

Effects of Modified Camitz Opponensplasty to Restore Thumb Opposition for Severe Carpal Tunnel Syndrome

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Abstract

Objective: Hand function damaged by Carpal tunnel syndrome (CTS) is usually recoverable after the surgery of carpal tunnel release, but treatment for severe CTS does not always result in functional recovery. The purpose of the present study was to assess the effectiveness of modified Camitz opponensplasty for severe CTS. Specifically, we employed a combined operation of open carpal tunnel release (OCTR) and modified Camitz opponensplasty for severe CTS patients who needed early recovery of thumb opposition.

Methods: The subjects were 26 hands in 22 patients with severe CTS. Before surgery, all hands had marked thenar muscle atrophy and loss of thumb opposition. All patients underwent surgery through OCTR and modified Camitz opponensplasty using a pulley at the radial side of the released flexor retinaculum. Compound muscle action potential (CMAP) from the abductor pollicis brevis (APB) muscle and the second lumbrical (SL) muscle were recorded and analyzed. Static 2 points discrimination test data, grip strength, pulp pinch strength and active palmar abduction of the thumb were assessed. Outcomes were evaluated according to Kelly's grading and patient-reported outcome measures were assessed using the Carpal Tunnel Syndrome instrument (CTS1).

Results: Before surgery, APB-CMAP was not recordable and SL-CMAP was recordable in all 26 hands. After surgery, according to Kelly's grading of outcome, results were excellent in 11 hands, good in 12, and fair in three. In all patients, both the symptom severity score and function score in CTS1 markedly improved at final follow-up. At 3 months, postoperative pulp pinch strength and active palmar abduction of the thumb increased significantly. There was no significant difference in postoperative thumb palmar abduction and pulp pinch strength between the hands showing and not showing the recovery of APB-CMAP.

Conclusion: Modified Camitz opponensplasty was effective to restore thumb palmar abduction and pulp pinch strength from the early postoperative phase in severe CTS.

Keywords: Carpal tunnel syndrome; Camitz opponensplasty; Abductor pollicis brevis; Thumb opposition; Nerve conduction measurement

Introduction

Carpal tunnel syndrome (CTS) is a common entrapment neuropathy of the median nerve at the wrist. Carpal tunnel release by dividing the flexor retinaculum is an accepted surgical technique when conservative therapy fails [1,2]. Hand function damaged by CTS is usually recoverable after the surgery of endoscopic or open carpal tunnel release (OCTR) [2-4]. However, treatment for severe CTS with thenar muscle atrophy and loss of thumb opposition does not always result in functional recovery [5,6]. In 2005, we reported the postoperative outcome after surgery in association with the distal latency (DL) of compound muscle action potential (CMAP) from the second lumbrical (SL) muscle [7]. Specifically, the ratio of excellent results after OCTR was compared between the severe CTS patients with DL of SL-CMAP less than 10 milliseconds (ms) and those with DL of SL-CMAP 10 ms or more. Our reports states that former had a

higher ratio (65 percent) than the latter (20 percent), and that the mean interval between surgery and recovery of thumb opposition in the recovered cases (88 percent) was 7 months. In 2008, we started to employ a combined surgery of OCTR and modified Camitz opponensplasty [8-12] for severe CTS patients who needed early recovery of thumb opposition and powerful pinch strength, and whose preoperative DL of SL-CMAP 10 ms or more. The purpose of the present retrospective study was to assess the effectiveness of modified Camitz opponensplasty for severe CTS.

Patients and Methods

Between May 2008 and September 2016, 34 hands of 30 patients with severe CTS underwent a combined surgery of OCTR and modified Camitz opponensplasty at our hospital. Among them, 26 hands of 22 patients were followed up for 6-43 months (mean 13 months). Among these 22 follow up patients, 4 patients had bilateral severe CTS, 10 had mild CTS on the contralateral side as well, and 8 had unilateral severe CTS. The affected side was right in 20 and left in 6, the dominant extremity was involved in 20. Written informed

consent was obtained from each patient. CTS was diagnosed with physical examination and electrodiagnostic assessment using CMAP from the abductor pollicis brevis (APB) and from SL. APB-and SL-CMAP were recorded with surface electrodes by supramaximal stimulation of the median nerve at the wrist [7]. Eight hands of 7 patients were from men and 18 hands of 15 patients were from women. All hands were idiopathic CTS, and had marked thenar muscle atrophy and loss of thumb opposition. All patients needed powerful pinch strength and recovery of thumb opposition from the early postoperative phase. The preoperative APB-CMAP was not recordable and DL of SL-CMAP 10 ms or more. Mean age at operation was 71 years (43-87). The average duration of symptoms was 53 months, ranging from 16 to 144 months.

