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Original Article / Özgün Araştırma

Is the difference between median sensory and ulnar motor latencies better than combined sensory index in carpal tunnel syndrome diagnosis?

Karpal tünel sendromu tanısında median duyusal ve ulnar motor latans arasındaki fark, bileşik duyusal indeksten daha mı iyidir?

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ABSTRACT

Objectives: This study aims to compare the sensitivity and specificity of median sensory nerve/ulnar motor nerve latency difference (MSUMLD) as a new method with combined sensory index (CSI) for accurate diagnosis of carpal tunnel syndrome.

Patients and methods: The study, which was conducted between November 2013 and May 2014, included 49 patients (7 males, 42 females; median age 45.9±6.6 years; min. 19 - max. 65) and their 97 hands. Of the hands, 47 had symptoms and signs of carpal tunnel syndrome with normal routine nerve conduction studies (group 1) and 50 had carpal tunnel syndrome by standard criteria (group 2). Then, MSUMLD and CSI were performed for the two groups.

Results: The median sensory-ulnar motor latency difference had sensitivity of 86% and specificity of 70%; however, CSI had a sensitivity and specificity 72% and 92%, respectively. The median sensory/ulnar motor latency difference was over the normal range in 14/47 hands (29%) with normal conventional nerve conduction study. Twenty-nine percent of these patients would be categorized as normal with standard nerve conduction studies.

Conclusion: This new method (MSUMLD) does not need to stimulate more sites during conventional electrodiagnosis and is just a simple mathematical practice that may be a complementary method in diagnosis of mild carpal tunnel syndrome.

Keywords: Carpal tunnel syndrome; median nerve; neural conduction; ulnar nerve.

ÖZ

Amaç: Bu çalışmada, karpal tünel sendromunun doğru tanısı için yeni bir yöntem olarak bileşik duyusal indeks (BDİ) ile birlikte median duyusal sinir/ulnar motor sinir latans farkının (MDSUMLF) duyarlılığı ve özgüllüğü karşılaştırıldı.

Hastalar ve yöntemler: Kasım 2013 - Mayıs 2014 tarihleri arasında yapılan çalışmaya 49 hastanın (7 erkek, 42 kadın; medyan yaş 45.9±6.6 yıl; min. 19 - maks. 65) 97 eli dahil edildi. Ellerin 47'sinde normal rutin sinir iletim çalışmaları ile karpal tünel sendromu semptom ve belirtileri (grup 1), 50'sinde standart kriterler ile karpal tünel sendromu (grup 2) vardı. Sonra, iki grup için MDSUMLF ve BDİ uygulandı.

Bulgular: Median duyusal sinir/ulnar motor sinir latans farkının %86 duyarlılığı ve %70 özgüllüğü olmasına rağmen, BDİ'nin sırasıyla %72 duyarlılığı ve %92 özgüllüğü vardı. Median duyusal sinir/ulnar motor sinir latans farkı, normal konvansiyonel sinir iletim çalışmaları ile ellerin 14/47'sinde (%29) normal aralıkta bitmiştir. Bu hastaların %29'u standart sinir iletim çalışmaları ile normal olarak sınıflandırılabilir.

Sonuç: Bu yeni yöntemin (MDSUMLF) konvansiyonel elektrodiyagnoz sırasında daha fazla alanı stimüle etmesi gerekmemektedir ve hafif karpal tünel sendromu tanısında tamamlayıcı bir yöntem olabilecek sadece basit bir matematiksel uygulamadır.

Anahtar sözcükler: Karpal tünel sendromu; kol orta siniri; sinir dokusu; ulnar sinir.

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Carpal tunnel syndrome (CTS) is the most common nerve entrapment syndrome, being prevalent of approximately 3% in the general population.[1]

It is caused by chronic compression of the median nerve at the wrist as it passes through the nonflexible carpal tunnel. It occurs more commonly among workers in occupations involving manual labor and repetitive use of hands.[2-4] Increasing pressure on the carpal tunnel by space occupying lesion or inflammatory processes leads to compression of median nerve.[5,6]

