

EVALUATION OF THE IMPINGEMENT OF THE PRONATOR MUSCLE IN OCCUPATIONAL CARPAL TUNNEL SYNDROME BY ELECTROMYOGRAPHIC AND ULTRASONOGRAPHIC TECHNIQUES

MAURILIO MISSERE¹, ALESSANDRA CASO MARIA², GIOVAN BATTISTA RAFFI²

Occupational Medicine Department, S. Orsola-Malpighi Hospital of Bologna, Bologna¹, Unit of Safety, Hygiene and Occupational Medicine of the Bologna University², Bologna, Italy

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Normal flexion of the fingers involves an involuntary contraction of the pronator and lumbrical muscle. In individuals whose profession involves constant flexing of the fingers those muscles become hypertrophied, impinging on the carpal tunnel. The narrowing of the carpal tunnel yields well to ultrasonography. The objective of this investigation was to find an ultrasonographic index of occupational carpal tunnel syndrome. Thus »Index M« denotes the variation obtained in the »M Space« before and after flexion-extension of the fingers. The study included 45 subjects performing tasks which involved the risk of cumulative trauma disorders. The subjects were tested using the electromyography and ultrasonography. The method was based on relation between the decrease in conduction of the median nerve measured by electromyography and the ultrasonographically measured variation of »M Space« in terms of sensitivity and specificity. The sensitivity of ultrasonography was 85%, as it confirmed the pathologic findings determined by electromyography (»M Index« positive) in twenty-two out of 26 hands, but the specificity was not statistically significant. Ultrasonography seems to have found very important application as a screening technique in occupational medicine. It is non-invasive, sensitive, easily repeated, and costs little.

Key words:
cumulative trauma disorders, hands

Literature on occupational health has widely confirmed the association between cumulative trauma disorders (1, 2), especially carpal tunnel syndrome (CTS), and the tasks involving repetitive and highly frequent movements of the hand-arm segment. This is particularly true if the movements are effectuated with a strong and precise

hold in an incorrect position of various anatomical segments of hands and the work is continued without breaks required for recovery (3–7).

The use of specific instrumental examinations is essential for the diagnosis and evaluation of the evolution of the CTS (8). The clinical suspects of CTS have been confirmed by electromyography (EMG) and ultrasonography (US).

The objective of this study was an objective evaluation of the carpal tunnel and its anatomic components: median nerve, the pronator muscle (9), and lumbrical muscle, which, according to our experience, are involved in the CTS. The evaluation included the dimension of the »M Space« defined as ultrasonographic-anatomical space. We applied electromyography according to the *Kimura* method (10) in order to identify an ultrasound index that is »quantifiable« and that reveals or points to a suspect of occupational CTS. We selected a group of individuals whose work tasks involve motions likely to lead to cumulative trauma disorders.

SUBJECTS AND METHODS

The study was performed on both hands in 45 male workers in a meat and cold cuts manufacturing plant, and aged 37.7 ± 8.0 years. The men performed the following work: they boned hams, made sausages, trimmed, strung, and tied sausage nets, and stored the products in refrigerated storerooms. To reveal the damage of the median nerve in the wrist area the subjects were tested using the EMGraphic with a Nicolet C4 instrument according to the segmental method by *Kimura* (10). The measurements involved the following parameters: conduction sensory velocity (CSV); nerve's motor latency; amplitude of sensory action potential; amplitude of muscular response; conduction motor velocity (CMV) in the wrist-palm and elbow-palm segments; and nerve's sensory latency of the wrist.

Workers with the CSV below 42.5 m/s (cut-off point) in the segment of median nerve into carpal tunnel were considered positive for the CTS. The subjects underwent ultrasonographic examination with Ultrasound Sonoline 1, equipped with a high linear frequency Probe (7.5 MHz) with and without the water spacer. The dimension of the »M Space« (Figure 1) was defined as an ultrasonographic-anatomical space with the following boundaries:

- in front: the ultrasonographic thickness of the cutis and the subcutis
- behind: the anterior ultrasonographic profile of the tract of flexor tendons of the fingers at the wrist joint
- at the bottom: carpal tunnel at the wrist joint
- at the top: the transverse section at the level of the fingers' flexor tendons.

The data were evaluated both during rest and after the flexion of the fingers. We termed »Index M« the variation obtained in the »M Space« before and after the flexion-extension of the fingers, using a cut-off point of 0.3 mm of ultrasonographic resolution power. The results of ultrasound (»Index M«) were compared to the results with electromyography and expressed as sensitivity and specificity of the ultrasound

Table 1 Results of sensitivity and specificity in population studied for the carpal tunnel syndrome applying ultrasonography and electromyography

Ultrasound »M Index«	Electromyographic findings	
	Normal (CSV > 42.5 m/s)	Pathological (CSV ≤ 42.5 m/s)
Positive (decrease in »M Space«)	39	22
Negative (increase in »M Space«)	25	4

CSV – conduction sensory velocity; »M Space« – ultrasonographic-anatomical space

Results

Sensitivity = 22/26 (85%). The ultrasonographic technique correctly identified as positive 85% of subjects with the carpal tunnel syndrome

Specificity = 25/64 (39%). Measured as a rate of correct ultrasonography hits with respect to a predetermined number of subjects without a disease

method. Table 1 shows the positive and negative findings as determined by US and EMG. The chi-square test was used for the statistical analysis of the results.

