E-ISSN: 2707-8353
P-ISSN: 2707-8345
IJCRO 2023; 5(1): 17-19
www.orthocasereports.com
Received: 26-10-2022
Accepted: 29-11-2022

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ECRB avulsion fracture therapy management: Case report

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DOI: https://doi.org/10.22271/27078345.2023.v5.i1a.138

Abstract
Avulsion fractures at the base of the second and third metacarpals are very rare, and there is no evidence in the literature for post-surgical therapy management. The purpose of this study was to identify a treatment protocol for post-surgical management of an extensor carpi radialis brevis (ECRB) avulsion fracture. The patient had a fabricated volar wrist splint with 30 degrees of wrist extension and 60 to 70 degrees of MCP flexion. At 4 weeks, the patient progressed to ROM outside of the splint. At 6 weeks, PROM was completed, and splint use was discontinued. At 8 weeks, the patient began progressive strengthening. Following therapy management, the patient achieved near normal range of motion, was pain-free, and had a functional wrist based on the Quick Disabilities of the Arm, Shoulder, and Hand score. Patients with an ECRB avulsion fracture managed with surgery should be splinted post-operatively and progressed through a therapy protocol to monitor both bone healing and the response of the tendon.

Keywords: Avulsion fracture, occupational therapy, ECRB

Introduction
Avulsion fractures occur frequently in the hand but are deemed rare in the metacarpals. Avulsion fractures occurring at the base of the second and third metacarpals are exceedingly rare due to both the anatomy and the mechanism of the injury which is required [1]. The second and third metacarpal base injuries occur less frequently due to the stability of these joints [2]. The capsuloligamentous attachments are strong in this area, providing stability, along with the architecture of the joints themselves [2]. In general, metacarpal fractures typically occur due to a direct injury to the hand [3]. Avulsion fractures at the second and third metacarpal typically occur as a result of the wrist being in a hyperextended position with force on the dorsal portion of the hand [4]. As a result of this positioning, the muscle can increase tension, resulting in the avulsion fracture [4]. The mechanism of injury with avulsion fractures to this anatomy typically results in damage to the extensor carpi radial brevis (ECRB) or extensor carpi radialis longus (ECRL). The ECRB has the "longest extension moment arm and the largest cross-sectional area" [5]. The ECRL has its insertion at the second metacarpal with the "longest muscle fibers and the largest mass" [5]. Both the ECRB and the ECRL work in concurrence to abduct and extend the wrist [6]. Protocols have been developed for metacarpal fractures and extensor tendon repairs, but nothing of significance has been identified in the literature for post-operative management of avulsion fractures to this anatomy of the hand. The protocols for metacarpal fractures typically have a period of splinting in an ulnar gutter splint, then active range of motion (AROM), followed by passive range of motion (PROM) when healed [7]. However, an extensor tendon repair in the area would typically be splinted in a metacarpal phalangeal (MCP) block splint, with the MCP joints in full extension to allow for the tendon to properly heal [7]. With an extensor tendon repair, ongoing monitoring of an extensor tendon lag also is pertinent to avoid this potential complication. While previous case reports have identified the surgical procedures associated with the metacarpal avulsion fractures and ECRB and ECRL damage and repair, there has not been literature addressing the treatment protocol following the surgical procedure [2, 8-10].

Case Report
A 28-year-old male suffered an injury because of hitting an arcade boxing machine game with a closed fist. The patient had pain and swelling in the dorsal portion of the hand and had difficulty completing composite finger flexion because of the injury, along with limited wrist extension.

The patient was evaluated by an orthopedic physician and underwent sonographic confirmation to have a displaced, non-articular avulsion fracture of the right third metacarpal base with attachments retracted but with an intact extensor carpi radialis brevis tendon. The sonography did provide evidence of partial-thickness/intrasubstance fraying at the attachment point. The patient underwent a surgical procedure to repair the avulsed fracture 8 days postinjury and had an ORIF of the middle finger with the suture anchor augmented by Kirschner-wire (k-wire) fixation. The k-wire fixation provided support as the anchor for the avulsed bone and tendon, with sutures also tying down the tendon and bone (Figure 1). The patient was placed in a post-surgical dressing with the wrist in extension and fingers flexed to approximately 45 degrees of MCP flexion to protect the surgical procedure until the occupational therapy evaluation. The patient had an initial evaluation with occupational therapy 2 weeks postoperatively. The initial evaluation conducted by the occupational therapist identified the inability to complete composite finger flexion, with the distance to the distal palmar crease measured at 6 centimeters on all fingers. This lack of ability to complete composite flexion appeared to be due to the tethering of the extensor tendons due to the k-wire fixation. A quick disabilities of the arm, shoulder, and hand (Q-DASH) score was utilized to assess functional ability and was scored at 61.63 (Table 1). No wrist motion was allowed and only finger range of motion of the proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints with the wrist extended was permitted outside of therapy. At the initial evaluation, a splint was fabricated for the patient. The splint was a forearm-based orthosis with the wrist in 30 degrees of extension, the metacarpals in a position of 60 to 70 degrees of flexion, and the IP joints free. This positioning was requested by the physician and allowed for the protection of the repair and due to the potential ECRB tendon involvement. This positioning also allowed for the motion of the fingers at the PIP and DIP joints outside of therapy.

