Electrophysiological Changes of Median Nerve Induced by An Intraoperative Phalen’s Test on Carpal Tunnel Syndrome

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Introduction: The Phalen’s test has been one of the most significant of clinical signs when making a clinical diagnosis of carpal tunnel syndrome and checking the progress of this condition since Phalen modified the test in 1966 [1]. It is generally believed that median nerve compression is caused by the surrounding tissues when the wrist is flexed, thus resulting in the onset of pain and tingling sensations. However, it remains unclear exactly how the median nerve are affected by the Phalen's test in vivo. Therefore, it is interesting to study to what extent blood flow is disturbed in the median nerve when pain and tingling sensations are experienced in carpal tunnel syndrome. In this study, an intraoperative Phalen's test was performed, with attention given to pain and tingling sensations experienced during the Phalen's test. In the Phalen test performed intraoperatively, we evaluated the extent of the electrophysiological values disturbed, which caused pain and tingling sensations to develop.

Methods: The subjects were 20 patients with carpal tunnel syndrome who underwent carpal release (4 men and 16 women, aged 63.9 years on average [range, 37-79]). The details of the test were explained to the patients in obtaining their informed consent in advance. The test was performed only on those who gave consent. The preoperative Phalen's test revealed that all patients experienced pain and tingling sensations. During operation, we confirmed that the median nerve was compressed by the transverse ligament by observation under a naked eye. Then, the compound nerve action potentials were used to assess neural function and quantified by peak-to-peak amplitude. A platinum needle recording electrode was placed at the distal site of carpal tunnel. A bipolar platinum needle electrode was used to apply stimulation to the nerve at the proximal site of carpal tunnel by square-wave pulse of 0.2 ms duration delivered using a stimulator (Fig.1). Compound action potential recordings were collected, stored and analyzed with an electrodiagnostic device. The amplitude immediately before the test was used as the baseline measurement, with the values obtained during and just after the test being expressed as a percentage of baseline and are presented as the mean ± SEM. Comparison of values was performed using Student’s t-test.

Results: The intraoperative Phalen's test showed that the narrowing carpal tunnel caused median nerve compression in all patients. During the Phalen's test, there was a sharp decrease of amplitude with increasing angle at which pain and tingling sensations were experienced in all the patients, and this decrease lasted during the minute of Phalen's test. The amplitude had decreased by 0~52.6% (average±SEM: 12.6±19.1%) at 60 seconds after initiating the test. When the angle of the wrists was returned to zero degrees, amplitude showed an immediate improvement and the value recovered to that obtained before the Phalen's test (Fig.2,3). After incision of the transverse ligament, the median nerve
showed smooth gliding in all patients. The intraoperative Phalen's test conducted after incision of the transverse ligament showed no significant decrease of amplitude, and confirmed that carpal release had improved nerve function. When the Phalen's test was performed at 1 week after the operation, all the patients were negative and did not develop pain and tingling sensations, unlike the results obtained preoperatively.

Discussion: The Phalen's test is a test by which compression is loaded to the median nerve. Narrowing carpal tunnel, which was caused by transverse ligament, resulted in compression of intraoperatively found transverse ligament to the median nerve, disturbing gliding of the median nerve, thus contributing to an increase in compression given to the median nerve by transverse ligament. When pain and tingling sensations were experienced during the Phalen's test, transverse ligament caused relatively strong acute compression to develop at the median nerve, resulting in around 70-80% decrease (on average) in amplitude. In previous our study, the blood flow in the median nerve is apparently reduced when Phalen’s test performed in patients with carpal tunnel syndrome (2). In this study, amplitude also apparently decreased during Phalen test. After carpal tunnel release, the median nerve showed smooth gliding in all patients and the Phalen's test showed no significant decrease of blood flow and amplitude. The presence of median nerve compression in the carpal tunnel will compound the naturopathic pain by fixing the nerve in one position and thus increasing the susceptibility of the nerve to tension or compression. It was predicted that disturbed blood flow caused by this mechanical stress led to development of edema and hypoxia [3], constituting an inductive factor in the ectopic discharge responsible for pain.

Significance: When pain and tingling sensations were experienced during the Phalen’s test, the amplitude of the nerve action potentials deteriorated significantly during the Phalen’s test.

ORS 2015 Annual Meeting
Poster No: 1891