



Intraoperative dynamic pressure measurements in carpal tunnel syndrome: Correlations with clinical signs



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ABSTRACT

Objective: This study was designed to evaluate the correlations between dynamic carpal tunnel pressure and clinical signs.

Methods: From December 2008 to May 2010, open carpal tunnel release (OCTR) was performed on a total of 90 hands (83 patients). All patients completed neurological and provocation tests (two-point discrimination, Tinel test, Phalen test, reverse-Phalen test and assessment of thenar muscle atrophy). Carpal tunnel pressure (CTP) was measured in two parts of carpal tunnel (proximal and distal carpal tunnel) and in three different postures (neutral, wrist flexion and wrist extension).

Results: There were 74 females and nine males aged 36 to 86 years (mean age 54). CTP values were more elevated in the wrist extension than wrist flexion in the proximal carpal tunnel but not at the distal carpal tunnel. There was no statistically significant correlation among CTP, provocation testing, and clinical signs. However, two-point discrimination (2-PD) showed a statistically significant correlation with CTP, especially in the proximal area in the wrist extension posture ($P < 0.01$). Duration of symptoms (SD) statistically correlated with CTP in the distal carpal tunnel in the neutral posture ($P < 0.01$).

Conclusions: 2-PD and duration of symptoms are correlated with the CTP value in specific areas and with hand postures. This emphasizes the importance of releasing the entire carpal tunnel lesion since CTP values appear to vary within the carpal tunnel space and according to hand posture.

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1. Introduction

The most important factor causing carpal tunnel syndrome (CTS) is high carpal tunnel pressure (CTP). High CTP is frequently associated with hand pain, paresthesia and other neurological signs. As a result, CTS can be easily diagnosed based on history; physical exam findings including thenar muscle atrophy, two-point discrimination testing (2-PD), and provocation testing using a Tinel, Phalen, or reverse-Phalen test; and electrodiagnostic testing (EDX).

Although many previous studies have tried to determine the physiological or pathological significance of CTP, there have been scanty quantitative analyses in the literature explaining the relationship between CTP and the above described clinical signs of CTS. This might be due to the fact that the previous studies were conducted using static (neutral) posture or measuring CTP in a restricted area, which is unlikely to sufficiently reveal the real

pathologic phenomenon of CTS. Meticulous CTP measurement with different hand postures would be a better method to evaluate the relationships between CTP and clinical signs and might be the best method to quantitatively explain the pathological influence of CTP. The purpose of this study was to determine the correlations between observed clinical signs and pathological CTP.

2. Materials and methods

2.1. Study patients

From December 2008 to May 2010, 90 hands of 83 patients were prospectively evaluated, including 54 right and 36 left hands (seven patients required bilateral treatment). There were 74 females and nine males aged 36 to 86 years (mean age 54). Patients who had symptoms in both hands (seven females) received operation on the more symptomatic hand first (Table 1). All operations were performed by a single neurosurgeon using the mini-open carpal tunnel release (OCTR) procedure. Patients who had additional complicating factors such as cervical myelopathy, previous wrist surgeries,

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Table 1
Summary of the clinical characteristic of the patients undergoing carpal tunnel release.

Characteristic	Value
No. of patients	83
No. of hands	90
No. of affected hands (n)	
Right	54 (60%)
Left	36 (40%)
Sex (n)	
Male	
Female	74
Mean age in years (range)	54 (36–86)
No. of duration of symptoms (%)	
1-SD group < 3 months	13 (14%)
2-SD group < 6 months (more than 3 months)	16 (18%)
3-SD group < 12 months (more than 6 months)	14 (16%)
4-SD group ≥ 12 months	47 (52%)
No. of Tinel test positive (%)	41 (46%)
No. of Phalen test positive (%)	57 (63%)
No. of reverse-Phalen test positive (%)	53 (59%)
No. of Tinel and Phalen test positive (%)	33 (37%)
No. of Tinel and reverse-Phalen test positive (%)	30 (33%)
No. of Phalen and reverse-Phalen test positive (%)	43 (48%)
No. of Tinel, Phalen and reverse-Phalen test positive (%)	26 (29%)
No. of thenar muscle atrophy (%)	21 (23%)
No. of electrodiagnostic grade (%)	
Mild	4 (4%)
Moderate	43 (48%)
Severe	43 (48%)

or systemic disease like rheumatoid arthritis were excluded from this study. Only idiopathic CTS patients were included in this study.

