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Comparison of Ultrasonic and Electrophysiological Pre and Postoperative Evaluation for Carpal Tunnel Syndrome

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Abstract

Purpose: The aim of this prospective study was to compare high definition ultrasonography vs. electrophysiological testing in order to evaluate their diagnostic value for Carpal Tunnel Syndrome (CTS).

Methods: In this prospective study forty patients with carpal tunnel syndrome were studied preoperatively and 1, 3, 6 and 12 months postoperatively. The electrophysiological testing included the distal motor latency and the sensory conduction velocity. The cross-sectional area of the median nerve at the carpal tunnel inlet (Level 1) and at the middle of carpal tunnel (Level 2) was measured with ultrasonography. The intensity of pre- and postoperative pain was also documented with pain scales and correlated with the electrophysiological and ultrasonic findings.

Results: A postoperative statistical significant alteration was observed for the distal motor latency and the sensory conduction velocity. At Level 1 and at Level 2 no statistical significant change of the cross-sectional area of the median nerve was observed postoperatively. The cross-sectional area of the median nerve of the operated and non-operated hand at Level 2 showed preoperatively a statistic significant difference which was not detectable 12 months postoperatively

Discussion: The electrophysiological testing as a clinically established method for diagnosing CTS also allows a postoperative monitoring of the level of regeneration and function of the median nerve. High definition ultrasound is a versatile method to diagnose CTS, but it is necessary to analyze both hands in order to identify a difference of the cross-sectional area of both median nerves. For the postoperative follow up of median nerve recovery electrophysiological testing has to be preferred.

Keywords: Carpal tunnel syndrome; Cross-sectional area; Distal motor latency; Electrophysiology; Ultrasound

Introduction

Carpal Tunnel Syndrome (CTS) is the most common nerve compression syndrome of peripheral nerves in the upper extremity. The CTS is caused by increasing pressure in the carpal tunnel with consecutive compression of the median nerve. The cause for the CTS is mainly idiopathic [1]. There is a prevalence of CTS in the adult population of 2.5-11% [2-4]. The mean age of patients with

carpal tunnel syndrome is 45 years up to 54 years. The Incidence is mentioned with 0.125 up to 1% [5-7]. Electrophysiological testing is one of the most important diagnostic tools for carpal tunnel syndrome and the current "gold standard" for the diagnosis. The distal motor latency of the median nerve shows a sensitivity of 63 % and a specificity of 98%. The sensory conduction velocity shows a sensitivity of 65% and a specificity of 98% [8]. Recently, high definition ultrasonography has been proposed for the diagnosis of CTS [9-13]. Previous studies have hypothesized that ultrasonography might be a useful alternative for testing the median nerve with suspected carpal tunnel syndrome [14-17]. The aim of this prospective study was to shed light on the informative value of high definition ultrasound in comparison with electrophysiological testing and to identify the responsible factors and parameters respectively.

Materials and Methods

For this prospective study 80 wrists of 40 patients were included (Male: 6, Female: 34). Their mean-age was 56.6 years (32 years - 82 years; standard deviation: 13,4). All persons gave their informed consent prior to their inclusion in the study. The study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki and an ethical committee authorized this study. All referred patients were diagnosed with CTS for the first time and surgical therapy was carried out with limited incision and decompression of the median nerve in wide awake anesthesia. Functional and neurological assessment of the hand was carried out preoperative and after 1, 3, 6 and 12 months postoperatively. Each evaluation of the patient was subdivided in a clinical inspection and clinical testing of the operated and the non-operated wrist (Phalen-Test/ Hoffmann-/ Tinel-sign). A "Dantec Neuromatic 2000M" (Dantec, Copenhagen, Denmark) was used for a detailed electrophysiological testing of both wrists of the patient. The investigator is neurologist and has 20 years of experience in electrophysiological testing.

Amongst others this electrophysiological evaluation of the wrists included the distal motor latency and the antidromic sensory conduction velocity as two relevant parameters for testing the median nerve in cause of a carpal tunnel syndrome. Furthermore, detailed sonographic measurements of the median nerve at 4 various levels of the forearm and wrists of both hands were performed. All measurements were performed by a single investigator in an objective manner. Two levels proximal of the carpal tunnel, one level at the carpal-tunnel-inlet and one level at the middle of the carpal tunnel. The cross-sectional area at the carpal tunnel inlet and at the middle of carpal tunnel was the preferred side of visualization. The cross-sectional area of the median nerve was calculated as an ellipsoid by measuring the anterior-posterior and the medio-lateral parameter.