Surgical technique and postoperative management: The technique was similar to that employed by Kato et al. [11] and Hattori et al. [12]. A curved incision was made at the wrist and extended proximally for a 3 cm incision in the distal forearm. A 1 cm strip of the palmar aponeurosis was left connected to the isolated palmaris longus tendon at the distal forearm. The flexor retinaculum was divided at its ulnar attachment to decompress the carpal tunnel and release the median nerve. After dissecting the palmaris longus tendon in continuity with the palmar aponeurosis and releasing flexor retinaculum, the palmaris longus tendon was passed through a small hole at the radial side of the released flexor retinaculum from its undersurface, the palmaris longus tendon was passed through a subcutaneous tunnel and was sutured to the tendinous insertion of the APB with the thumb in palmar abduction (Figure 1).



Figure 1: Surgical technique of modified Camitz opponensplasty. After dissecting the palmaris longus tendon in continuity with the palmar aponeurosis and releasing the flexor retinaculum at its ulnar attachment, the palmaris longus tendon was passed through a small hole of the released flexor retinaculum from its undersurface of the released retinaculum (arrow), the palmaris longus tendon was passed through a subcutaneous tunnel and was sutured to the tendinous insertion of the APB.

The hand was placed in a short arm spica orthosis with the thumb at 45 degrees of palmar abduction and the wrist at neutral position for 3 weeks. Then, the orthosis was removed and patients were instructed to perform the range of motion exercises of thumb palmar abduction and pulp pinch motion twice a week for 4 weeks as outpatients.

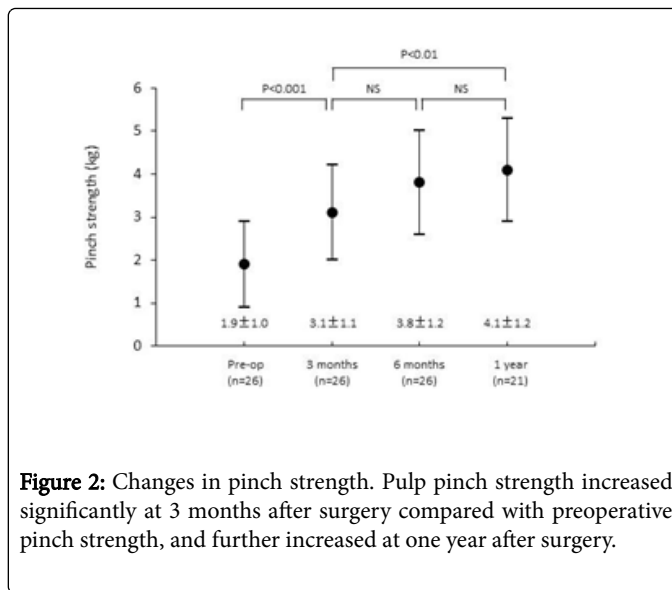


Figure 2: Changes in pinch strength. Pulp pinch strength increased significantly at 3 months after surgery compared with preoperative pinch strength, and further increased at one year after surgery.

The postoperative results were evaluated into four categories according to the relief of symptoms by Kelly et al. [13], i.e., excellent meant complete relief of symptoms (recovery of the thumb opposition more than 40 degrees of palmar abduction), good was persistence of occasional minor symptoms (recovery of the thumb opposition), fair meant some constant or annoying symptoms (residual loss of the thumb opposition), and poor was symptoms unchanged or worse. Patient-reported outcomes were also measured using the Japanese Society for Surgery of the Hand version of the Carpal Tunnel Syndrome instrument (CTSI) [14].

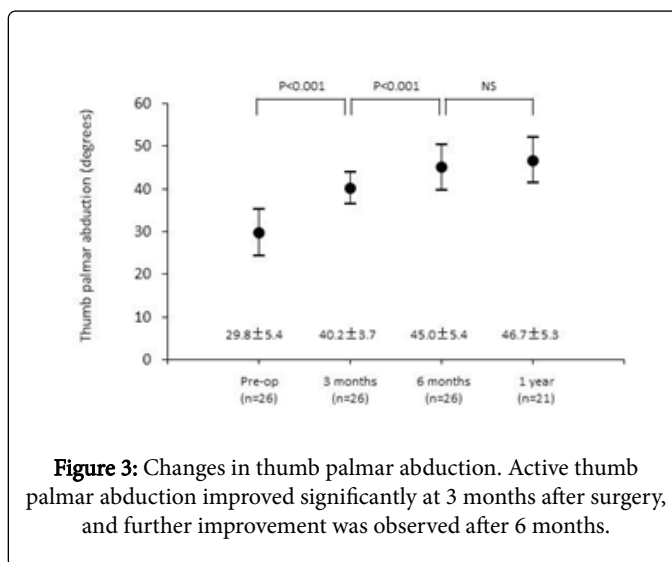


Figure 3: Changes in thumb palmar abduction. Active thumb palmar abduction improved significantly at 3 months after surgery, and further improvement was observed after 6 months.

