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## Surgical Technique

## A New Approach for the Correction of Type I Thumb Deformity Owing to Rheumatoid Arthritis



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A major transition in the surgical treatment of rheumatoid arthritis has been facilitated by a recent paradigm shift in its diagnosis and treatment. Improved outcomes in the treatment of the rheumatoid thumb are desirable; however, the results of conventional surgery are less than ideal. Even if the rheumatoid arthritis is well-controlled, the progression of thumb deformity may persist owing to an ineffective deformity correction and an insufficient understanding of the mechanism by which the deformity occurs. The mechanism of rheumatoid thumb deformity should be considered, using it to base the appropriate correction. We applied a new deformity correction procedure that accounts for the mechanism of type I rheumatoid thumb deformity and obtained positive results without recurrence. Although the primary cause of type I thumb deformity is believed to be an extensor mechanism failure resulting from synovitis of the metacarpophalangeal (MCP) joint, surgical outcomes are negatively affected as a result of flexion contracture caused by the adductor pollicis (ADP). Because the ADP attaches to the ulnar sesamoid on the palmar side of MCP joint, we release the ADP tendon to improve flexion contracture of the MCP joint. We consider release of ADP to be effective in preventing the recurrence of flexion contracture of the MCP joint and re-tensioning of the extensor pollicis brevis. Rheumatoid thumb deformity can be restored by applying this procedure, improving a patient's outcome.

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Hand deformity in rheumatoid arthritis is known as a rheumatoid hand. It occurs frequently and causes cosmetic and functional disorders in hand grip, pinching, and activities of daily living.<sup>1</sup> Among the joints affected, the distal thumb is commonly involved and prone to functional disorders. Treatment of distal thumb deformities is a significant subject in the approach to rheumatoid hands, because the thumb has such an important role in hand function.<sup>2</sup>

In 1968, Nalebuff<sup>3</sup> categorized thumb deformities into 3 patterns and expanded the classification in 1984 to include 3 additional patterns and their respective treatment strategies. In 1996, Stein and Terrono<sup>4</sup> reported partial modification of the 1984 Nalebuff classification. In this classification system, type I thumb deformity is characterized by flexion of the metacarpophalangeal (MCP) joint and hyperextension of the interphalangeal (IP) joint. Its

reported incidence accounts for 50% to 74% of distal thumb deformities.<sup>5</sup> In routine practice, cases are often encountered with remarkable functional disorders caused by type I thumb deformities. Extensor pollicis longus (EPL) rerouting is performed for early treatment of type I thumb deformity, and arthroplasty using silicone implants and arthrodesis are performed for more advanced cases.<sup>6</sup> Among problems associated with these procedures, deformity recurrence is especially interesting. Given the crucial role of the thumb in hand function, further improvements in treatment outcome are highly desirable. In particular, because the progress of drug therapy for rheumatoid arthritis has enabled early diagnosis and biological preparation, good postoperative results are expected in the treatment of rheumatoid hands.<sup>7</sup> Therefore, we developed and report a new surgical procedure for deformity correction that revisits and accounts for the mechanism of type I thumb deformity.

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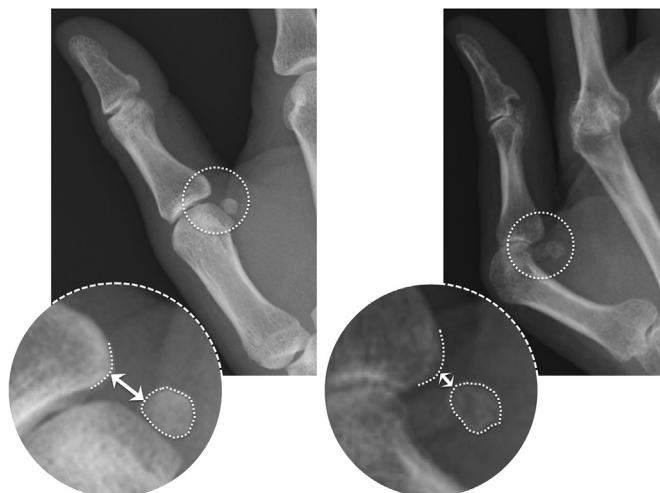
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## Indications and Contraindications

Regardless of the degree of deformity, this surgical technique is indicated in patients with functional impairment as a result of type I deformity resulting from rheumatoid arthritis. Under the staging

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**Figure 1.** Plain radiograph of a normal thumb (left) and type I deformity of a thumb (right). Bidirectional arrows show the shortened distance between the palmar aspect of the proximal phalanx and the sesamoid bone in type I deformity.

