

# Dynamic Distraction External Fixation for Contracture of the Metacarpophalangeal Joint

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**Abstract:** Metacarpophalangeal (MP) joint contractures are common after traumatic injury, and can be difficult to manage. After surgical capsulectomy, it remains challenging to maintain motion that was obtained at the time of surgery. Our group uses a novel, prefabricated digital external fixator to provide both distraction, and motion therapy across the MP joint after surgical treatment of MP contracture. The purpose of this technique is to demonstrate the effectiveness of an adjunctive dynamic distraction external fixator for the maintenance of joint motion after surgical treatment of MP contractures of the border digits.

**Key Words:** metacarpophalangeal joint contracture, dynamic distraction external fixator, capsulectomy, metacarpophalangeal joint stiffness

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The management of a stiff finger after traumatic injury is often a challenge. Although surgical releases are available,<sup>1,2</sup> the need for consistent postoperative motion and therapy remains essential for successful outcome. Dynamic distraction external fixation has been described in the treatment of unstable hand fractures with success.<sup>3</sup> To our knowledge, dynamic distraction has not been used for metacarpophalangeal (MP) joint contractures. The advent of a novel, prefabricated external fixator (DigiFix, Virak Orthopedics LLC, Short Hills, NJ) has allowed for this application. We report a technique of dynamic distraction and postoperative elastomer band therapy using the DigiFix for treatment of recalcitrant MP contractures.

## ANATOMY

The MP joints are composed of the larger convex surface of the metacarpal head and the shallow elliptical concavity of the proximal phalanx.<sup>4</sup> This permits flexion/extension as well as an abduction/adduction motion planes. The soft tissue anatomy surrounding the MP joints is complex, and is the typical culprit for symptomatic contracture. The collateral ligaments are comprised of the accessory and proper collateral ligaments. The proper collateral ligaments arise from the posterior tubercle of the metacarpal head, and insert onto the palmar surface at the base of the proximal phalanx. The accessory collateral ligaments are vertically oriented structures that arise from the volar plate.<sup>4</sup> There is a distinct joint capsule surrounding the MP joint. Because of the bony architecture

of the MP joint, the dorsal joint capsule and collateral ligaments are taut in flexion and loose in extension, causing profound MP extension contracture with prolonged immobilization in extension.

## INDICATIONS/CONTRAINDICATIONS

MP contracture is common, especially after trauma. Structural injury to the joint should be ruled out as a cause of the contracture. To address the contracture, a trial of nonoperative techniques is appropriate that include gentle manipulation and structured therapy. This technique is indicated for function-limiting MP contractures that have failed conservative treatment. Because of the use of the external fixator, this procedure is limited to the border digits. Other contraindications are active infection and poor bone quality.

## SURGICAL TECHNIQUE

The technique uses a dorsal capsulectomy, release of the collateral ligaments, and a dynamic external fixator placed in distraction mode to allow the soft tissues to lengthen during the healing phase.

A tourniquet is used for the procedure. A dorsal approach to the MP joint is made. The subcutaneous tissue is dissected, and the extensor tendon is mobilized from the underlying capsule. The extensor tendon (or radial sagittal band) is divided longitudinally. The dorsal capsule is exposed and a capsulectomy is performed. At this juncture, a scalpel is used to release both collateral ligaments from their origin at the metacarpal head. The MP joint is gently manipulated to achieve passive motion. The extensor mechanism is repaired, and closure of the surgical incision is performed in layers.

Application of the DigiFix is accomplished by inserting a K-wire (either 0.054" or 0.062") transversely through the axis of rotation in the metacarpal head, on the lateral projection. Alternatively, a 0.045" wire may be selected if the patient's bone requires a smaller gauge wire. Confirmation of the appropriately sized wire is recommended before insertion, and position of the K-wire is confirmed with fluoroscopy. This K-wire will serve as the axis pin for the fixator. The DigiFix Bracket is used as a template to place the distal K-wires into the proximal phalanx (P1). Two K-wires (either 0.045" or 0.054") are inserted transversely through the holes in the DigiFix Bracket and into P1 to provide distal fixation. The position of the K-wires is checked under fluoroscopy. The distal K-wires are locked onto the Bracket by tightening the setscrew. The axis K-wire is bent to 90 degrees. All K-wires are cut short.