Static 2 points discrimination (2PD) test results, grip strength, pulp pinch strength and active palmar abduction of the thumb (measured as the angle between the first and the second metacarpal lines) were recorded. Clinical evaluation was performed before surgery, 3 months, 6 months, and at final follow up after surgery. Complications including hematoma, infection, rupture of the tendon, and bowstringing of the tendon were also examined. The data were analyzed with the Student's t-test and the Mann-Whitney U test. A p-value less than 0.05 was considered statistically significant.

Results

Before surgery, APB-CMAP was not recordable and SL-CMAP was recordable in all 26 hands. The mean amplitude of SL-CMAP was 0.1 millivolts (mV), mean DL was 11.9 ms (Table 1).

	Preoperative	Final follow-up	p Value
Static 2 points discrimination test (mm) (SD)	27.9(12.6)	9.2(3.6)	<0.001
Pulp pinch strength (kg) (SD)	1.9(1.0)	4.1(1.2)	<0.001
Grip strength (kg) (SD)	11.9(4.7)	14.4(6.2)	N.S.
Thumb palmar abduction (degrees) (SD)	29.8(5.4)	46.7(5.3)	<0.001
CTSI (n=20)			
Symptom severity score (points) (SD)	2.41(0.7)	1.44(0.37)	<0.001
Function score (points) (SD)	2.54(0.99)	1.53(0.41)	<0.001
Nerve conduction measurement			
Detection of APB-CMAP (hands)	0(all N.R.)	21(5: N.R.)	
Amp.(mV) (SD)		1.3(1.4)	
DL (ms) (SD)		5.6(1.7)	
Detection of SL-CMAP (hands)	26	18(8: N.D.)	
Amp.(mV) (SD)	0.1(0.1)	0.2(0.2)	N.S.
DL (ms) (SD)	11.9(3.4)	6.2(2.8)	<0.001

Table 1: Demographic Data of Overall Results (SD: Standard Deviation; APB: Abductor Pollicis Brevis; CMAP: Compound Muscle Action Potential; N.R.: Not Recordable; N.D.: Not Done; Amp: Amplitude; DL: Distal Latency; SL: Second Lumbrical; N.S: No Significance).

In 20 hands, DL of SL-CMAP was 10 ms or more. According to Kelly's grading of outcome, results were excellent in 11 hands, good in 12, fair in three and there were no poor cases. Three cases with fair result had constant residual hypesthesia in the hand. Overall results are shown in Table 1. The mean preoperative static 2PD (27.9 mm) improved to 9.2 mm postoperatively ($p < 0.001$), and the mean preoperative pulp pinch strength (1.9 kg) markedly increased to 4.1 kg ($p < 0.001$). The mean preoperative grip strength (11.9 kg) slightly improved to 14.4 kg, and the mean preoperative active palmar abduction of the thumb (29.8 degrees) markedly improved to 46.7 degrees ($p < 0.001$). In all patients, both symptom severity score and function score in CTSI improved at final follow-up ($p < 0.001$). Concerning the interval between surgery and recovery, pulp pinch strength increased to 3.1 kg at 3 months after surgery ($p < 0.001$) and further increased to 4.1 kg at one year (Figure 2), while active palmar abduction of the thumb improved to 40.2 degrees at 3 months ($p < 0.001$) and further improved to 45 degrees at 6 months (Figure 3). Meanwhile, in 8 hands (8 patients) with the normal contralateral side without CTS, the mean pulp pinch strength was 5.3 kg (SD 2.4), and the mean palmar abduction of the thumb was 55 degrees (SD 5.6). Postoperative APB-CMAP was recordable in 21 hands with the mean DL of 5.6 ms and the mean amplitude of 1.3 mV. Postoperative SL-

CMAP was recorded in 18 hands with the mean DL of 6.2 ms and the mean amplitude of 0.2 mV, which showed a significant shortening of DL compared with preoperative DL of 11.9 ms (Table 1). The mean postoperative pulp pinch strength in 21 hands with a recovery of APB-CMAP was 4.1 kg (SD 1.2), while that in 5 hands without a recovery was 3.5 kg (SD 0.7), which showed no significant difference. The mean postoperative palmar abduction of the thumb in 21 hands with a APB-CMAP recovery was 46.8 degrees (SD 5.1), while that in 5 hands without a recovery was 42.0 degrees (SD 5.7), which revealed no significant difference. There were no complications including hematoma, infection, rupture and bowstringing of the tendon.