2.2. Pre-operative evaluation

All patients had typical CTS symptoms such as paresthesia and numbness in the median nerve distribution, and the duration of symptoms was assessed using a self-administered questionnaire. Persistent symptom duration (SD) was classified into four different subgroups. The level one (1-SD) group included patients with classical CTS symptoms occurring over a period of less than three months. The level two (2-SD) group comprised patients with a symptom duration between three and six months. The level three (3-SD) group included patients with a symptom duration between six and 12 months, and the level four (4-SD) group was patients with a symptom duration longer than 12 months. The presence of thenar muscle atrophy (TMA), defined as loss of thumb muscle volume and a specific oppositional posture, was assessed and classified as negative (absence group) or positive (presence group). Provocation testing using Tinel, Phalen, or reverse-Phalen tests was performed on all patients and classified as positive or negative. Patients in the positive group had reproducible symptoms on the recently affected hand. Each measurement was performed three times by two neurosurgeons with intervals. Static 2-PD was assessed as the smallest reliably detectable distance at which two points could be distinguished on the distal-intermetacarpophalangeal joint volar surface between the index and middle fingers (Fig. 1).

All EDX was performed by a consulting neurophysiologist in a standard manner. Motor velocity and sensory nerve latency were measured preoperatively. The electrodiagnostic grade (EDG) was assessed preoperatively and classified as mild, moderate, or severe based on the guidelines of the American Association of Electrodiagnostic Medicine (AAEM). The study was explained to all patients, and informed consent for the pressure measurement was obtained. This study was approved by the Institutional Review Board (IRB) of the Catholic University of Korea.

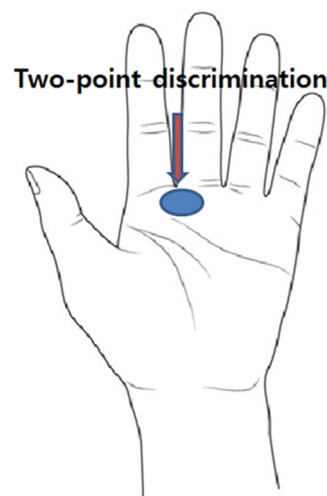


Fig. 1. The site of two-point discrimination measurement (arrow).



Fig. 2. Intraoperative pressure measurement. After mid-carpal ligament dissection, the catheter was inserted along the ulnar wall of the carpal tunnel.

2.3. CTP measurement

CTP was preoperatively and postoperatively measured in all patients. The patients were placed in the supine position on the operating table. After dissecting the subcutaneous layer in the center of the carpal ligament, the partial-transcarpal ligament was opened, and a catheter was inserted to the distal and proximal carpal tunnel. The area of the distal and proximal carpal tunnel was artificially divided by the midline of the transverse carpal ligament. The catheter was inserted along the ulnar side of the carpal tunnel to avoid unintentional injury to the thenar motor branch. An Integra™ Camino® Post Craniotomy Subdural Intracranial Pressure kit system was inserted into the proximal carpal and distal carpal tunnel lesion, and the highest pressure reading was recorded (Fig. 2).

Dynamic pressure measurements were also recorded in three different hand postures (neutral, passive flexion, and passive extension). The neutral posture required the forearm to be fully supinated with a flat wrist and metacarpophalangeal joint. Flexion and extension of the hand were manipulated by the operator from 0° to 90°. As a result, proximal-neutral (Pn), proximal-flexion (Pf), proximal-extension (Pe), distal-neutral (Dn), distal-flexion (Df), and distal-extension (De) CTPs were measured. To compare pathologic CTP and normal CTP, the pressure was also measured in the superficial antebrachial fascia area of the forearm, 5 cm proximal

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