The distraction of the joint is achieved by compressing the Diamond portion of the Bracket with parallel pliers. The purpose of distraction is to unload the joint and to allow the collateral ligaments to heal in a lengthened position. A 0.062" is placed proximal to the fixator into the metacarpal shaft as an anchor for the elastomer. Elastomer bands are placed to provide a constant force across the MP joint. When the line of pull

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of the bands is dorsal to the axis pin, there is an extension moment to pull the MP into extension. Conversely, when the line of pull is volar to the axis pin, the bands produce a flexion moment to bend the MP.

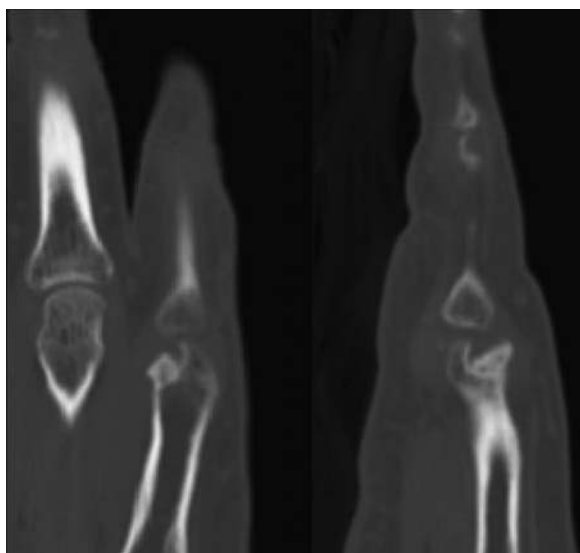
A betadine scrub sponge is cut to shape and placed between the skin and fixator Bracket. A light dressing is applied such that it does not impede motion. The fixator is kept in place for 4 to 5 weeks.

### Case 1

A 34-year-old right hand dominant woman presented 4 months status postinjury of her left small finger MP joint in a motor vehicle accident. She complained of persistent pain and stiffness despite therapy. This lack of motion limited her ability to perform work as a photographer. Examination revealed the small finger MP range of 0 to 20 degrees and only mild stiffness at the proximal interphalangeal joint. The other joints in the left hand had full range of motion. Radiographs and dynamic fluoroscopic imaging were highly suspicious for an articular irregularity about the metacarpal head. Confirmatory computed tomographic scan was obtained (Fig. 1), demonstrating an osteochondral fracture involving the radial aspect of the metacarpal head that had subsequently healed in a malunited position.

Given the amount of time from injury to presentation and nature of the osteochondral injury, the decision was made for excision of the fragment to achieve secondary joint congruency and release of the collateral ligaments and capsulectomy. The DigiFix was placed (Fig. 2) to provide distraction across the joint and constant passive motion to supplement the postoperative therapy. The elastomer bands were placed volar to the axis of rotation of the MP joint to provide a flexion force.

Postoperatively, she was seen 8 days after surgery where the MP had 95 degrees of passive motion without crepitus. At 3.5 weeks, passive MP flexion was 100 degrees. The DigiFix was removed a week later. She continued on home therapy but formal therapy ended by the sixth week due to insurance limits. At 8 weeks postoperative, she was able to return to her profession as a photographer. At 10 weeks, she had painless active flexion of her small finger into the palm with full



**FIGURE 1.** Coronal and sagittal computed tomographic images demonstrating an osteochondral fracture of the small finger metacarpal head.

extension (Figs. 3A, B). These results were similar at the 6-month follow-up.

### Case 2

The patient was a 47-year-old right hand dominant pedestrian female who was struck by a bus. She experienced loss of consciousness and multiple internal organ injuries. Her orthopedic injuries included a left glenohumeral dislocation, left humeral shaft fracture, right sternoclavicular anterior dislocation, right index metacarpal and P2 non-displaced fractures, and L1-L2 transverse process fractures. The left glenohumeral dislocation and humeral shaft fracture were treated operatively. The remainder of her orthopedic injuries was managed nonoperatively. Because of the multiplicity of injuries, she required 5 days of surgical intensive care unit care and a prolonged hospitalization. She was discharged hospital day #11.

After 3 weeks of splinting, therapy was started for the right hand. Despite 8 months of hand therapy, the index MP had recalcitrant stiffness with ROM of only 10 to 40 degrees (Fig. 4A). She was unable to make a composite fist, lacking 4 cm from tip-to-palm. She then underwent a capsulectomy and collateral ligament releases and placement of the DigiFix external fixator in dynamic mode with distraction.