The ultrasonic device was the High-Definition-Ultrasonic-device "Micromaxx, Sonosite" (Sonosite, Bothell, USA) with a "HFL-38 E"-linear-probe (6-13 MHz) (Figure 1).

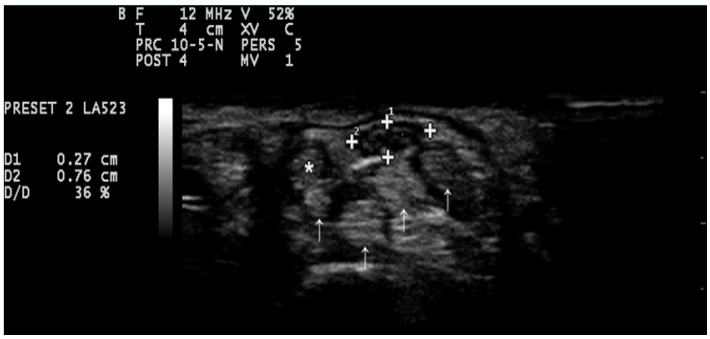

Figure 1: Sonographic representation of the carpal tunnel.

(+ = N. medianus; * = tendon of the M. flexor pollicis longus; ↑ = tendons of the M. flexor digitorum superficialis)

All results were compared with the initial evaluation and were compared with the non-operated wrist of the patients. The operated hand was in 62.5 % the dominant hand of the patient. In this study 38 right-handed and 2 left-handed patients were included. Observed mean values, standard deviations, medians, minimum and maximum values of the distal motor latency, the sensory conduction velocity, the cross-sectional area at the carpal-tunnel-inlet and at the middle of the carpal tunnel, and the pain of the operated hand were calculated. In order to identify potential influences linear regression analysis was carried out for age, sex, operated hand (left/right), guide hand (left/right), duration of discomfort, and time after surgery. These models provide estimated means adjusted for the influenced variables. The preoperative values were compared with postoperative values during the follow-up.

Results

Electrophysiological Testing

Surgery was carried out after a pathological prolonged Distal Motor Latency (DML) of the operated hand was observed (DML> 4ms was considered pathologic). After surgical decompression of the median nerve a statistic significant reduction for the distal motor latency was detected at all time points during the postoperative period of one year. The Sensory Conduction Velocity

(SCV) increased significantly at each time point during the follow-up of one year and was statistic significant after month 3 for the remaining period of the investigation (Figures 2,3).

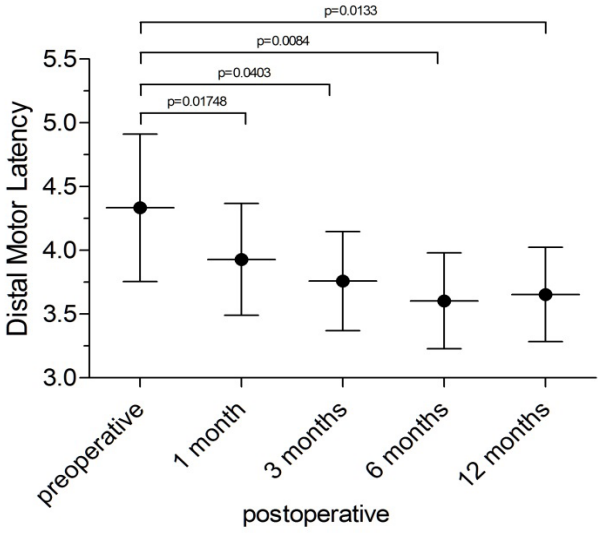

Figure 2: Distal Motor Latency.

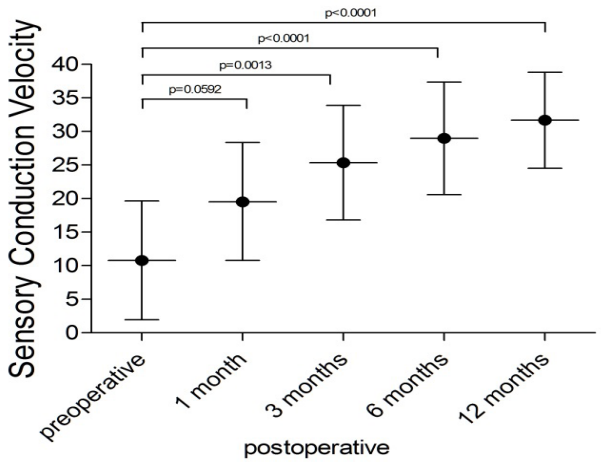

Figure 3: Sensory Conduction Velocity.