The patients have pain, numbness and paresthesia in the median nerve distribution and sometimes weakness in the affected hand.[7] This syndrom is diagnosed on the basis of clinical signs and symptoms and is confirmed by an electrodiagnostic study, which is the most reliable method currently available. Although nerve conduction studies (NCS) have been widely used in diagnosing CTS, they are not particularly accurate. Sensitivities of electrodiagnostic methods have ranged between 49% and 84% with specificities of 95% or higher.[8] Ordinary nerve conduction study is valuable. The most common findings are prolonged terminal latency of motor or sensory median nerve in CTS hands. Based on standard criteria, CTS was diagnosed by distal motor latency more than 4.2 ms and sensory latency more than 3.6 ms from the wrist crease and more than 2 ms from midpalm.[9-11] If the patient has signs and symptoms of CTS but the conventional study showed equivocal or false negative, more sensitive methods are needed.[12] Several methods of electrophysiological study have been introduced for more accurate diagnosis of carpal tunnel syndrome. These include segmental sensory conduction study across the carpal tunnel by median stimulation at midpalm, difference between the median motor latency to the second lumbrical and the ulnar motor latency to the interossei muscles. Other diagnostic methods are somatosensory evoked potential, assessment of median nerve conduction after incited test (e.g. after wrist flexion) and interpolation; a mathematical method for finding median NCV at carpal tunnel site.[13-17]

Combined sensory index (CSI) is an interesting approach that uses three different techniques including median/ulnar difference to the ring finger (≤0.4), median/ulnar mixed nerve midpalm difference (≤0.3) and median/radial to thumb difference (≤0.5). The summated latency difference for each test should be ≤0.9.[18,19] This technique is time consuming and uncomfortable for the patient, due to multiple stimulation sites. Bodofsky[20] showed that by using only standard median and ulnar motor and sensory testing can make more precise and early diagnosis of CTS with the least amount of testing. We assumed that differences between ulnar motor nerve and median sensory nerve latencies could be used as an early and simple diagnostic method in CTS.

In this study, we aimed to evaluate the diagnostic value of this method as a complementary test in diagnosis of mild CTS and then we compared it with combined sensory index as a sensitive test but time consuming technique. We did this comparison for the first time. Bodofsky[20] used ulnar nerve motor latency because a latency that remains clearly normal in CTS was needed. However, because of the close anatomical contiguity between median and ulnar nerves at wrist, pathologic process causing CTS may also affect ulnar nerve (both motor and sensory nerve).[21,22] But regarding ulnar sensory nerve is more affected in patients with CTS and ulnar motor nerve is more constant in these patients, we also used this for comparison as near fixed parameter.[23,24]

PATIENTS AND METHODS

Patients were selected from those who were referred to the electrodiagnostic clinic. We recruited patients with typical signs and symptoms of CTS, including pain, paresthesia, and numbness in a median nerve distribution, nocturnal awakening and history of objects falling from the hands. Patients with secondary CTS, diabetes mellitus, peripheral neuropathy, severe CTS with muscle atrophy, those having undergone surgical release of median nerve and patients with history or confirmed other nerve entrapment in upper limbs such as cubital tunnel syndrome were excluded. Informed consent was obtained from each participant and this protocol was approved in the Ethics Committee of Shiraz University of Medical Sciences with code number 5789. The study was conducted in accordance with the principles of the Declaration of Helsinki. The study, which was conducted between November 2013 and May 2014 and it included 49 patients (7 males, 42 females; median age 45.9±6.6 years; min. 19 - max. 65) and their 97 hands. Of the hands, 47 had symptoms and signs of carpal tunnel syndrome with normal routine nerve conduction studies (group 1) and 50 had carpal tunnel syndrome by standard criteria (group 2). Then, MSUMLD and CSI were performed for the two groups.

For evaluation of exclusion criteria, we first took their history and performed physical examinations for all patients in electrodiagnostic clinic and then we performed laboratory investigations, including

Table 1. Demographic data of patients

	Normal EDX		Abnormal EDX		
	n	Mean±SD	n	Mean±SD	*p*
Patients	24		25		0.996
Hands	47		50		0.743
Gender					
Male	3		4		0.998
Female	21		21		-
Median age		45.2±8.5		46.1±7.8	0.469

EDX: Electrodiagnostic study; SD: Standard deviation.