Intervention

Following the initial evaluation, the patient initially participated in therapy emphasizing active range of motion of the fingers at all joints with the wrist held in extension (Table 2). Heat modalities were utilized during this time in conjunction with the AROM of fingers. Finger motion was emphasized during this period until 4 weeks when the k-wire was removed. At 4 weeks, AROM of the wrist was allowed with initial measurements of wrist motion consisting of 0 degrees of wrist flexion, 35 degrees of wrist extension, 5 degrees of radial deviation, and 10 degrees of ulnar deviation (Table 1). AROM of the MCP joints was also allowed outside of therapy and was completed in therapy without the wrist maintained in extension. Scar mobilization techniques were also completed following pin removal and healing of the affected area.

Following the removal of the pin at 4 weeks post-operatively, passive range of motion (PROM) was initiated on fingers, with AROM of the wrist also allowed. At 6 weeks postoperatively, the patient achieved full composite flexion of the fingers and 5 degrees of wrist flexion, 50 degrees of wrist extension, 5 degrees of radial deviation, and 25 degrees of ulnar deviation. Splint use was discontinued at 6 weeks postoperatively. Passive range of motion of the wrist was completed at 6 weeks postoperatively. At 8 weeks postoperatively, grip strength was assessed with a Jamar dynamometer with an average of 118.33lbs on the left and 68.33lbs on the right (Table 1).

The patient was seen for a total of 17 visits and discharged at 15 weeks postoperatively due to insurance limitations. At discharge, the patient was evaluated to have 30 degrees of wrist flexion, 65 degrees of wrist extension, 10 degrees of radial deviation, and 30 degrees of ulnar deviation. The patient's grip strength was an average of 91.67 lbs as measured by a Jamar dynamometer. The discharge Q-DASH score was 2.27. At a physician's visit at 6 months follow-up, it was noted the patient had no noticeable range of motion deficits by the physician, emphasizing the return of full range of motion of wrist flexion.

Table 1: Range of Motion, Q-Dash Scores, Grip Strength

	2 Weeks Postop	4 Weeks Postop	6 Week Postop	8 Week Postop	15 Weeks Postop
Wrist Range of Motion					
Flexion	N/A	0 degrees	5 degrees	8 degrees	30 degrees
Extension	N/A	35 degrees	50 degrees	52 degrees	65 degrees
Radial Deviation	N/A	5 degrees	5 degrees	5 degrees	10 degrees
Ulnar Deviation	N/A	10 degrees	25 degrees	25 degrees	30 degrees
Q-Dash Scores					
	61.631	54.5	43.2	15.9	2.27
Grip Strength					
	N/A	N/A	N/A	68.33lbs	91.67lbs

Fig 1: X-Ray Hand Post-Op

Discussion

Limited literature exists identifying the protocol for an avulsion fracture related to the metacarpals with the involvement of the ECRB. Although there is no consensus regarding the treatment of an ECRB tendon avulsion, surgical management has been identified as a treatment without complications [11-13]. A combination of previous protocols identified within the Diagnosis and Treatment Manual for Physicians and Therapists was utilized to base the progression of the range and motion and strength for the diagnosis and post-surgical progression [9]. Another similar case delayed movement for 6 weeks with no formal recommendation of therapy, however, this would not have

been appropriate due to the ORIF being completed [14]. The healing of the avulsion fracture was accounted for to allow for the appropriate post-surgical protocol and timeframe. However, the orthopedic surgeon also had some initial concern about the ECRB tendon, which is the reason the MCP joints were not allowed full flexion initially. In this specific case, the therapeutic timeframe is not specifically transferable as it was a combination of protocols, however a general outline can be identified. Based on the parameters of the outcome of the case, a suitable timeframe for intervention could be as follows:

Approximately 2 weeks-fabricated volar wrist splint allowing IP motion and position of 30 degrees of wrist extension and 60 to 70 degrees of MCP flexion

4 weeks-maintain splint use and progress to active range of motion of the wrist and MCP motion

6 weeks-begin passive range of motion of wrist and fingers

8 weeks-begin strengthening as tolerated with fingers and wrist

Some limitations may exist transferring protocol directly to other cases, as the k-wire was placed versus a full tendon repair, however, a general timeframe can develop due to the case. Overall, the time frame and interventions provided allowed for a successful outcome based on the range of motion, strength, and Q-DASH score.

The specific protocol was developed with the clinical experience in treating both metacarpal fractures and extensor tendon repairs of the wrist and hand. Guidance was provided from the referring physician based on the healing parameters of the bone-to-bone fragment with the k-wire in place. Careful monitoring and examination of the patient must continue throughout the treatment time period, with an extra emphasis on monitoring for extensor lag of the affected finger.

The case report represents a guideline for treatment following surgical management of an avulsion fracture to the base of the third metacarpal with the ECRB tendon intact. The therapy protocol can act as a timeline for similar interventions.

Acknowledgments

The authors declare there is no conflict of interest or funding sources associated with the completion of the manuscript.

Conflict of Interest

Not available

Financial Support

Not available

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How to Cite This Article

Mitchell V, Andrew K. ECRB avulsion fracture therapy management: Case report. International Journal of Case Reports in Orthopaedics. 2023;5(1):17-19.