.9% agreement in the assessment of severity grades of CTS. He also mentioned that both USG and NCS are complementary tests having separate edge over each other. USG is better at showing anatomy of the region and physical causes of CTS while NCS was better at determining the functionality of MN at CT. They also included other parameters like visual analog scale and body mass index as coincident factors which can influence CTS severity. Similarly Kang *et al*<sup>5</sup> in their study determined that there is a 72% correlation between USG at wrist and the severity of CTS at wrist. They said there is a substantial agreement between the two tests and both tests are complementary to each other in the determination of disease severity. They also

divided CTS severity into mild, moderate and severe and then assessed it against USG CSA of MN at wrist. Their results showed 72% correlation. They also determined wrist to forearm ratio for their study. In another study however Ayatollahi and Saied *et al*<sup>4</sup> found out a weak correlation between USG and NCS. According to them their results showed only a weak link that is 38% between the two investigations in assessment of CTS. However they mentioned in their study that other studies have shown significant agreement between the two. Azami *et al*<sup>12</sup> and Tajika *et al*<sup>13</sup> also reported that the findings of CSA on USG correlated with the severity grades of CTS according to NCS. Qualitative analysis of the MN at wrist revealed that not only does USG measure the CSA of MN at wrist joint but also it provides a lot of additional anatomical information which includes direct and indirect causes of MN swelling at wrist joint resulting in CTS. These include causes like mass lesions at wrist joint, and inflammation or swelling of tendon sheaths, any vascular malformation, traumatic variations in anatomy resulting in narrowing of CT and local compressions by variations in the anatomy of MN. All this information is an additional tool which can help patients a lot in reaching a definite diagnosis and a definite cause of CTS. This will result in significant reduction in the morbidity of the patient and delay in the diagnosis which is usually delayed in these patients. USG is probably preferable because it is painless, fast, easily accessible and preferred by the patients<sup>11</sup>. NCS is an invasive test and is not easily available in smaller medical facilities so patient has to get referred to a tertiary care facility to undergo this investigation. USG on the other hand is easily available and non invasive and also cost effective test which result in less patient morbidity. It is also more acceptable to patient as compared to the invasive NCS. The results of my study show that the USG can be strongly adjunctive to NCS in reaching a final diagnosis and confirming the severity of the disease. USG in no way can replace the NCS

completely but it can be used with confidence and reliability as an adjunctive test for the benefit of patients. Significant correlation was found in our study according to Pearson’s R and Spearman tests which is 69.6% and 68.9% respectively. Cohen’s kappa coefficient also showed substantial agreement. These findings signify that USG and NCS are at same page in the assessment of CTS patients and USG should be used as an adjunctive test.

**CONCLUSION**

Ultrasound is an additional noninvasive modality for assessment of severity of carpal tunnel syndrome having results comparable to nerve conduction studies.

**CONFLICT OF INTEREST**

This study has no conflict of interest to be declared by any author.

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