complete blood count, erythrocyte sedimentation rate, C-reactive protein, rheumatoid factor, fasting blood sugar and thyroid function tests. Then, a conventional nerve conduction study was performed; accordingly, peripheral neuropathy or other nerve entrapments were excluded. The tests were performed by a MEDELEC SYNERGY electromyography instrument (Viasys Healthcare UK, Manor Way, Old Woking, Surrey, UK). All the participant had NCS in an air-conditioned room (26 °C). The skin temperature on the hand maintained above 32 °C. As previously mentioned at first a conventional nerve conduction study was performed; according to it, distal median motor latency was obtained from abductor pollicis brevis muscle belly with stimulation at 8 cm proximal to it and for antidromic sensory latency from the third digit while stimulating the median nerve 7 cm and 14 cm proximal to the active recording electrode from midpalm and wrist crease, respectively. Ulnar compound muscle action potential latencies were recorded at abductor digiti minimi (ADM) muscle belly (motor point) with stimulation at 8 cm proximal to it. After the initial routine electrodiagnostic study, the patients were categorized into two groups (normal electrodiagnostic test and abnormal electrodiagnostic test) based on motor and sensory latency of median nerve. Then for these two groups, the difference of ulnar motor nerve/median sensory nerve latency was calculated and CSI technique was done and compared together in terms of sensitivity and specificity for diagnosis of CTS. For determination of median/ulnar difference to the ring finger, a recording electrode was placed at the ring finger and stimulated 8 cm proximal to it. A similar technique was done to define median sensory/radial sensory latencies difference. The recording electrode was placed at the thumb and stimulation was performed 10 cm and 8 cm proximal to it for obtain radial and median sensory latencies, respectively. For specify of median/ulnar mixed nerve difference, a recording electrode was placed at the wrist and stimulation was done at 8 cm distal to recording electrode in mid-palm. Then summation of these three differences was calculated and the CSI was determined.

Statistical analysis

All data were analyzed using PASW, version 18.0 software (SPSS Inc., Chicago, IL, USA). We used student's t test if data was normal; otherwise, non-parametric Mann-Whitney test was applied. Data was reported as mean ± standard deviation. *P* value ≤0.05 was considered statistically significant.

RESULTS

We evaluated the hands of 49 patients which had the symptoms of and signs of CTS and normal routine NCS (group 1), and 50 hands with carpal tunnel syndrome by standard criteria (group 2). The members of the two groups were predominantly female. Because the majority of the patients are female, the gender not affect on the results (Table 1).

Table 2. Comparison latencies between two groups (Normal routine EDX and Abnormal routine EDX)

	Normal EDX	Abnormal EDX	
	Mean±SD	Mean±SD	*p*
Median sensory latency (ms)	3.4±0.3	4.3±0.4	<0.0001
Ulnar sensory latency (ms)	3.4±0.4	3.5±0.5	0.004
Ulnar motor latency (ms)	2.9±0.2	3.0±0.3	0.456
Median sensory/ulnar motor latency difference (ms)	0.5±0.2	1.0±0.3	<0.0001
Combined sensory index (ms)	0.8±0.4	1.8±0.7	<0.0001

EDX: Electrodiagnostic study; SD: Standard deviation; ms: Millisecond.

This classification of patients in two groups was done on the basis of median sensory and motor nerve latencies. Mean ulnar motor nerve/median sensory nerve latency difference in group 1 with normal conventional NCS is 0.5±0.2 ms and in group 2 with abnormal formal NCS is 1.0±0.3 ms. As well as, mean CSI in normal and abnormal conventional NCS are 0.8±0.4 ms and 1.8±0.7 ms respectively (Table 2). The differences between the two groups were significant at $p<0.05$ level. Mean value for the median and ulnar motor and sensory latencies are presented in Table 2.

