MEDIAN NERVE DIMENSIONS, A PREDICTIVE FACTOR FOR CARPAL TUNNEL SYNDROME

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DROME **(Abstract)** : Introduction. Carpal tunnel syndrome is the most frequent type of upper
limb compression neuropathies. Sometimes, it's quite difficult to diagnose it only by the signs and
syptomes observed by the examiner. Using ultrasound examination to assess the median nerve in
the carpal tunnel syndrome is a relatively recent acquisition, but as imaging techniques have
evolved, some authors consider that sonography can even replace electrophysiological studies.
Material and methods.The study included 29 asymptomatic subjects without injuries at the level
of carpal tunnel or palmar region and 7 patients hospitalized in the Department of Plastic Surgery
of SUUB diagnosed with carpal tunnel syndrome. For each of the persons included in the study
median nerve cross-sectional area was measured.Results. The cross-sectional area of the median
nerve fot the asymptomatic subjects were between 8.5 and 14.2 mm^2, with a mean value of
$10,18 \pm 1,55$ mm^2. A cross-sectional area value above 10, 182 mm2 can be suggestive for the pres-
ence of carpal tunnel syndrome, when associated with characteristic signs and symptoms. Conclu-
sions. Sonographic examination of the median nerve and measurement of its cross-sectional area
is a useful diagnostic tool in the evaluation of carpal tunnel syndrome. **Key words** : ASYMPTO-
MATIC, SONOGRAPHIC, CROSS-SECTIONAL AREA, COMPRESSION

INTRODUCTION

Carpal tunnel syndrome is the most frequent type of upper limb compression neuropathies. Sometimes, it's quite difficult to diagnose it only by the signs and syptomes observed by the examiner. (1)

Most experts believe that the diagnosis for this disease is based on patient history and clinical examination, the accuracy of the latter depending heavily on examiner's experience. Because there may be pathologies which hide or exacerbate certain symptoms, making diagnosis difficult, challenge tests may be used.(2) These can be useful for making a differential diagnosis with a wide range of diseases, such as : peripheral neuropathy, cervical radiculopathy, multiple sclerosis, syringomyelia, rheumatoid arthritis, Raynaud syndrome, tenosynovitis syndrome, motor neuron disease, localized muscle dystonia.

Using ultrasound examination to assess the median nerve in the carpal tunnel syndrome is a relatively recent acquisition, one of the first papers in this respect was made by Buchberger in 1992, and most studies were published after 2000. As imaging techniques have evolved, some authors consider that sonography can even replace electrophysiological studies (1), (3), (4)

Carpal tunnel is a complex three-dimensional structure which contains a variety of structures with different textures. In both transverse and longitudinal section, median nerve appears as a hypoechoic structure surrounded by a hyperechoic halo represented by nerve fibrous sheaths.(5), (6), (7)

MATERIAL AND METHODS :

The study included 29 asymptomatic subjects without injuries at the level of carpal tunnel or palmar region and 7 patients hospitalized

in the Department of Plastic Surgery of SUUB diagnosed with carpal tunnel syndrome. For each of the persons included in the study median nerve cross-sectional area was measured. An important moment during the differentiation procedure is between the median nerve and flexor tendons of the fingers, by performing flexion, during which the tendons position change, and the property of anisotropy that tendons show. Although the median nerve cross-sectional shape is variable and hasn't a regular shape, the software allows calculating the area by simply tracing the outline nerve.

The statistical analysis was performed with IBM SPPS v.19.

RESULTS

The cross-sectional area of the median nerve (MCS) fot the asymptomatic subjects were between 8.5 and 14.2 mm^2, with a mean value of $10,18 \pm 1,55$ mm^2.

The mean values for the cross-sectional area in the two groups, asymptomatic and symptomatic are resumed in the following table.

Using discriminant analysis for dependent variable CTS and independent variable MSC, we obtained the following results:

The ANOVA table shows that the difference between surface values of the median nerve in the two groups are statistically significant.

Since the categorical variable CTS has only two values, 0 for asyptomatic and 1 for symptomatic, we will obtain one function whose discriminant capacity is 100%. Canonical correlation coefficient also has a high value, which shows a good ability to discriminate. (the value 1 is the highest).

Wilks'Lambda table shows that discriminant function has the p value smaller than 0.05, which means it has a discriminative value.

The discriminant function is
$$CTS = -12,851 + 1,262 \text{ x MCS.}$$

The centroids table above show that CTS value calculated for asymptomatic patients is -0.82 and for symptomatic 3.397. A value close to the latter one, calculated using discriminant function, is a mark for the possibility of a latent compression syndrome, or an increased risk of developing carpal tunnel syndrome, if some more etiological factors are present.

The cut-point for these values of centroids will be -0.00002.

If the calculated values of the discriminant function are between -0.82 and -0.00002, there is a high probability that the patient is asymptomatic, and for values between -0.00002 and 3.397, the highest probability is that the patient be symptomatic.

If we introduce the cut-point value in the discriminant function equation, we can calculate the surface of the median nerve, which is 10 182 mm2. A cross-sectional area value above 10, 182 mm2 can be suggestive for the presence of carpal tunnel syndrome, when associated with characteristic signs and symptoms.

