



## Consecutive Changes in Nerve Conduction Studies After Surgery for Carpal Tunnel Syndrome – Useful Parameters for Evaluating Postoperative Recovery

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### Abstract

**Objective:** We quantitatively evaluated indicators of postoperative recovery from surgery for carpal tunnel syndrome (CTS) and determined the most sensitive nerve conduction study [NCS] parameters.

**Materials and Methods:** NCSs were performed in 50 hands with CTS preoperatively, and at 1 and 3 months postoperatively. Four NCS parameters were assessed: abductor pollicis brevis-distal motor latency (APB-DML), index-distal sensory latency (DSL), 2nd lumbrical – interossei latency difference (2L-INT), and ring finger test (Ring).

**Results:** The 33 hands in which APB compound muscle action potentials (CMAPs) were preoperatively detected showed significant improvement in APB-DML over time. The 46 hands for which 2L CMAPs were preoperatively detected showed significant improvement in 2L-INT over time, clearly reflecting postoperative recovery. Index-sensory nerve action potentials (SNAPs) and Ring-SNAPs were undetected in 41 hands and 50 hands, respectively, and remained undetected at 3 months in 27 hands and 45 hands, respectively.

**Conclusion:** Our findings suggest that 2L-INT and APB-DML, in this order, are suitable parameters for evaluating postoperative recovery of CTS, while Index-DSL and Ring using SNAPs are not useful.

**Keywords:** Carpal Tunnel Syndrome; Nerve Conduction Study; Surgery; Median Nerve; Lumbrical

### Abbreviations

2L-INT: 2<sup>nd</sup> Lumbrical – Interossei Latency Difference; APB-DML: Abductor Pollicis Brevis-Distal Motor Latency; CMAP: Compound Muscle Action Potential; CTS: Carpal Tunnel Syndrome; DSL: Index-distal Sensory Latency; NCS: Nerve Conduction Study; Ring: Ring Finger Test; SNAP: Sensory Nerve Action Potential.

### Introduction

Carpal tunnel syndrome surgery is mainly performed in patients who are severely affected. Patients who do not experience marked recovery immediately following surgery may question the success of the surgery. Therefore, a quantitative method for assessing postoperative recovery after CTS surgery is needed. In the

present study, we determined the most sensitive NCS parameters for evaluating postoperative recovery following CTS surgery.

### Materials and Methods

In 78 patients, 90 open carpal tunnel release surgeries were performed over a 45-month period, and 50 hands of 46 patients were monitored for 3 months. Patients who exhibited marked recovery do not require a 3-month follow-up, and thus these 50 hands belonged to patients with rather severe CTS. Of the 46 patients, 10 were men and 36 were women with a mean age of  $74.4 \pm 1.9$  years (range: 51~94). We evaluated 4 NCS parameters: abductor pollicis brevis-distal motor latency (APB-DML), index-distal sensory latency (Index-DSL), 2<sup>nd</sup> lumbrical – interossei latency difference (2L-INT), and ring finger test (Ring), as shown in figure 1 [1-3].

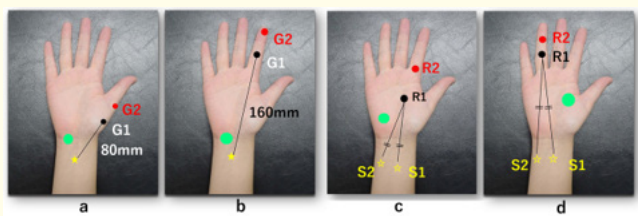


Figure 1: a) APB-DML, b) Index-DSL, c) 2L-INT, d) Ring

### Results and Discussion

Of the 50 hands, 8 were classified with moderate CTS, 25 with severe CTS, and 17 with extreme CTS following Padua’s classification, as shown in figure 2 [4]. APB-compound muscle action potentials (CMAPs) were preoperatively undetected in 17 hands; the 33 hands in which APB-CMAPs were detected exhibited significant improvement in APB-DML over time (Figure 3). 2L-CMAPs were preoperatively undetected in only 4 hands and detected in 46 hands. The 46 hands in which 2L-CMAPs were detected showed significant improvement in 2L-INT over time, clearly reflecting postoperative recovery (Figure 4). INT-CMAPs were detected in all 50 hands. Index-sensory nerve action potentials (SNAPs) and Digit 4-SNAPs evoked by median nerve stimulation were undetected in 41 hands and 50 hands, respectively, and remained undetected at 3 months in 27 hands and 45 hands, respectively (Figure 5). Digit 4-SNAPs evoked by ulnar nerve stimulation were detected in all 50 hands.

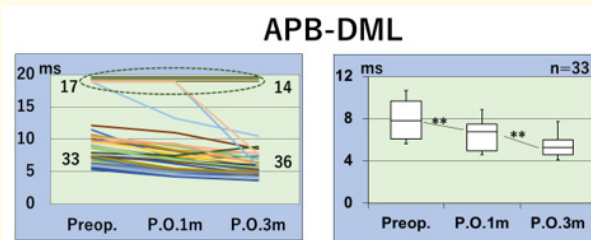


Figure 3: APB-CMAPs were preoperatively undetected in 17 hands, while detected 33 hands consecutively improved APB-DML and clearly reflected the postoperative recovery ( $P < 0.01$ ; Wilcoxon t-test with Bonferroni correction).

