Carpal Tunnel Cross Sectional Area Measurement In Carpal Tunnel Syndrome

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Abstract : Carpal tunnel cross sectional area and carpal tunnel area/wrist area ratios of 23 subjects including 8 bilateral, 9 unilateral carpal tunnel syndrome patients and 6 control patients were examined. Carpal tunnel areas of the patients were found to be 1.7-1.6 cm^2 and the control group 1.9-2.1 cm^2. The carpal tunnel/wrist area ratios were calculated to exclude anatomical differences. This ratio of the patient group was found to be statistically different from the controls. Measurements of the unilateral carpal tunnel patients revealed a predisposing narrowing of the affected wrists.

Key Words : Carpal tunnel syndrome, computed tomography.

INTRODUCTION

Carpal tunnel syndrome, the most common entrapment syndrome a neurosurgeon confronts in his clinical practice, is a combination of symptoms and clinical manifestations of an entrapment lesion of the median nerve in the carpal tunnel. The syndrome is usually seen in elderly women and the dominant hand is most often affected.

The syndrome presents itself with persistent or transient numbness or paresthesia of fingers innervated by the median nerve. The numbness is aggravated by activities such as typing, driving or knitting and nocturnal dysesthesia interrupts sleep and is relieved by shaking or rubbing the hand.

Neurological examination reveals motor weaknees in the hand muscles innervated by the median nerve and thenar atrophy. Electromyographic confirmation is important in most cases while in mild ones, it can be normal. Prolongation of the median nerve motor or sensory distal latencies is the primary criterion of the syndrome. Median motor distal latency is considered prolonged if it is more than 4.6 msec at approximately 7 cm, or 1.8 msec or more than the ipsilateral ulnar nerve. The sensory latency is considered to be prolonged when it is longer than 3.8 msec (5,10,11,12).

The syndrome is caused either by the increased volume of carpal tunnel contents or decreased carpal tunnel volume. Both pathological mechanisms can alter the electromyographic findings but the treatment will be completely different. Surgery is indicated in small carpal tunnel volume cases while carpal tunnel immobilisation and anti inflammatory treatment will be sufficient for patients with normal carpal tunnel volume but increased contents volume (4).

MATERIALS AND METHODS

46 carpal tunnel cross sectional areas were examined in 23 subjects of which 8 had bilateral, and 9 unilateral carpal tunnel syndrome and 6 were normal clinically and electrophysiologically (motor latencies 7.2 ± 1.4 msec and sensory latencies 4.1 ± 0.8 msec). Biopsies of the carpal ligaments obtained at operation were examined. Rheumatoid arthritis, amyloidosis or connective tissue disease was not observed. Electromyography (EMG) and computeriz-

ed tomography performed by the contributors of this communiqué and the surgical interventions by surgeons from the same clinic.

Our series was composed of female patients as only female patients were admitted during the research time of one year. Therefore, the control group was also chosen from females. Carpal tunnel cross sectional area measurements were made at three levels: Proximal level is the proximal entrance of the carpal tunnel where the pisiform and tubercle of the scaphoid bones are seen, and distal level is the exit in the palm which is 5 cm distal approximately, where the hook of hamatum and tubercle of trapezium are seen. Third level is the midpoint of entrance and exit. The cross sectional areas of the soft tissue surrounded by the bony structure on the floor and limited by a curve through the pisiform bone and scaphoid tubercle in the proximal and hook of hamate and tubercle of the trapezoideum in the distal end was measured by Tomoscan 350 CT device standard software after outlining the area using track-ball with magnification. The data obtained was processed by Apple Macintosh Color Classic computer with Stat View 4.0 statistics software. Student's t test was used to test the results with the exception of the measurements of unilateral carpal tunnel patients as the number of parameters was small (9 cases), therefore a nonparametric test, Mann-Whitney U was used.

RESULTS

Carpal tunnel cross sectional area measurements are given in Table 1. Results were tested with Student's t test and the difference was found to be statistically significant.

Table 1 : Carpal tunnel area measurements (cm^2)

	Patient	Control	t	p
Proximal	1.7 ± 0.03	2.1 ± 0.06	−5.375	0.0001
Midpointl	1.6 ± 0.04	2.1 ± 0.07	−5.604	0.0001
Distal	1.6 ± 0.04	1.9 ± 0.06	−4.171	0.0001

A carpal tunnel/wrist area ratio was calculated to exclude anatomical differences. The ratio was multiplied by 100 to make the values easily recognizable. Carpal tunnel/wrist area ratios are presented in Table 2. Results were examined with Student's t test and the difference was statistically significant.

