Journal of Hand Surgery Global Online 7 (2025) 238–241

Contents lists available at ScienceDirect

Journal of Hand Surgery Global Online

journal homepage: www.JHSGO.org

Case Report

Delayed Repair of Recurrent Motor Branch Injury after Carpal Tunnel Release

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ARTICLE INFO

Article history:
Received for publication October 6, 2024
Accepted in revised form November 6, 2024
Available online December 12, 2024

Key words:
Carpal tunnel
Median nerve
Nerve injury
Recurrent motor branch
Repair

Iatrogenic injury to the recurrent motor branch of the median nerve is an uncommon but severe complication following carpal tunnel release. Surgeons should be aware of the anatomical variations of this branch, particularly with the advent of smaller incisions and endoscopic techniques. Here, we present the case of a 60-year-old woman whose recurrent motor branch injury was not identified until 2 years following her index procedure. She underwent a successful primary repair 25 months after her initial injury, with notable improvements in thumb function, strength, and return of thenar muscle bulk beginning 2 months after surgery and continuing through last follow-up at 7 months. Our patient's outcome suggests that repair of a severed recurrent motor branch remains a viable option 2 years after initial injury and that functional improvement and thenar muscle reinnervation can occur even after considerable time has elapsed.

Carpal tunnel release is a reliable and safe procedure that produces satisfying results, yet complications can cause significant functional impairment. One particularly devastating complication is iatrogenic injury of the recurrent motor branch of the median nerve.[1,2] This branch innervates the abductor pollicis brevis (APB), opponens brevis, and the superficial head of the flexor pollicis brevis and is crucial for thumb opposition and overall hand function.[2]

Here, we present a case of iatrogenic recurrent motor branch injury identified 24 months after carpal tunnel release and review the work-up and examination findings suggestive of this diagnosis. Given the patient's delayed presentation, many surgeons might recommend a tendon transfer. Our patient was successfully treated with nerve exploration and direct primary repair of the recurrent motor branch 25 months after initial injury. Within 6 months after surgery, the patient developed meaningful improvement in affected muscle strength, thenar bulk, and thumb stability.

This outcome is important as the potential recovery of nerve function wanes as time passes from the injury date. Our patient's outcome demonstrates the potential for successful primary repair of a severed recurrent motor branch over 2 years out from initial injury, the longest period of time reported in the literature.[3,4]

Statement of Informed Consent

Informed consent was obtained from all individual participants included in the study.

Case Report

A 60-year-old otherwise healthy right-hand-dominant woman presented with right thumb pain and weakness 24 months following a carpal tunnel release. The patient reported that there had been complications during the surgery which was prolonged and required conversion to general anesthesia. Although her nocturnal paresthesias resolved, the patient reported she never fully recovered, continuing to have achy pain over the thenar eminence and at the base of the thumb with a sensitive scar. Five months after surgery, the patient noticed new atrophy of her thenar eminence with worsening weakness in opposition and grip. She described her thumb as unstable and "floppy" and had developed pain over the thumb carpometacarpal (CMC) joint as well. The patient had been managed conservatively with steroid injections, hand therapy, and splinting but continued to have pain and disability with daily activities.

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https://doi.org/10.1016/j.jhsg.2024.11.009

Table
Patient's Strength Measurements Before and After Recurrent Motor Branch Repair

Strength Measurement	Hand Laterality	Before Surgery	2 mo	4 mo	7 mo*
Grip	R	30	25	23	52
	L	49	45	45	30
Lateral pinch	R	8.5	10.5	11	13
	L	12	14	16	13
3-Point pinch	R	9	5.5	6	11
	L	12	14	14.5	9

* The patient underwent a left carpal tunnel release 4.5 months after her right-sided nerve repair, which accounts for the decrease in left-handed strength measurements at 7 months.