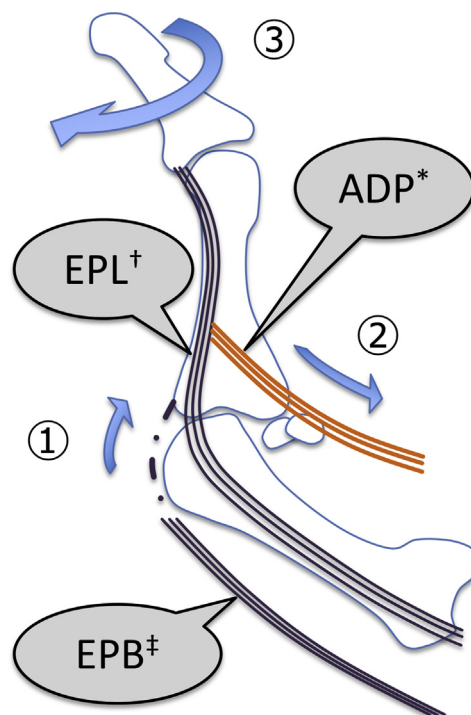
classification of type I deformity, this operation is indicated for moderate and severe cases with flexion contracture of the MCP joint. If MCP joint destruction of the thumb is mild, the flexion contracture is released and attenuation of the extension mechanism is repaired. If joint destruction is remarkable, artificial joint replacement surgery is performed as a combined treatment. In terms of the IP joint of the thumb, if there is residual hyperextension after flexion contracture release of the MCP joint, the technique is combined with lengthening of the EPL. If there is instability or hyperextension contracture owing to deformity of the IP joint, arthrodesis is performed.

This surgical technique is not indicated for the thumb under the following conditions: (1) the thumb has hyperextension of the MCP joint with an attenuated palmar capsule, including Nalebuff type III, IV, V, and VI deformities; (2) the thumb has a radially displaced EPL with ulnar instability at the MCP joint; or (3) there is a long-standing thumb deformity with a severe soft tissue imbalance caused by irreversible myostatic contracture of the EPL or flexor pollicis longus.

### Surgical Anatomy

In a detailed comparison of type I thumb deformity with the normal hand using plain radiography, apart from flexion of the MCP joint and hyperextension of the IP joint, the proximodistal phalanges of the thumb and sesamoid bones are internally rotated, and there is a noticeable shortening of distance between the palmar aspect of the proximal phalanx and the sesamoid bone (Fig. 1). The adductor pollicis (ADP) is attached to the ulnar sesamoid bone, and flexor pollicis brevis (FPB) and abductor pollicis brevis are attached to the radial sesamoid bone. Like the lateral band, these intrinsic muscle tendons terminate at the EPL.<sup>8</sup>

Flexion deformity of the MCP joint is caused by attenuation of the extensor mechanism but also by shortening of the palmar aspect of the MCP joint, which consists of the intrinsic muscles of the thumb and sesamoid bones. The soft tissues surrounding the MCP joint are composed of a thin extensor tendon and joint capsule on the dorsal aspect and a thick palmar plate and a fan-like portion of the collateral ligament on the volar aspect. Therefore, when arthritis of the MCP joint occurs, the soft tissues of the dorsal side are loosened, while the palmar side shortens and contracts. In a



**Figure 2.** Schema of type I thumb deformity. As a result of arthritis of the MCP joint, (1) laxity of the EPB attachment site is observed; (2) flexion of the MCP joint progresses as a result of shortening of the ADP and FPB muscles, both of which are intrinsic muscles, and (3) the entire thumb rotates while the IP joint is hyperextended to complete a typical type I thumb deformity. \*ADP, adductor pollicis; †EPL, extensor pollicis longus; ‡EPB, extensor pollicis brevis.