RESULTS AND DISCUSSION

The objective of this study was to evaluate ultrasonographically measured variations of »M Space«, and compare them to the decrease in conduction velocity of the median nerve measured by the electromyography. This study has its roots in the personal experience in ultrasonographic evaluation of the carpal tunnel performed on several thousands of subjects affected by the CTS. On the basis of this experience we proposed an ultrasonographic index of occupational CTS measuring variations of »M Space«.

During the contraction of the fingers, the hypertrophied pronator muscle and the lumbrical muscle enter the carpal tunnel »raising its floor and lowering the roof«, and thereby reducing the space (Figure 1). When that does not happen it means that the muscles have not increased in volume, which is an unusual occurrence in individuals who strain their hands so excessively at work.

Traditionally, a diagnostic value of a test is measured by its sensitivity and specificity. The two parameters serve to compare the diagnostic discrimination of a test with a standard. A standard is a test generally accepted as the best available for diagnosing a disease. The »gold standard« for the study of the entrapment is peripheral neuropathy as measured by electromyography. Sensitivity is measured as a rate of correct hits with respect to a predetermined number of subjects with a disease (the standard). Specificity is measured as a rate of correct hits with respect to a predetermined number of subjects without a disease (the standard). Sensitivity and specificity

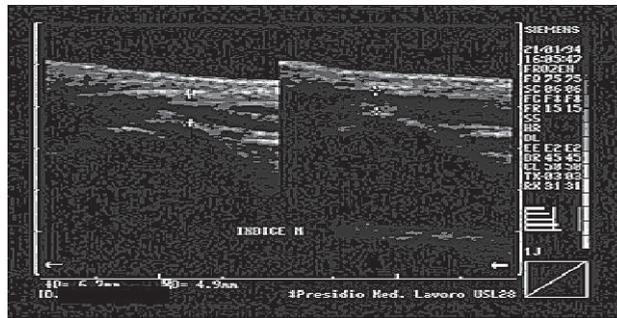


Figure 1 *Ultrasound scan: variations in the »M Space« before (left) and after (right) the flexion of the fingers (caliper). A subject with carpal tunnel syndrome. Longitudinal sonogram shows the variation of the »M Space« (left 7 mm, right 5 mm) before and after flexion of the fingers with impingement of the pronator and the lumbrical muscles*

are important since they are independent of the prevalence of the disease in the studied population and are inherent properties of a test.

The sensitivity of our study equalled 85%, that is, the US technique correctly identified as positive 85% of subjects with the CTS (Table 1). This fact argues in favour of the US as a good screening test. It is very important for occupational medicine to use a test which is safe, noninvasive, easily repeated, and bearing low cost, as is the US. Moreover, one usually favours sensitivity over specificity, hoping to correctly identify as many cases as possible. It is important not to miss a treatable disease like the occupational carpal tunnel syndrome.

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Sažetak

PROCJENA OMETANJA FUNKCIJE MIŠIĆA PRONATORA U SINDROMU PROFESIONALNOG OŠTEĆENJA KARPALNOG TUNELA S POMOĆU ELEKTROMIOGRAFIJE I ULTRAZVUKA

Normalna fleksija prstiju uključuje i nekontroliranu kontrakciju pronatora i lumbrikalnog mišića. U osoba čija profesija uključuje opetovano stiskanje prstiju ovi mišići hipertrofiraju i blokiraju karpalni tunel. Sužavanje karpalnog tunela može se utvrditi ultrazvukom. Svrha je ovog rada bila utvrditi objektivni indeks sindroma karpalnog tunela s pomoću ultrazvuka. Tako »Indeks M« označuje varijacije u ultrazvučno-anatomskom »M prostoru« prije i nakon fleksije i ekstenzije prstiju. U istraživanje je uključeno 45 ispitanika koji su obavljali rizični posao što može dovesti do kumulativnih traumatskih poremećenja. Ispitanici su testirani elektromiografski i ultrazvučno. Metoda se zasniva na odnosu između smanjenja brzine provođenja impulsa *nervusa medianusa* elektromiografski. Ultrazvučno je mjerena varijacija »M-prostora« u smislu utvrđivanja osjetljivosti i specifičnosti. Od 26 patoloških elektromiografskih nalaza ultrazvučno je patološki nalaz potvrđen u 22 ruke. Čini se stoga da ultrazvuk ima vrlo važno mjesto u izdavanju mogućih bolesnika u rizičnim skupinama, posebice stoga jer je neinvazivna, osjetljiva, ponovljiva i jeftina tehnika.

Ključne riječi:

kumulativna traumatska poremećenja, lumbrikalni mišić, ruke

Requests for reprints:

Maurilio Missere, M.D.
Servizio di Medicina del Lavoro
Policlinico S. Orsola-Malpighi Hospital of Bologna
Via P. Palagi 9, 40138 Bologna, Italy
E-mail: missere@med.unibo.it