The discriminant function obtained was able to correctly classify 97.2% of the cases included in the study, which is the function accuracy. Thus, all asymptomatic patients were correctly classified in the group of asymptomatic, while of the 7 symptomatic, 6 were correctly classified, and a patient with carpal tunnel syndrome was, according to this function, included in the asymptomatic group.

The sensitivity of the function is 96.6% and the specificity 85.7%.

DISCUSSIONS

Upper limit of normal for the median nerve area in the carpal tunnel varies from 10.5 to 14 mm, the difference coming from the quality of ultrasound probe, the method of measurement and chosen section, the experience of the examiner and not least the population within which the study was conducted.[7]

In the meta-analysis studies it was observed that the sensitivity of ultrasound examination for diagnosing carpal tunnel syndrome is between 66 and 91%, while specificity is lower, between 47 and 87%.[7][8][9][10]

The graph below shows the values obtained from measurements made on 1542 hands with carpal tunnel syndrome electrophysiologically diagnosed. The study was conducted at East Kent Hospitals University NHS and received an award for innovation in the diagnosis of carpal tunnel syndrome. [7]

It shows that 19% of patients would present surface normal of the median nerve , although compression syndrome is present and objectified paraclinically (given that the maximum allowance of normal is 9 sqmm). In this study, ultrasound examination sensitivity was 81% and specificity 95%. To solve this problem, we can adopt the solution presented by Hobson and

TABLE I
Descriptive statistics for MCS

Statistics		
MCS		
N	Valid	36
	Missing	0
Mean		10.1806
Std. Error of Mean		.25859
Median		9.8000
Mode		9.80
Std. Deviation		1.55156
Variance		2.407
Minimum		8.50
Maximum		14.20

TABLE II
MCS value in asymptomatic versus symptomatic group

Group Statistics					
	SCC	N	Mean	Std. Deviation	Std. Error Mean
MCS	.00	29	9.5310	.56259	.10447
	1.00	7	12.8714	1.44189	.54498

TABLE III
t-test table

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means							
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Suprn-median	Equal variances assumed	9.871	.003	-10.013	34	.000	-3.34039	.33360	-4.01835	-2.66244
	Equal variances not assumed			-6.020	6.447	.001	-3.34039	.55491	-4.67569	-2.00509

TABLE IV
Equality of group means

Tests of Equality of Group Means					
	Wilks' Lambda	F	df1	df2	Sig.
MCS	.253	100.265	1	34	.000

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TABLE V
Eigenvalues table

Eigenvalues				
Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	2.949[a]	100.0	100.0	.864
a. First 1 canonical discriminant functions were used in the analysis.				

TABLE VI
Wilks'Lambda table

Wilks' Lambda				
Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.253	46.011	1	**.000**

TABLE VII
Function unstandardized coefficients table

Canonical Discriminant Function Coefficients	
	Function
	1
Suprnmedian	1.262
(Constant)	-12.851
Unstandardized coefficients	

TABLE VIII
Function values at group centroids

Functions at Group Centroids	
SCC	Function
	1
.00	-.820
1.00	3.397
Unstandardized canonical discriminant functions evaluated at group means	

TABLE IX
Summary classification table

Classification Results[b,c]					
		SCC	Predicted Group Membership		Total
			.00	1.00	
Original	Count	.00	29	0	29
		1.00	1	6	7
	%	.00	100.0	.0	100.0
		1.00	14.3	85.7	100.0
Cross-validated[a]	Count	.00	29	0	29
		1.00	1	6	7
	%	.00	100.0	.0	100.0
		1.00	14.3	85.7	100.0
a. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.					
b. 97.2% of original grouped cases correctly classified.					
c. 97.2% of cross-validated grouped cases correctly classified.					

TABLE X

Comparative sensitivity and specificity of of ultrasound examination for diagnosing carpal tunnel syndrome (8), (9), (10)

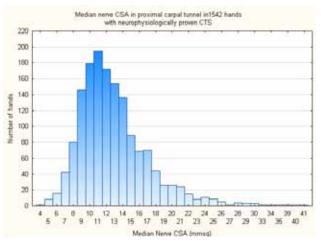|	Sensitivity	Confidence interval 95%	Specificity	Confidence interval 95%
Fowler	77.6%	71.6-83.6	86.8%	78.9-94.8
Roll	66% - 91%		47% - 87%	
Descatha	84%		78%	

Fig. 1. Median nerve cross-sectional area measured in East Kent Hospitals University (7)

Webb in 2008 (11), who suggested the comparison of the median nerve surface in the forearm and in the carpal tunnel. The authors consider that if the ratio of the two dimensions exceeds 1.4, there is a sensitivity and specificity of 100% for ultrasound method for diagnosing carpal tunnel In Visser's (12) study in the same year, in spite of calculating this ratio, the sensitivity was 69% and specificity 90%.

CONCLUSIONS

Sonographic examination of the median nerve and measurement of its cross-sectional area is a useful diagnostic tool in the evaluation of carpal tunnel syndrome. A value higher than 10, 182 mm^2 is highly suggestive for the presence of carpal tunnel syndrome, when associated with characteristic patient history, signs and symptoms.

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