The ulnar motor and sensory distal latency were normal in a great majority of patients. However, the ulnar sensory latency was significantly longer in the group with CTS by conventional criteria than in group with normal formal NCS (mean value 3.5±0.5 vs. 3.4±0.4), but the ulnar motor latency difference between two groups was nearly the same (mean value 2.9±0.2 vs. 3.0±0.3). Therefore, the ulnar motor latency seems to be the better fixed parameter for diagnosis of CTS; thus, in this hypothesis the median sensory-ulnar motor latency difference (MSUMLD) may be sensitive and specific. The MSUMLD in the group with abnormal conventional NCS showed a larger difference, arising from both a higher median sensory latency (mean value 4.3±0.4 vs. 3.4±0.3, $p<0.05$) and a shorter ulnar motor latency (mean value 3.0±0.2 vs. 2.9±0.3, $p<0.05$). Using the MSUMLD, this parameter was over the normal range in 14/47 (29%) hands with normal NCS. 29% of patients would be categorized as normal with standard NCS. Altogether, the MSUMLD had sensitivity of 86% and specificity of 70%. The rate of CSI was above the normal range in 13/47 (27%) hands with normal NCS, as well. This parameter had a sensitivity and specificity 72% and 92%, respectively.

DISCUSSION

This study evaluated the diagnostic value of difference between ulnar motor nerve and median sensory nerve latencies and then compared it with CSI. A number of patients who have signs and symptoms of CTS but their conventional NCS were diagnosed as normal, using the MSUMLD were classified as CTS. In our study, the results showed that the sensitivity of MSUMLD was higher than CSI (86% vs. 72%), but on the contrary, the specificity of MSUMLD was less than CSI (70% vs. 92%). In contrast to other methods such as CSI, this new method (MSUMLD) does not need more stimulation and is a simple mathematical operation. Nevertheless, MSUMLD does not have a high sensitivity and specificity and this study did not confirm the results of the similar study conducted by Bodofsky et al.[20] They showed MSUMLD has sensitivity of 95% and specificity of 100%. But in our study, obtained sensitivity and specificity of this method was less than the results of Bodofsky's study and the number of patients with normal conventional NCS was more than that (23 vs. 47 hands). This study reveals that ulnar sensory latency in patients with CTS was longer than normal. This finding has been shown in previous studies.[23,24] The cause of prolongation of ulnar sensory latency in patient with CTS is not still clearly understood; this could be either due to very slight pressure on the ulnar nerve at the wrist or a generalized decrease in nerve conduction in patients with CTS. In this study, ulnar sensory latency was prolonged as well, so it cannot be used as a fixed parameter for comparison to other parameters for the diagnosis of CTS. But ulnar motor latency is nearly constant and it can be used for detecting CTS. We found CSI has sensitivity and specificity 72% and 92%, respectively; its specificity is similar to that of other studies.[18,19] As previously mentioned, unlike the retrospective study of Bodofsky, the MSUMLD did not have a higher diagnostic value for detecting CTS in our prospective study. However, the MSUMLD is less time consuming and more comfortable for the patients and it can be used to determine the number of false negatives. Therefore, perhaps this can be used as a test for accurate and early diagnosis of CTS and reduce the number of false negatives.

Our study had several limitations including the lack of a control group with no signs and symptoms of CTS and the fact that other diagnostic modalities such as ultrasonography were not compared. We used ulnar motor nerve latency as a nearly fixed parameter to comparison, however this parameter can be prolonged in patients with CTS.

In conclusion, the routine electrodiagnostic study for diagnosis of CTS has false negatives. In our study, using MSUMLD as a simple and not time consuming test reduced the number of false negatives. But this method does not have high sensitivity and specificity. As the results of the two studies (Bodofsky and this study) are inconsistent, further studies are needed to compare the results recorded from symptomatic patients with asymptomatic (or control) group and also compare the electrodiagnostic tests with other diagnostic modalities such as ultrasonography.