Physical examination was notable for significant thenar atrophy, no discernable APB motor function, and limited abduction and opposition. Sensation was intact in the median nerve distribution with two-point discrimination of 5 mm. She had pain and sensitivity at the wrist with compression and Tinel testing over the carpal tunnel, but reported no numbness or paresthesias radiating distally in the median nerve distribution. Preoperative strength measurements demonstrated considerable weakness compared to her non-dominant left hand (Table). Repeat electrodiagnostic studies showed no response of the right median motor nerve at the wrist with 2+ Fibs/Pwaves and severely reduced recruitment of the APB. This was compared to the preoperative electrodiagnostic study from 2018, which demonstrated only prolonged distal latency of the median motor nerve, with normal amplitude, conduction velocity, and electromyographic findings. Ultrasound of the carpal tunnel showed a round-appearing median nerve, indicating adequate decompression of the carpal tunnel. Thumb radiographs demonstrated only mild CMC joint subluxation, but overall well-preserved joint space without any degeneration or osteophyte formation.

Considering the above findings, there was high suspicion for iatrogenic damage to the recurrent motor branch of the median nerve. Treatment options were discussed, including nonsurgical management, wound exploration with possible primary nerve repair, and opposition transfer. She elected to proceed with exploration and repair, with the understanding that opposition transfer remained an option should the surgery be unsuccessful.

At the time of surgery, incision was made through the previous scar, and dissection was carried down to the transverse carpal ligament, which was thin and did not appear compressive. This was longitudinally released revealing an intact and healthy median nerve. The incision was then extended along the thenar crease toward the first webspace. A full median nerve neurolysis was performed distally. The recurrent motor branch was indeed found to have been transected with formation of a neuroma that had scarred to the overlying palmar fascia. Examination showed it likely was extraligamentous with a more central (ulnar) takeoff. No other injured nerve branches were identified. Dissection was carried into the thenar musculature to identify distal nerve targets. Only one target was found to be sufficient, traveling to the APB muscle. Using a microscope, intraneural dissection of the recurrent motor branch was performed to mobilize and increase the excursion of the nerve. Approximately 1.5 cm of scarred nerve had to be excised until healthy fascicles were apparent in the proximal and distal stumps (Fig 1). A tension-free epineural repair of the recurrent motor branch to the distal nerve stump was performed with 9-0 nylon supplemented with a nerve conduit. A nerve wrap was then used to fully cover the median nerve and recurrent motor branch within the carpal tunnel.

The patient was placed in a thumb spica splint maintaining the thumb in palmar adduction and slight radial abduction for one month, after which she began hand therapy. At her 2-month follow-up, the patient reported subjective improvement in the ability to use her right hand with computer-based work and self-care activities. Her thenar eminence remained atrophied without significant change. She was still unable to actively abduct her thumb. Postoperative strength measurements are reported in the Table.

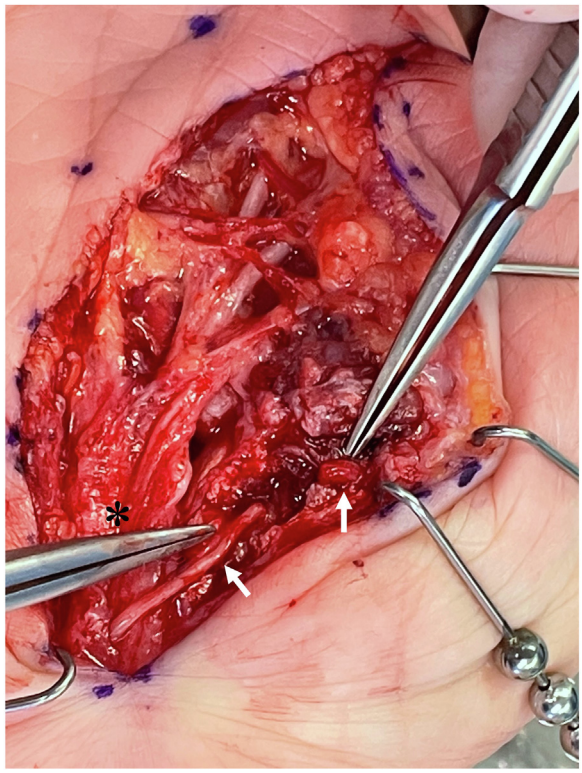

Figure 1. Intraoperative photograph showing intraneural dissection of the recurrent motor branch of the median nerve and its distal target to the thenar muscles (white arrows). Median nerve proper is indicated with a black asterisk.

