Effect of Acupuncture on Carpal Tunnel Syndrome with fMRI Assessment of Cortical Somatotopy

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Abstract We investigated finger somatotopic reorganization in chronic carpal tunnel syndrome (CTS), the most common entrapment neuropathy. Confirmed CTS patients were enrolled in a 5-week acupuncture protocol. Physiological exam, nerve conduction, and somatosensory fMRI data were collected for patients and healthy subjects before, during, and after treatment. Boston CTS Questionnaire results showed a significant decrease in CTS neuropathic symptom severity ($p<0.005$). For healthy subjects, fMRI results demonstrated distinct finger separation in the post-central gyrus (POG). For CTS patients, POG activation after acupuncture changed more for digits 2 and 3, as compared to digit 5. These preliminary results suggest that CTS may benefit from acupuncture treatment, while fMRI may be used to monitor cortical activation associated with a chronic nerve entrapment neuropathy.

Introduction Carpal tunnel syndrome is the most common entrapment neuropathy, with a U.S. prevalence of 3.72% [1]. CTS pathophysiology includes compression of the distal median nerve and a broad range of sensory symptoms, predominantly in the 1st through 3rd digits. Increasing evidence suggests that acupuncture is promising in treating CTS [2]. In addition, fMRI has been used to map finger somatotopy in normal subjects [3]. In this study, fMRI was used in conjunction with other objective measurements of somatosensory dysfunction in order to explore the potential efficacy of acupuncture in treating CTS patients.

Methods Patients (n=6) with a positive clinical diagnosis of mild to moderate carpal tunnel syndrome were recruited. Inclusion criteria were based on both physical exam (Phalen's, Tinel's sign, grip strength, 2-point discrimination, Boston CTS Questionnaire [4]), and nerve conduction findings (median nerve sensory latency and velocity). CTS patients were administered physical exam and nerve conduction tests prior to, two weeks into, and after a 5 week session of acupuncture (3x/week for 3 weeks and 2x/week for 2 weeks), and were scanned with fMRI before and after acupuncture treatment. Control subjects (n=5) were also administered physical exam and nerve conduction tests, and were scanned 5 weeks apart. Block design fMRI involved separate runs to stimulate digits 2, 3, and 5 with 100Hz electrostimulation. BOLD fMRI was completed on a Siemens Allegra 3T system equipped with head coil (TR/TE = 3000/30ms, 38 sagittal slices, 3.13 x 3.13 x 3.6mm). Data were processed with FSL ver3.1 (FMRIB Software Library, 2003), and visualized with SUMA (AFNI ver2.55, 2003). Functional activity was superimposed on Freesurfer (MGH) reconstructed and inflated individual brain surfaces [4,5].

Results fMRI demonstrated activation in the contralateral POG for all three digits tested. The cluster of S1 activation for a healthy subject translated in a dorsal direction from digit 2 to 5 (**Figure 1**). For CTS patients, POG activation after 5 weeks of acupuncture changed more for digits 2 and 3, as compared to digit 5 (**Figure 2**). In addition, acupuncture diminished the mean neuropathic symptom severity for CTS patients (n=6), as measured by the Boston CTS Questionnaire ($p<0.005$) (**Figure 3**).

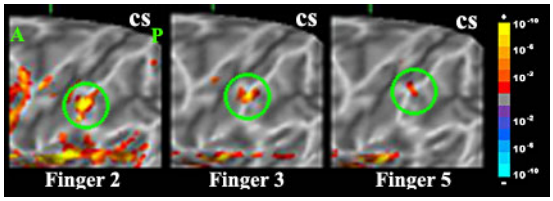

Figure 1 – contralateral POG activation in a healthy adult subject translated dorsally from finger 2 to 3 to 5.

Discussion The results demonstrate the feasibility of exploring somatosensory dysfunction with fMRI. Chronic entrapment neuropathy may contribute to altered finger somatotopy. Specifically, a conduction block of the median nerve may produce abnormal S1 and/or S2 representation of the 2nd and 3rd digit, sparing the ulnar nerve associated 5th digit. In addition, these neuroplastic changes could conceivably be effected by appropriate therapy. We suggest that acupuncture may be an effective modality in improving the affective and perceptive symptomatology of CTS and more studies are warranted.

References

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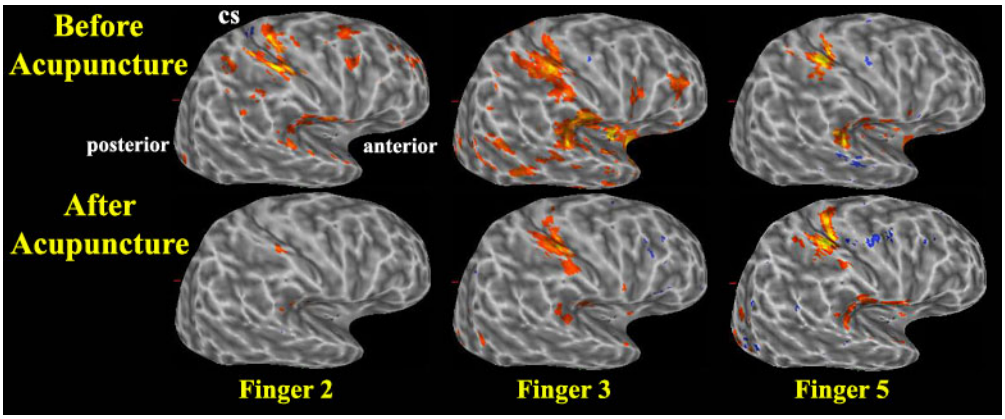

Figure 2 – Contralateral activation in a CTS patient, before and after acupuncture treatment. More variability is seen for digits 2 and 3, than for digit 5. In the POG, Brodmann Areas 3a, 3b, 1, and sometimes 2 demonstrated activation in the hand area. (n.b. cs = central sulcus).

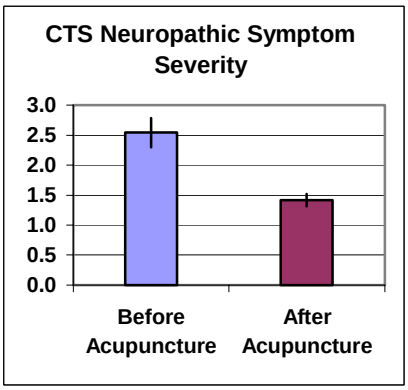

Figure 3 – Mean neuropathic symptom severity in CTS patients (n=6), decreased after acupuncture treatment ($p<0.005$).