Ultrasonography

After open decompression of the median nerve no statistical difference was observed in regard to the cross-sectional area. At the follow-up period (12 months) a decreasing and increasing of the cross-sectional area is shown but it was not statistically significant (Figure 4).

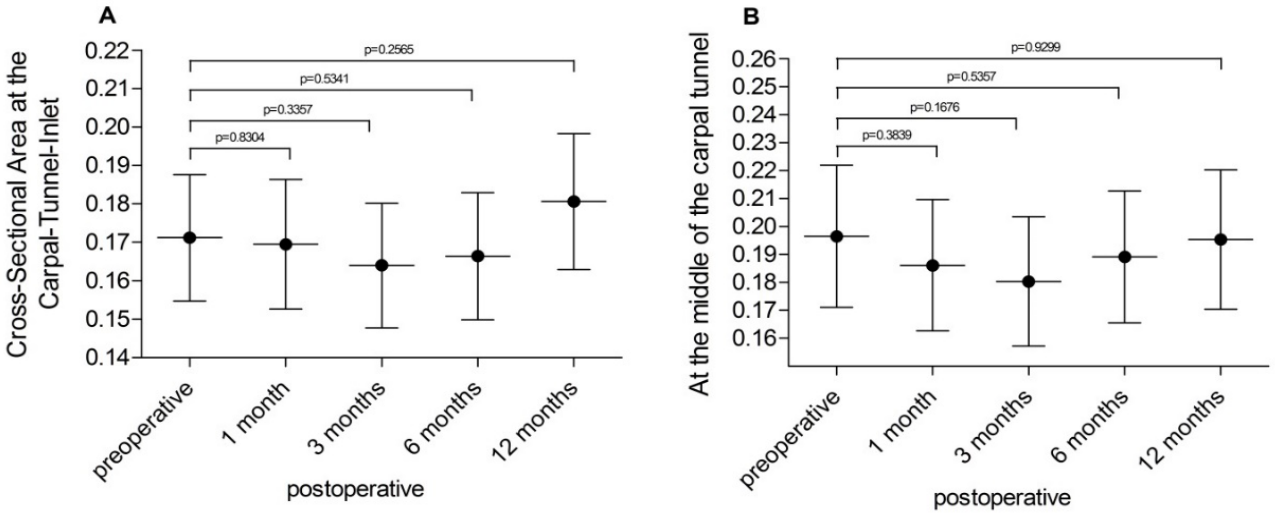

Figure 4: Cross-Sectional Area.

The comparison of the cross-sectional area at the middle of the carpal tunnel of the operated hand and the no-operated hand demonstrated that there was a statistic significant difference preoperative (p = 0.004) and 1 month postoperative (p = 0.005). Later time points revealed no significant difference anymore (Figure 5).

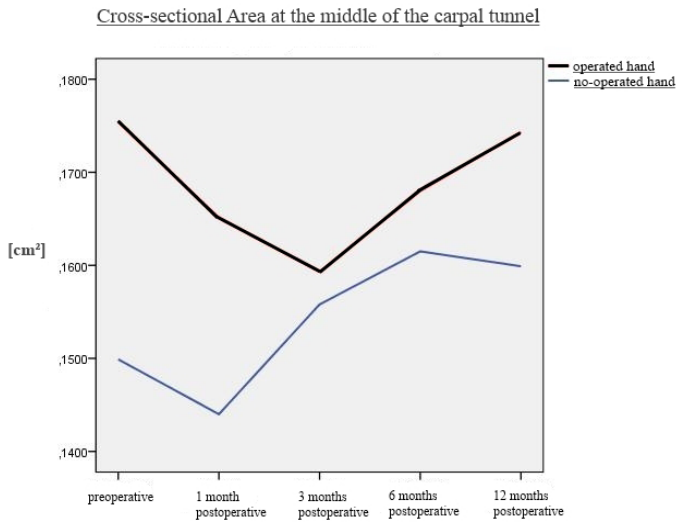

Figure 5: Comparison Cross-Sectional Area.

Clinical Evaluation

The surgical decompression of the median nerve resulted in a fast and highly significant reduction of the initial pain of the patients at all time points (Figure 6).