Table 2 : Carpal tunnel/wrist area ratio

	Patient	Control	t	p
Proximal	7.3 ± 0.1	9.5 ± 0.1	−10.875	0.0001
Medial	6.5 ± 0.1	8.7 ± 0.2	−11.519	0.0001
Distal	6.2 ± 0.1	8.2 ± 0.1	−10.028	0.0001

Affected and unaffected carpal tunnel areas and carpal tunnel / wrist area ratios of unilateral carpal tunnel patients were also examined and the results are presented in Table 3. Result were examined with Mann-Whitney U test and the difference was statistically significant.

Table 3 : Area measurements and carpal tunnel/wrist area ratios of unilaterally affected patients. Comparison with the unaffected wrist.

	Affected	Unaffected	U	p
Proximal	1.6 ± 0.04	2.2 ± 0.01	6.5	0.0027
Medial	1.5 ± 0.03	2.1 ± 0.01	6.0	0.0023
Distal	1.5 ± 0.05	2.0 ± 0.01	8.0	0.0041
Proximal	7.1 ± 0.2	9.5 ± 0.30	0.5	0.0004
Medial	6.1 ± 0.2	8.9 ± 0.20	0	0.0003
Distal	5.8 ± 0.2	8.3 ± 0.20	1.0	0.0005

DISCUSSION

Diagnosis of carpal tunnel syndrome is mainly based on the clinical picture and additional electro neurophysiological test result. Patients with persistent or transient paresthesia of the hand and fingers were directed to electroneuromyography to support the initial diagnosis.

Electroneuromyography, of course is the best and most direct method to test the condition of the nerve and muscles innervated by that nerve. But this method had no value in determining the carpal tunnel morphology which will have importance in planning the treatment. If the patient has a normal carpal tunnel area with increased contents volume, then treatment will be conservative. But if the area is found to be reduced from the normal population, surgical intervention is required (1,2,5,10,12).

Pain which almost all our patients complained of is another disadvantage of electromyography. These complaints led us to optimize another non invasive method to support our clinical diagnosis.

Ultrasonography was our first trial but we were unable to show the carpal tunnel contents and especially the median nerve. Echo characteristics of the carpal tunnel contents and surrounding tissue were so close to each other that the radiologists could not differentiate the tissues or measure the cross section area (3).

Magnetic resonance imaging (MRG) was the second and maybe the best choice of supportive diagnostic technique. It can give brief information about the median nerve swelling or flattening, contents of the carpal tunnel and the condition of the carpal ligament. In the literature, MRI of the carpal tunnel region is also referred to as one of the most reliable non-invasive methods. The problem with MRI is the time needed for examination, which, with our 0.5 T MRI scanner, is about 40 minutes for a complete wrist scan (Figs. 1,2). It is uncomfortable for the patient to stay in an MRI magnet lying supine or prone with the wrist positioned above the head. It must also be stated the availability of MRI scanner in our country while CT may be regarded as a conventional and more economical diagnostic tool today (Figs. 3,4) (6,7,8,9).