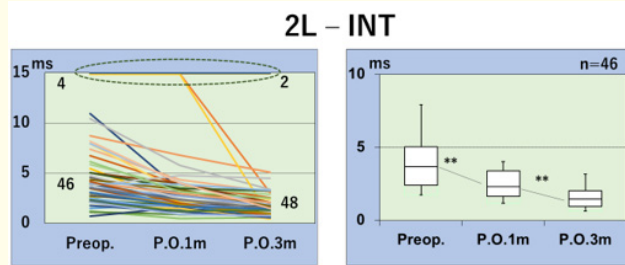


Figure 4: 2L-CMAPs were preoperatively undetected in only 4 hands, and detected in 46 hands, in which 2L-INT showed significant improvement over time, clearly reflecting postoperative recovery ( $P < 0.01$ ; Wilcoxon t-test with Bonferroni correction).

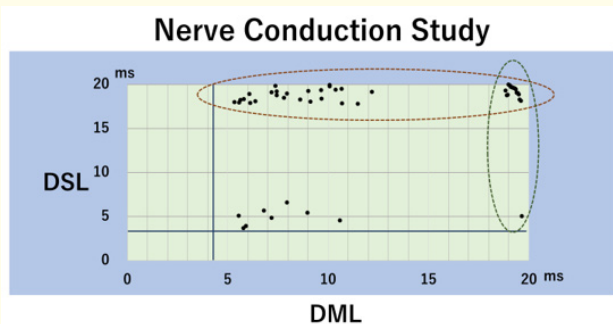


Figure 2: Fifty hands were classified into moderate, severe, or extreme CTS following Padua’s classification (cut-off values;  $DML > 4.2ms$ ,  $DSL > 3.5ms$ ). The dotted circles indicate that parameters were not detected.

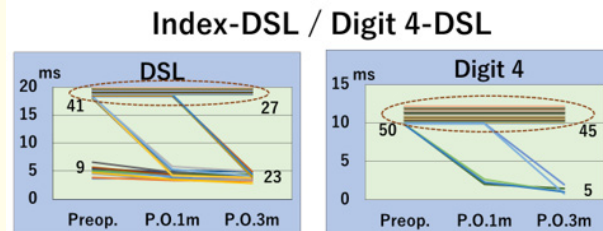
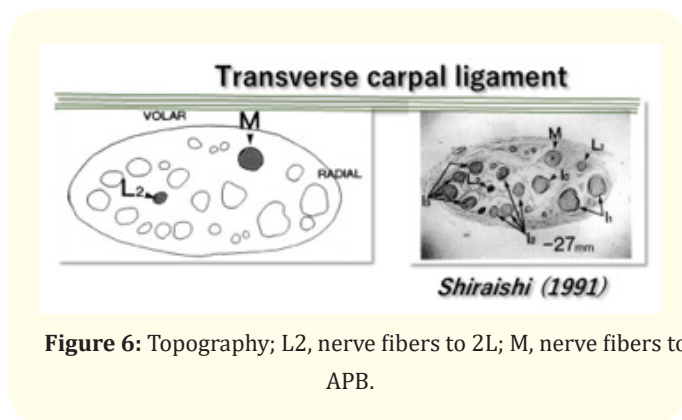


Figure 5: Index-SNAPs and Digit 4-SNAPs [median nerve] were preoperatively undetected in 41 and 50 hands, respectively, and remained undetected in 27 and 45 hands at 3 months, respectively.

SNAPs have a short duration, and are susceptible to temporal dispersion in peripheral neuropathy, which is why they are undetectable in severe CTS. Long-lasting CMAPs, on the other hand, are not susceptible to temporal dispersion and are maintained even in severe CTS. For this reason, APB-DML and 2L-INT are useful for determining improvement after CTS surgery [5]. Because the nerve fibers to the 2nd lumbrical are located deep in the carpal tunnel, as shown in the topography of the median nerve (Figure 6), and are thus spared in severe entrapment, 2L-CMAPs are still detected even in extreme CTS [6-10]. Comparison studies including 2L-INT and Ring have high sensitivity because the differences between the latencies detected by median-ulnar stimulation extract the delay at entrapment, which leads to low cut-off values [2,3]. These comparison studies have another advantage in that they exclude errors associated with polyneuropathy [11]. Comparison studies are valuable for evaluating CTS, but in the Ring finger test, SNAPs by radial half digital nerve stimulation show low amplitudes and are often undetected in severe CTS, whereas 2L-INT is suitable for evaluating mild to severe CTS. 2L-INT is strongly recommended and is generally considered the most valuable parameter for predicting postoperative improvement.



**Figure 6:** Topography; L2, nerve fibers to 2L; M, nerve fibers to APB.

### Conclusion

Our findings demonstrated that 2L-INT and APB-DML, in this order, are suitable parameters for evaluating postoperative recovery of CTS, while Index-DSL and Ring using SNAPs are not useful.

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### Conflict of Interest

All authors declare no conflicts of interest.

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