type I thumb deformity, the proximal phalanx internally rotates and leads to palmar subluxation as a result of synovitis at the MCP joint. An increase in tension as a result of shortening in the ADP and FPB muscles causes a hyperextended IP joint deformity. From an anatomical perspective, the intrinsic muscles of the ADP, FPB, and abductor pollicis brevis run through the palmar aspect of MCP joint via the sesamoid bone and reach the EPL on the dorsal aspect of the phalanx. Like the intrinsic muscles of the fingers, these intrinsic muscles flex the MCP joint of the thumb and also extend the IP joint. Therefore, if synovitis is present in the MCP joint of the thumb, the EPB attachment site attenuates, causing an extension lag at the MCP joint and producing further flexion owing to the intrinsic tightness (ADP and FPB). This results in hyperextension of the IP joint (Fig. 2). This closely resembles the ulnar deviation and swan neck deformity that occur when the EDC dislocates toward the ulnar side, thereby shortening the intrinsic muscles on the ulnar side.

This deformity reduces the working space between the thumb and the index finger. Eventually leading to flexion contracture of the MCP joint, the sesamoid bone approaches the proximal phalanx owing to shortening of the intrinsic muscle and anchors itself to the palmar plate. In addition, mainly as a result of the traction of the ADP muscle, the entire thumb internally rotates against the carpals, completing the type I deformity.

Careful observation of plain radiography reveals that the type I deformity is similar to what is commonly known as hallux valgus (Fig. 3). Radial abduction of the carpometacarpal joint in type I thumb deformity, internal rotation and ulnar flexion of the thumb, tightness of the ulno-palmar MCP joint, and attenuation of the radio-dorsal MCP joint each correspond to adduction of the metatarsal bone in the hallux valgus, internal rotation and valgus in the hallux, laxity of the medial side, and bunion, respectively. Surgical



**Figure 3.** Plain radiograph of type I thumb deformity and hallux valgus deformity. Similar findings are found, including subluxation of the MCP joint toward the ulno-palmar side, rotation of the sesamoid bone, abduction of the CMC joint, and hyperextension of the IP joint. **A** Type I thumb deformity. **B** Hallux valgus deformity

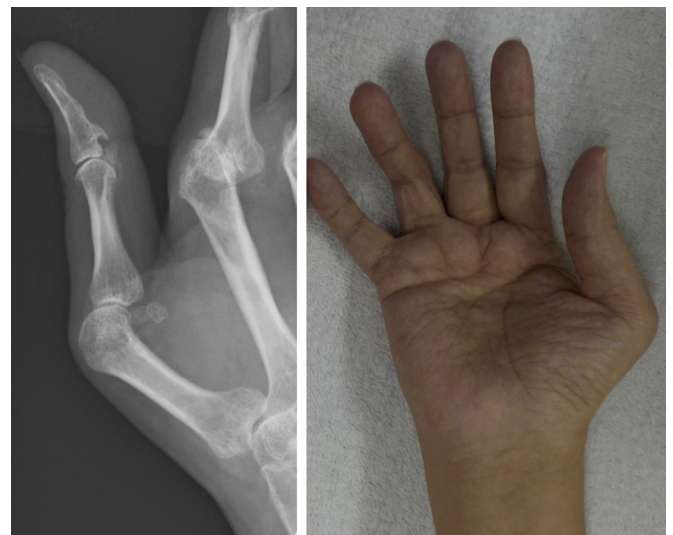
treatment of hallux valgus can be a reference for type I deformity of the thumb. From what was reported earlier, we recommend that surgical treatment of type I deformity of the thumb be performed with release of the ulno-palmar side and plication of the radio-dorsal side.