At her four-month follow-up, the patient reported significant improvement in thumb stability with resolution of CMC pain. On examination, there was undeniable improvement in the contour of her thenar musculature (Fig 2). Motor testing demonstrated 4/5 APB strength, with excellent palmar abduction and opposition to the palmar flexion crease of the small finger. The sensitivity at the carpal tunnel and Tinel sign had resolved. She was back to work without any limitations.

At 7 months after surgery, the patient reported her right hand had become her dominant hand again with continued improvement in thumb strength and stability. She had excellent return of thenar muscle bulk (Figure 2). Strength testing of her grip, lateral pinch, and 3-point pinch revealed considerable improvements compared to preoperative values, with all three now exceeding or comparable to initial contralateral measurements (Table). The Disabilities of the Arm, Shoulder, and Hand score was 6.82, indicating only slight disability.

Discussion

The rate of revision surgery following carpal tunnel release is 4.8% within the first year after surgery, with a significantly higher risk of revision carpal tunnel release associated with an endoscopic approach.[5] In another series of 200 patients who had persistent symptoms following carpal tunnel release, 6% were because of median nerve or recurrent motor branch injury during the index procedure.[6]

Variations in the recurrent motor branch may result in an increased risk of iatrogenic nerve injury. Prior anatomical studies

Figure 2. Photographs of the patient's hand. **A** Before surgery. **B** 4 months after surgery. **C** 7 months after surgery. Notable improvement in the contour and bulk of the thenar musculature can be appreciated. Preoperative photographs were provided by the patient. Photographs were taken and reproduced with the patient's permission.

have demonstrated variability in the branch point of this nerve in up to 54% of cases.[7] The most common branch point of the thenar motor branch is extraligamentous (distal to the transverse carpal ligament) with a radial-sided origin. Less common origins of thenar motor branching are extraligamentous with an ulnar-sided branch point, sub-ligamentous, and transligamentous. The transligamentous variant may be the most dangerous of these as it runs directly through the transverse carpal ligament being released.[1] Our patient appeared to have a more central (ulnar) takeoff of the recurrent motor branch, which could have predisposed it to injury.

The potential for nerve recovery worsens as more time passes following nerve injury because of scarring, nerve retraction, and degeneration of the neuromuscular junction resulting in muscle atrophy and fibrosis.[8–10] Delayed repair carries a poor prognosis, with a lack of evidence on successful outcomes if presentation is delayed greater than 6 months.[8,9] Our patient's successful outcome has a few possible explanations. One is the mixed muscle fiber phenotype of the APB. Previous studies have demonstrated that the APB and other smaller muscles predominantly consist of type I, or "slow twitch" muscle fibers (>60%), which have been shown to be less sensitive to denervation atrophy than type II, or "fast twitch" fibers.[11] It is possible that type I muscle fibers have greater capacity to maintain their size following denervation, or that they are preferentially reinnervated relative to fast fibers.[10]

It is also possible that a neural connection existed between the ulnar nerve and recurrent motor branch of the median nerve in the

palm (Richè-Cannieu anastomosis). If this were the case, some of the innervation to the APB may have been spared, creating a "babysitter" effect to the motor endplates and increasing the timeline for successful reinnervation. While this was not observed intraoperatively, it is plausible that a Richè-Cannieu anastomosis existed within the thenar musculature outside of the field of dissection.

Perhaps a final reason is that the thenar branch of the median nerve is primarily a motor nerve relatively close to its target muscles. Sunderland reported that nerves with a single function tend to recover better than mixed motor and sensory nerves.[12] In addition, once healthy fascicles were identified and coapted, the motor axons of the recurrent motor branch had to travel only a short distance to the motor endplates. Ultimately, many factors influence the outcome after nerve repair including patient age, mechanism of injury, comorbidities, surgical timing, defect length, operative technique, and repair type.[13] Muscle fiber phenotype, muscle size, nerve type, and level of injury should also be considered, all of which likely contributed to our patient's good functional recovery. Our patient's outcome suggests that repair of a severed recurrent motor branch remains a viable option 2 years after initial injury, and that functional improvement and APB motor endplate reinnervation can occur even after considerable time has elapsed.

Conflicts of Interest

No benefits in any form have been received or will be received related directly to this article.

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