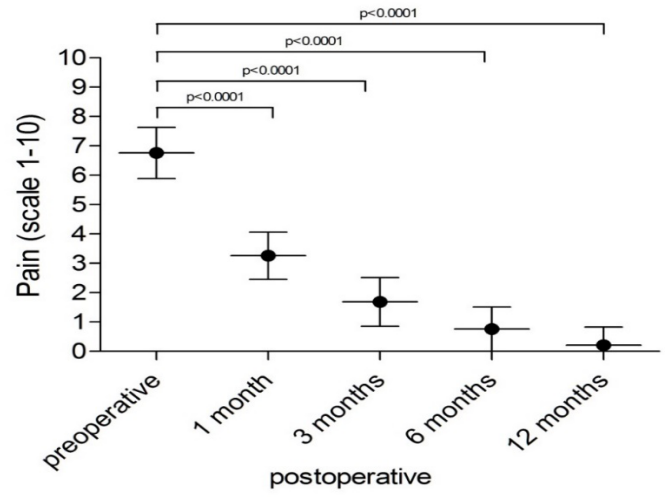

Figure 6: Pain Scale.

Discussion

TThe "carpal tunnel syndrome" is diagnosed clinically. The exact evaluation of the symptoms and the physical examination of the patients allow usually the diagnosis "carpal tunnel syndrome" [6,18,19]. Furthermore, the verification of CTS is frequently carried out before planning the surgery. Currently electrophysiological testing is the clinical "gold-standard" for the diagnosis for CTS [8,20]. The distal motor latency and the sensory conduction velocity of the median nerve are the two most important electrophysiological parameters. The distal motor latency shows a sensitivity of 63 % and a specificity of 98%. The sensory conduction velocity shows a sensitivity of 65% and a specificity of 98% [8]. Recently, several studies demonstrated that high definition ultrasound might be a potential alternative for the electrophysiological testing [14,9,21-23]. In this study we were able to demonstrate that electrophysiological testing is a reliable and reproducible method for the diagnosis of carpal tunnel syndrome. Furthermore, it could be shown that the regeneration of the median nerve after surgical decompression in the carpal tunnel could be demonstrated and monitored with the electrophysiological method. The analysis of the patients conception of pain after surgical decompression of the median nerve is a sufficient method for assessing the success of the surgical decompression. We observed a good correlation between the pain-reduction and the electrophysiological improvement of the median nerve. The high definition ultrasound assessment did not hold the promises we had at the initiation of this study [14].

Further refinements in the ultrasonic assessment and resolution are required and both hands need to be investigated because there was a statistic significant difference between the cross-sectional area of the operated and the no-operated hand detectable (p = 0.004). In the 3-months postoperative measurement this difference was no longer detectable.

In the postoperative follow-up of one year the ultrasound testing was not able to show a statistic significant changing of the cross-sectional area of the median nerve. In our study we were not able to repeat previous studies that demonstrated a significant postoperative change of the cross-sectional area after surgical decompression [1,11,10]. Due to this fact one of the most important benefits of the high-definition ultrasound is the real-time visualization of the carpal tunnel and the median nerve. In the preoperative analyze tumorous lesions, ganglions or an atypical anatomical course of the median nerve can be visualized and included in the surgical strategy. In the postoperative ultrasound follow-up possible complications like edema or post-operative-bleeding could be excluded or detected. In future the high definition ultrasound will presumably be qualified for standardized preoperative testing of patients with clinical symptoms of carpal

tunnel syndrome because a first meta-analysis presents new reference parameters for the cross-sectional area of the median nerve [24]. If postoperative testing is necessary, the electrophysiological measurement demonstrates the regeneration of the median nerve reliably and reproducible and has to be preferred.