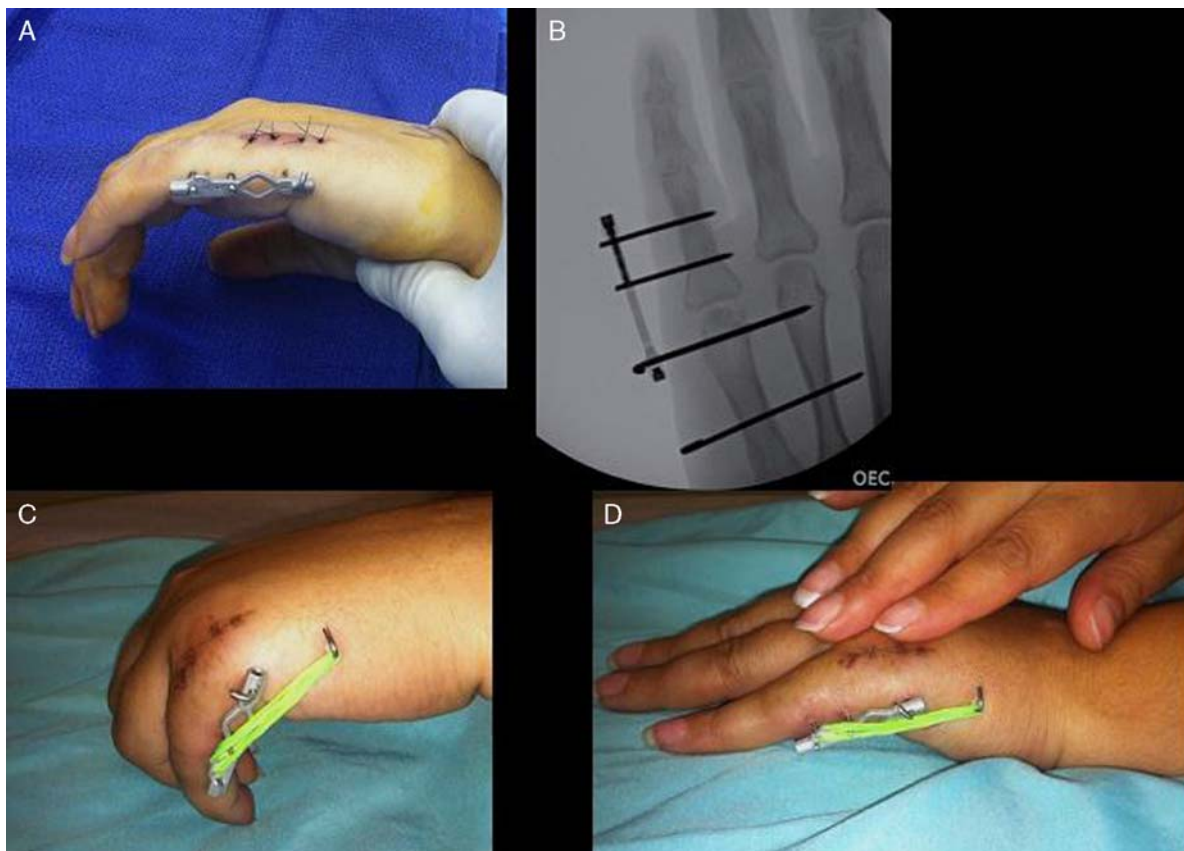
Postoperatively, elastomer bands were attached to the fixator to aid in passive motion, alternating between flexion and extension. At 4 weeks, she demonstrated active MP flexion to 85 degrees (passively to 95 degrees), and the external fixator was removed in the office. At the 6-month follow-up, the patient was able to flex the index finger into the palm. Active MP range was 0 to 85 degrees (Figs. 4B, C).

### EXPECTED OUTCOMES

We describe a new technique for dynamic MP joint distraction as an adjunct treatment for recalcitrant contractures. Although contracture release of the MP joint is an accepted procedure, the outcomes are varied.<sup>2,5</sup> We believe that the above technique for the border digits offer advantages for an improved outcome. In addition, it is anticipated that patients will require less hand therapy to regain motion because of the built-in therapy provided by the elastomer bands.

In case 1, the unique injury pattern presented many challenges not typical of a garden variety MP contracture. The presence of a chronic osteochondral injury causing joint incongruity and painful motion led us to consider addressing the joint in addition to the contracture release. Performing the release without distraction was considered, but the persistent articular defect was a concern. We used the principles of distraction arthroplasty used in other joints for this patient to unload the MP joint. Although case 1 demonstrated the effectiveness of this technique for the small finger, case 2 did the same for the index finger.