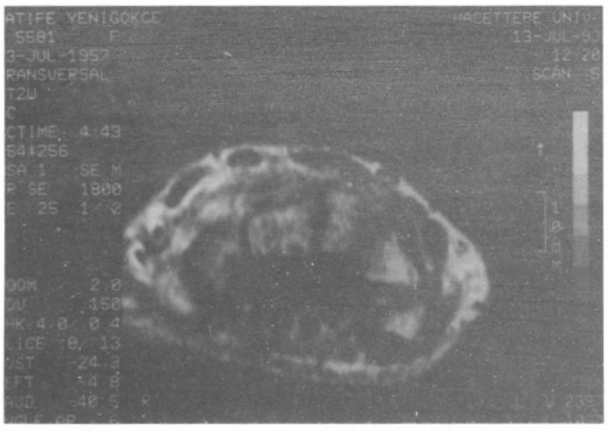

Fig. 1 : MR scan of the proximal entrance of the carpal tunnel

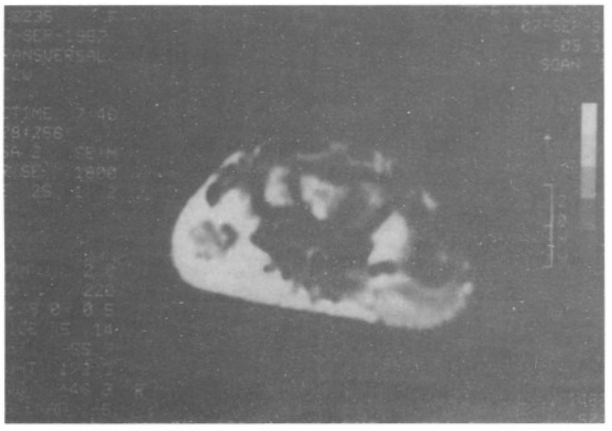

Fig. 2 : Postoperative MR scan of the same patient at the same level.

Fig. 3 : CT scan of proximal entrance of a carpal tunnel patient. Area of carpal tunnel is 1.5 cm².

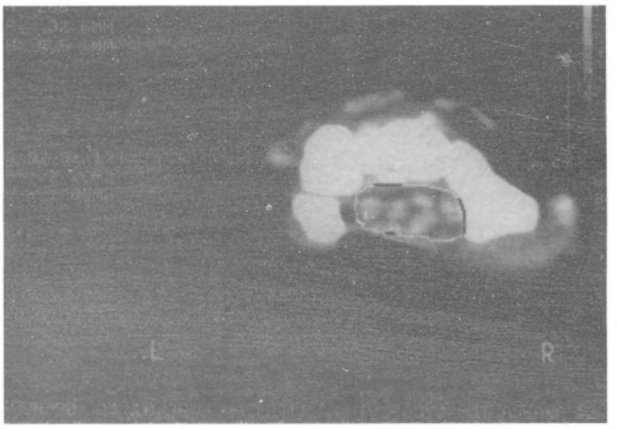

Fig. 4 : CT scan of proximal entrance of a control patient. Area of carpal tunnel is 2.2 cm².

Two measurements were made in our research. One was the cross sectional area of proximal, intermediate and distal carpal tunnels and the other the cross sectional area of the corresponding wrist sections which was the denominator of the ratio of carpal tunnel/wrist cross sectional area ratio. This ratio was used to exclude anatomical differences. The mean value in the proximal portion was 7.366 % $\pm$ 0.114 and 9.533 % $\pm$ 0.170 in the control group. The difference was statistically significant ($p<0.0001$).

As seen in Tables 1 and 2, the differences between the carpal tunnel areas of corresponding sections in the control group and the ratio of areas of corresponding sections between the patient and control groups were statistically significant.

Results obtained from unilateral carpal tunnel patients helped us to suggest an answer as to why some patients are affected while others doing the same job

have no complaints. We believe that it is the comparison of carpal tunnel cross sectional area and carpal tunnel area/wrist area ratio of unilaterally affected patients. The values of affected wrists are all within the limits of the patient group while the unaffected wrist area measurements were found to be in the normal group.

According to the results of this study, we plan to measure the carpal tunnel areas of all patients with carpal tunnel syndrome complaints and carpal tunnel area values greater than 1.9 cm^2 will be treated conservatively that is complete wrist rest for six weeks with nonsteroid anti-inflammatory drug treatment. But patients with proximal carpal tunnel areas smaller than 1.8 cm^2 (mean + 3 SD) will be surgically treated. Surgery can also be considered when the carpal tunnel/wrist area ratio is less than 8 % (mean + 3 SD). Carpal tunnel area measurements have been made to explain the cause of this syndrome. Some authors confirmed the carpal tunnel area difference in the carpal tunnel patients while others found no difference between patients and controls (1,2,4,13). Our results support the first group. The results of the unilaterally affected group suggest an anatomical disposition to carpal tunnel syndrome. The number of unilaterally affected patients is small and it needs a larger group to consider this proposal as a proof. But it is hard to find a unilateral carpal tunnel syndrome patient having no complaint in the healthy hand with electrophysiological confirmation.

We believe that EMG is the most reliable technique in the diagnosis of carpal tunnel syndrome, but CT measurement of the carpal tunnel cross sectional area and the carpal tunnel/wrist area ratio is also a very useful non-invasive and painless technique when supported by the clinical history and examination findings.

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