References

1. Colak A, Kutlay M, Pekkafali Z, Saracoglu M, Demircan N, et al. (2007) Use of sonography in carpal tunnel syndrome surgery. A prospective study. Neurol Med Chir 47:109-115.
2. de Krom MC, Knipschild PG, Kester AD, Thijs CT, Boekkooi PF, et al. (1992) Carpal tunnel syndrome: prevalence in the general population. J Clin Epidemiol 45: 373-376.
3. Descatha A, Dale AM, Franzblau A, Coomes J, Evanoff B (2011) Comparison of research case definitions for carpal tunnel syndrome. Scand J Work Environ Health 2011.
4. Kwon BC, Jung KI, Baek GH (2008) Comparison of sonography and electrodiagnostic testing in the diagnosis of carpal tunnel syndrome. J Hand Surg Am 33: 65-71.
5. Patijn J, Vallejo R, Janssen M, Huygen F, Lataster A, et al. (2011) Carpal Tunnel Syndrome. Pain Pract 2011.
6. Aroori S, Spence RA (2008) Carpal tunnel syndrome. Ulster Med J 77: 6-17.
7. Mondelli M, Giannini F, Giacchi M (2002) Carpal tunnel syndrome incidence in a general population. Neurology 58: 289-294.
8. AAEM (2002) Practice parameter for electrodiagnostic studies in carpal tunnel syndrome: summary statement. Muscle Nerve 25: 918-922.
9. Wong SM, Griffith JF, Hui AC, Lo SK, Fu M, et al. (2004) Carpal tunnel syndrome: diagnostic usefulness of sonography. Radiology 232: 93-99.
10. Vogelin E, Nuesch E, Juni P, Reichenbach S, Eser P, et al. (2010) Sonographic follow-up of patients with carpal tunnel syndrome undergoing surgical or nonsurgical treatment: prospective cohort study. J Hand Surg Am 35: 1401-1409.
11. Mondelli M, Filippou G, Gallo A, Frediani B (2008) Diagnostic utility of ultrasonography versus nerve conduction studies in mild carpal tunnel syndrome. Arthritis Rheum 59: 357-366.
12. Kele H, Verheggen R, Bittermann HJ, Reimers CD (2003) The potential value of ultrasonography in the evaluation of carpal tunnel syndrome. Neurology 61: 389-391.
13. Kaymak B, Ozcakar L, Cetin A, Candan Cetin M, Akinci A, et al. (2008) A comparison of the benefits of sonography and electrophysiologic measurements as predictors of symptom severity and functional status in patients with carpal tunnel syndrome. Arch Phys Med Rehabil 89: 743-748.
14. Rahmani M, Ghasemi Esfe AR, Bozorg SM, Mazloumi M, Khalilzadeh O, et al. (2011) The ultrasonographic correlates of carpal tunnel syndrome in patients with normal electrodiagnostic tests. Radiol Med 116: 489-496.
15. Padua L, Pazzaglia C, Caliandro P, Granata G, Foschini M, et al. (2008) Carpal tunnel syndrome: ultrasound, neurophysiology, clinical and patient-oriented assessment. Clin Neurophysiol 119: 2064-2069.
16. El Miedany YM, Aty SA, Ashour S (2004) Ultrasonography versus nerve conduction study in patients with carpal tunnel syndrome: substantive or complementary tests?. Rheumatology (Oxford) 43: 887-895.
17. Beekman R, Visser LH (2003) Sonography in the diagnosis of carpal tunnel syndrome: a critical review of the literature. Muscle Nerve 27: 26-33.
18. Kamath V, Stothard J (2003) A clinical questionnaire for the diagnosis of carpal tunnel syndrome. J Hand Surg Br 28: 455-459.
19. Geraets JJ, Geijer RM, Goudswaard AN (2010) Dutch College of General Practitioners' practice guideline on symptoms of the hand and wrist: a summary. Ned Tijdschr Geneeskd 154: A1795.
20. Assmus H, Antoniadis G, Bischoff C, Haussmann P, Martini AK, et al. (2007) Diagnosis and therapy of carpal tunnel syndrome--guideline of the German Societies of Handsurgery, Neurosurgery, Neurology, Orthopaedics, Clinical Neurophysiology and Functional Imaging, Plastic, Reconstructive and Aesthetic Surgery, and Surgery for Traumatology. Handchir Mikrochir Plast Chir 39: 276-288.
21. Domanasiewicz A, Koszewicz M, Jablecki J (2009) Comparison of the diagnostic value of ultrasonography and neurography in carpal tunnel syndrome. Neurol Neurochir Pol 43: 433-438.
22. Moran L, Perez M, Esteban A, Bellon J, Arranz B, et al. (2009) Sonographic measurement of cross-sectional area of the median nerve in the diagnosis of carpal tunnel syndrome: correlation with nerve conduction studies. J Clin Ultrasound 37: 125-131.
23. Kwon HK, Kang HJ, Byun CW, Yoon JS, Kang CH, et al. (2014) Correlation between Ultrasonography Findings and Electrodiagnostic Severity in Carpal Tunnel Syndrome: 3D Ultrasonography. J Clin Neurol 10: 348-353.
24. Roomizadeh P, Eftekharsadat B, Abedini A, Ranjbar-Kiyakalayeh S, Yousefi N, et al. (2018) Ultrasonographic assessment of carpal tunnel syndrome severity: A systematic review and meta-analysis. Am J Phys Med Rehabil 2018.