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REFERENCES

1. Atroshi I, Gummesson C, Johnsson R, Ornstein E, Ranstam J, Rosén I. Prevalence of carpal tunnel syndrome in a general population. JAMA 1999;282:153-8.
2. Gelberman RH, Hergenroeder PT, Hargens AR, Lundborg GN, Akeson WH. The carpal tunnel syndrome. A study of carpal canal pressures. J Bone Joint Surg Am 1981;63:380-3.
3. Werner RA. Evaluation of work-related carpal tunnel syndrome. J Occup Rehabil 2006;16:207-22.
4. Cartwright MS, Walker FO, Blocker JN, Schulz MR, Arcury TA, Grzywacz JG, et al. The prevalence of carpal tunnel syndrome in Latino poultry-processing workers and other Latino manual workers. J Occup Environ Med 2012;54:198-201.
5. Szabo RM, Madison M. Carpal tunnel syndrome. Orthop Clin North Am 1992;23:103-9.
6. von Schroeder HP, Botte MJ. Carpal tunnel syndrome. Hand Clin 1996;12:643-55.
7. Keith MW, Masear V, Chung KC, Maupin K, Andary M, Amadio PC, et al. American Academy of Orthopaedic Surgeons Clinical Practice Guideline on diagnosis of carpal tunnel syndrome. J Bone Joint Surg [Am] 2009;91:2478-9.
8. Jablecki CK, Andary MT, So YT, Wilkins DE, Williams FH. Literature review of the usefulness of nerve conduction studies and electromyography for the evaluation of patients with carpal tunnel syndrome. AAEM Quality Assurance Committee. Muscle Nerve 1993;16:1392-414.
9. Johnson EW, Melvin JL. Sensory conduction studies of median and ulnar nerves. Arch Phys Med Rehabil 1967;48:25-30.
10. Melvin JL, Schuchmann JA, Lanese RR. Diagnostic specificity of motor and sensory nerve conduction variables in the carpal tunnel syndrome. Arch Phys Med Rehabil 1973;54:69-74.
11. Cruz Martínez A, Barrio M, Pérez Conde MC, Gutiérrez AM. Electrophysiological aspects of sensory conduction velocity in healthy adults. 1. Conduction velocity from digit to palm, from palm to wrist, and across the elbow, as a function of age. J Neurol Neurosurg Psychiatry 1978;41:1092-6.
12. Kohara N. Clinical and electrophysiological findings in carpal tunnel syndrome. Brain Nerve 2007;59:1229-38. [Abstract]
13. Ilkhani M, Jahanbakhsh SM, Eghtesadi-Araghi P, Moayyeri A. Accuracy of somatosensory evoked potentials in diagnosis of mild idiopathic carpal tunnel syndrome. Clin Neurol Neurosurg 2005;108:40-4.
14. Emad MR, Najafi SH, Sepehrian MH. The effect of provocative tests on electrodiagnosis criteria in clinical carpal tunnel syndrome. J Electromyogr Kinesiol 2009;19:1061-3.
15. Bodofsky EB. Diagnosing mild Carpal Tunnel Syndrome with interpolation. Electromyogr Clin Neurophysiol 2004;44:379-83.
16. Bahrami MH, Rayegani SM, Nouri F. Study of interpolation method in diagnosis of carpal tunnel syndrome and comparison with midpalm antideromic sensory method. Electromyogr Clin Neurophysiol 2009;49:259-62.
17. Ashraf A, Daghaghzadeh A, Naseri M, Nasiri A, Fakheri M. A study of interpolation method in diagnosis of carpal tunnel syndrome. Ann Indian Acad Neurol 2013;16:623-6.
18. Robinson LR, Micklesen PJ, Wang L. Strategies for analyzing nerve conduction data: superiority of a summary index over single tests. Muscle Nerve 1998;21:1166-71.
19. Lew HL, Wang L, Robinson LR. Test-retest reliability of combined sensory index: implications for diagnosing carpal tunnel syndrome. Muscle Nerve 2000;23:1261-4.
20. Bodofsky EB, Wu KD, Campellone JV, Greenberg WM, Tomaio AC. A sensitive new median-ulnar technique for diagnosing mild Carpal Tunnel Syndrome. Electromyogr Clin Neurophysiol 2005;45:139-44.
21. Yemisci OU, Yalbuzdag SA, Cosar SN, Oztop P, Karatas M. Ulnar nerve conduction abnormalities in carpal tunnel syndrome. Muscle Nerve 2011;44:352-7.
22. Ginanneschi F, Dominici F, Milani P, Biasella A, Rossi A. Evidence of altered motor axon properties of the ulnar nerve in carpal tunnel syndrome. Clin Neurophysiol 2007;118:1569-76.
23. Cassvan A, Rosenberg A, Rivera LF. Ulnar nerve involvement in carpal tunnel syndrome. Arch Phys Med Rehabil 1986;67:290-2.
24. Gozke E, Dortcan N, Kocer A, Cetinkaya M, Akyuz G, Us O. Ulnar nerve entrapment at wrist associated with carpal tunnel syndrome. Neurophysiol Clin 2003;33:219-22.