The DigiFix is a novel device that permits both distraction across the joint and dynamic motion to aid in the rehabilitative process. To our knowledge there is no other device available that can achieve these goals. Although finger external fixators have been popularized by many,<sup>3,6</sup> they are often not specific to the hand and do not have the above-described features available. We feel that this device notably contributed to our patients' successful outcome for 3 reasons. First, application of the fixator in the dynamic mode still allowed for MP motion, which is important in cartilage health. Second, the distraction can temporarily reduce the joint reaction force and, just as importantly, allow the collateral ligaments to heal in a lengthened state; thereby they are less



**FIGURE 2.** Clinical (A) and radiographic (B) pictures of placement of the DigiFix in the dynamic mode. The axis of rotation of the fixator is about the center of rotation of the metacarpophalangeal (MCP) joint. The elastomer (rubber band) is hooked to the fixator distally and anchored to a point proximal in the hand. In this case, a K-wire is placed into the small and ring finger metacarpal bones to provide the anchor. Clinical photographs in the postoperative period, whereby (C) the elastomer is providing passive MCP flexion and the patient is performing active-assisted MCP extension. full color online

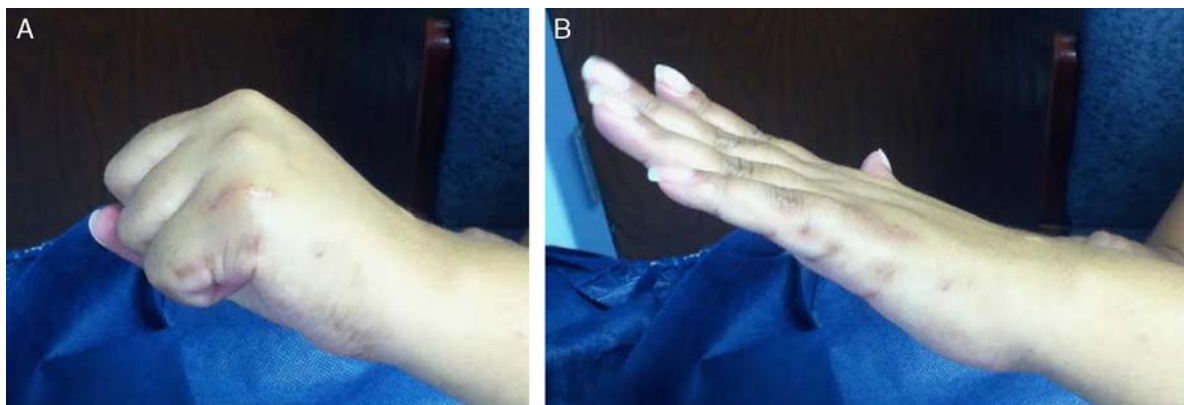
restrictive on joint motion. Finally, the ability to use elastomer bands provides a built-in therapy without necessarily requiring the patient's participation. The bands will continue their pull even when the patient is asleep.

Although there is no consensus when it comes to contracture release of the MP joint, it is generally agreed that postoperative therapy is critical. It is our opinion that the

DigiFix facilitated our patients' ability to regain motion postoperatively.

### COMPLICATIONS

Complications should always be considered and therefore appropriately anticipated and mitigated during and after



**FIGURE 3.** A and B, Clinical photographs 3 months after index procedure. full color online



**FIGURE 4.** A, Preoperative contracture of the index metacarpophalangeal joint. B and C, Postoperative motion of the index metacarpophalangeal joint demonstrating full extension, and composite fist formation. full color online

surgery. The most common risk after contracture release, despite adequate occupational therapy is recurrence. It is for this reason we utilize dynamic distraction external fixation.

The use of an external fixator comes with the inherent risk of pin-tract infection, which could even lead to osteomyelitis. To minimize this occurrence, we keep the Bracket 3 to 4 mm off the skin to allow for pin care. In addition, we find that using the betadine scrub sponge anecdotally seems to decrease the rate of pin-tract infection. However, any evidence of infection should be brought to the attention of the surgeon to appropriately treat with antibiotics or pin removal.

Careful pin placement should be used when applying the external fixator. For this reason, a prefabricated guide is available with the DigiFix system. This will facilitate proper placement of the pins into bone.

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