### Surgical Technique

A 2.5-cm longitudinal incision is made to the MCP joint of the thumb on the ulno-dorsal aspect, and the transverse and oblique heads of the ADP muscle of the thumb are surgically exposed. The muscle belly, palmar plate, and subsequent tendon components can be clearly identified. Because the sesamoid bones firmly adhere to the palmar plate, they are completely separated from the palmar plate with a knife, and the remaining tendon running distally is transected as distally as possible. The sesamoid bone of the radial side can also be exposed from the ulnar aspect and separated from the palmar plate. The palmar plate and fan-like portion of the radial and ulnar collateral ligament should be resected at the attachment site of the proximal phalanx. At this stage, the surgeon should confirm that the MCP joint can achieve sufficient passive extension. In patients with synovitis, complete synovectomy should be performed to prevent a recurring deformity. The parts of the EPB attachment site that exhibit laxity should undergo either plication or reattachment using an anchor, and the flexion-extension balance of the MCP joint should be adjusted to a slightly flexed position. Returning to the ulno-dorsal aspect, the ADP is released and transferred to the proximal ulnar aspect of the MCP joint and sutured to the proximal attachment site of the ulnar collateral ligament. Through these maneuvers, the type I thumb deformity can

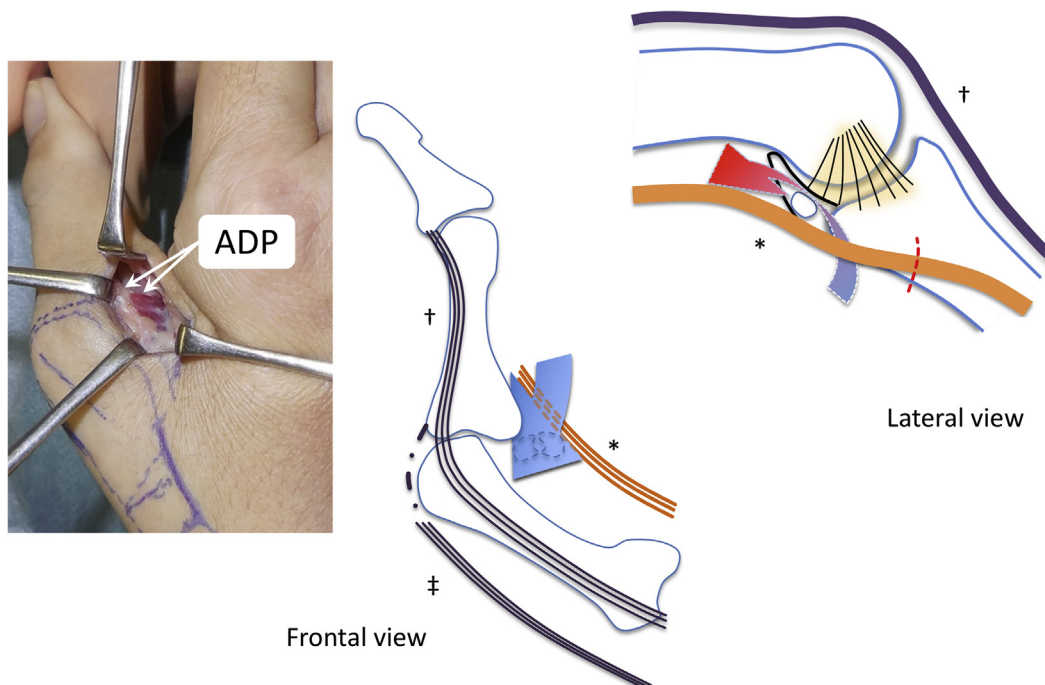
maintain its corrected position within the normal range without arthrodesis or other, similar procedures.

Although an additional corrective osteotomy of the metatarsal bone is often performed in hallux valgus deformity, corrections for non-loading joints such as the thumb can be achieved with soft tissue procedures alone. For patients with severe bone destruction owing to rheumatoid arthritis and severe pain at the MCP joint,