Discussion

The indication for opponensplasty to restore thumb opposition for severe CTS is still controversial. Although APB-CMAP directly assesses the function of APB, it is often not recordable in severe CTS patients with thenar muscle atrophy [6,7,12,15]. Mondelli et al. [4] reported that even severe CTS patients with absent APB-CMAP had a satisfactory recovery after OCTR alone, and Hara et al. [16] demonstrated that the APB muscle recovery rate was 100 percent at one year after OCTR in the severe CTS patients who had a evoked motor unit potential (MUP) of the APB muscle at preoperative needle electromyography. It is known that SL-CMAP is preserved in most cases with absent APB-CMAP [7,17,18], and Kamiya et al. reported that the severe CTS patients with preoperative DL of SL-CMAP 8 ms or less showed a good recovery at 12 months after OCTR [19]. Nobuta et al. reported that the ratio of the thumb opposition recovery after OCTR in severe CTS patients whose DL of SL-CMAP less than 10 ms was higher (90 percent) than that in those with DL of SL-CMAP 10 ms or more (80 percent), and that the mean interval between surgery and recovery of the thumb opposition in the recovered cases (88 percent) was 7 months [7]. In these previous reports, the interval between the surgery and recovery of thumb opposition was 7 months to one year. Therefore, for severe CTS patients who needed early recovery of the thumb opposition and powerful pinch strength and whose DL of SL-CMAP was 10 ms or more, we performed a combined surgery of OCTR and modified Camitz opponensplasty.

Camitz opponensplasty using palmaris longus tendon has been performed in severe CTS patients, and is usually treated simultaneously with OCTR [5,20-23]. However, Camitz opponensplasty provides abduction rather than opposition because of its radial orientation of the transferred tendon. That is the reason why postoperative prominent bowstringing of the transferred tendon is noted [12]. In order to avoid this complication, the dissected flexor retinaculum was used as a pulley to modify the direction of the transferred tendon [8-12]. In our series, 23 of the 26 hands showed excellent or good results by Kelly's grading of outcome, 2PD test markedly improved after surgery, and both the symptom severity score and function score in CTSI improved significantly at final follow up. Improvement in CTSI was almost equal to the outcome reported by Hattori et al. [12]. Pulp pinch strength increased significantly at 3 months and further increased at one year after surgery (Figure 2). Active palmar abduction of the thumb improved significantly at 3 months after surgery and further improvement was observed at 6 months (Figure 3). Kato et al. [11] and Hattori et al. [12] also reported that pulp pinch and palmar abduction of the thumb improved at 3 months after surgery. Our results of postoperative APB-CMAP recovery (21 hands) suggest the spontaneous recovery of the thenar muscle after OCTR [12]. However, postoperative pulp pinch strength

and palmar abduction of the thumb showed no significant differences between those in 21 hands that showed a recovery of APB-CMAP and those in 5 hands with no recovery. Of 21 hands with our APB-CMAP recovery cases, only 5 hands showed APB-CMAP amplitude more than 1.8 mV which is useful for recovering the APB function [7,12]. Therefore, we suppose that spontaneous recovery of APB have little contribution to pinch strength and palmar abduction.

Our results revealed the effectiveness of modified Camitz opponensplasty for early recovery of pulp pinch strength and thumb palmar abduction in severe CTS. However, there were several limitations with this study. First, we were not able to measure the recovery of pronation of the thumb, which is a component of thumb opposition [5]. Measurement of the thumb pronation was difficult [11,12], while measurement of palmar abduction was simple and accurate. Thus, we measured palmar abduction alone. Second, there was no control group to compare postoperative results between severe CTS treated with OCTR alone and those with simultaneous opponensplasty. A report states that the patients who needed early recovery of pinch strength and thumb palmar abduction were highly motivated and healthy compared with those who underwent OCTR alone [12]. Therefore, we did not perform a randomized controlled trial for comparison. Third, since the palmaris longus may be sacrificed without noticeable deficit, the palmaris longus is absent in 14 percent of hands [5]. Thus, we had to consider another surgical technique using the extensor pollicis brevis to restore thumb opposition [24] for the patients with an absent palmaris longus. Finally, in our series, various conservative treatments were performed before surgery, such as steroid injection and/or antiinflammatory drugs, which were not taken into consideration in this study.

Conclusion

Modified Camitz opponensplasty was effective to restore thumb palmar abduction and pulp pinch strength from the early postoperative phase in severe CTS.

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