**Figure 4.** Preoperative plain radiography and type I thumb deformity observed from the palmar aspect.





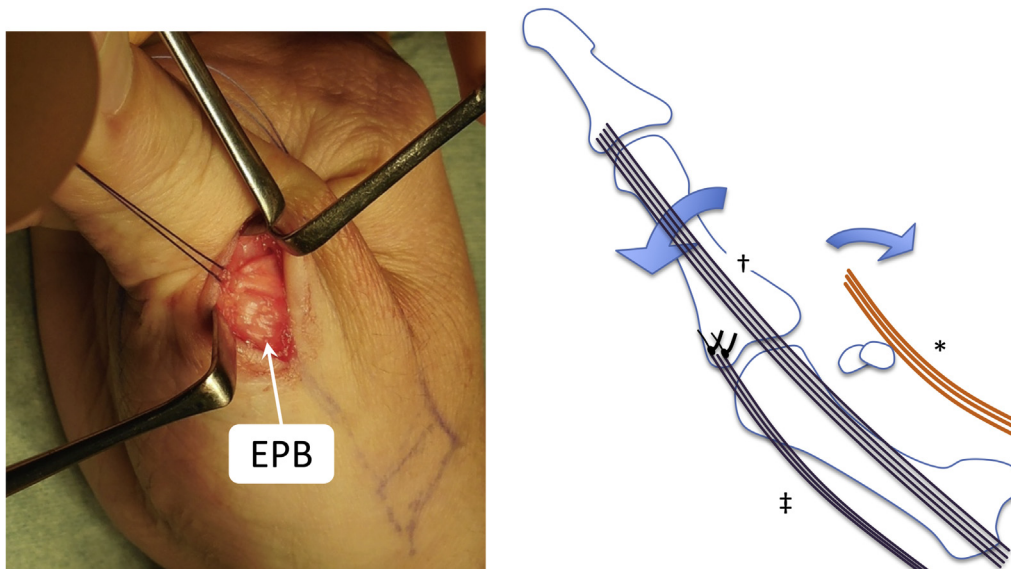
**Figure 5.** Surgical findings and schema. The muscle belly and tendon of the ADP muscle (white arrows) can be observed from the ulno-dorsal aspect of the MCP joint of the thumb. The sesamoid bones are released from the palmar plate and the proximal phalanx with the ADP. The ADP tendon is transected distally to the base of the proximal phalanx. \*ADP, †EPL, ‡EPB.

postoperative results may be improved when combined with surface replacement arthroplasty.

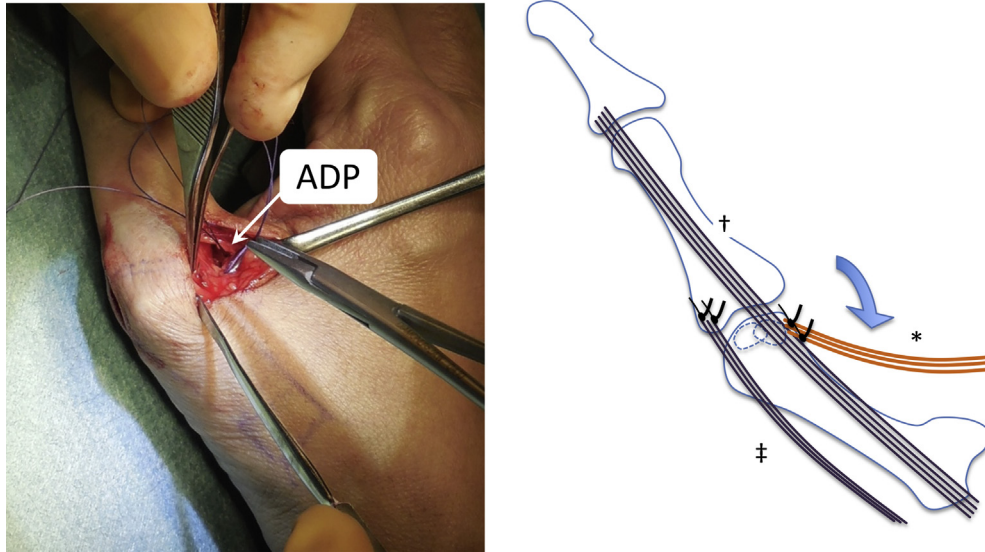
**Postoperative Management**

There is no need for immediate postoperative immobilization, and the affected limb is elevated after a bulky dressing is applied. At 1 day after surgery, active exercise of the IP joint is allowed in the extended position of the MCP joint; tendon gliding exercises are initiated for each joint of the digits with a particular focus on the

thumb. At 2 days after surgery, the dressing is exchanged; the MCP joint of the thumb is fixed in anatomic position with an orthosis. The orthosis is removed when the patient undergoes physical therapy. At 1 week after surgery, the sesamoid alignment of the thumb is confirmed under plain radiography. The duration of orthosis wear is decreased according to improvements in range of motion (ROM) at approximately 6 weeks after surgery, when the soft tissues are repaired and healed. The orthosis is removed at 3 months after surgery. Postoperative rehabilitation is performed for approximately 4 months.



**Figure 6.** Extension mechanism with laxity of the MCP joint in the radio-dorsal aspect of the thumb is exposed. The ADP muscle and sesamoid bone are both separated, the MCP joint is extended, and the EPB attachment site with laxity is plicated (white arrow). \*ADP, †EPL, ‡EPB.

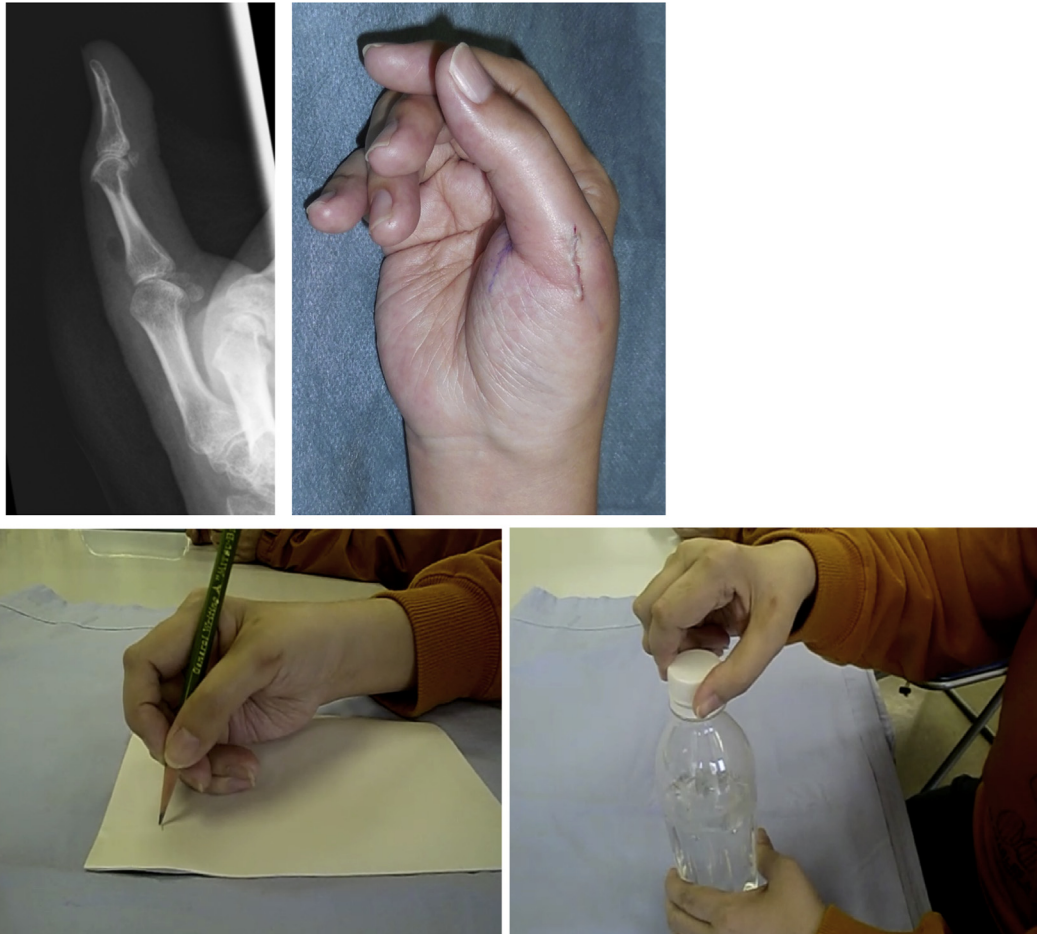


**Figure 7.** Returning to the ulno-dorsal aspect of the thumb MCP joint, the released ADP muscle (white arrow) is sutured to the proximal ulnar aspect of the MCP joint. \*ADP, †EPL, ‡EPB.

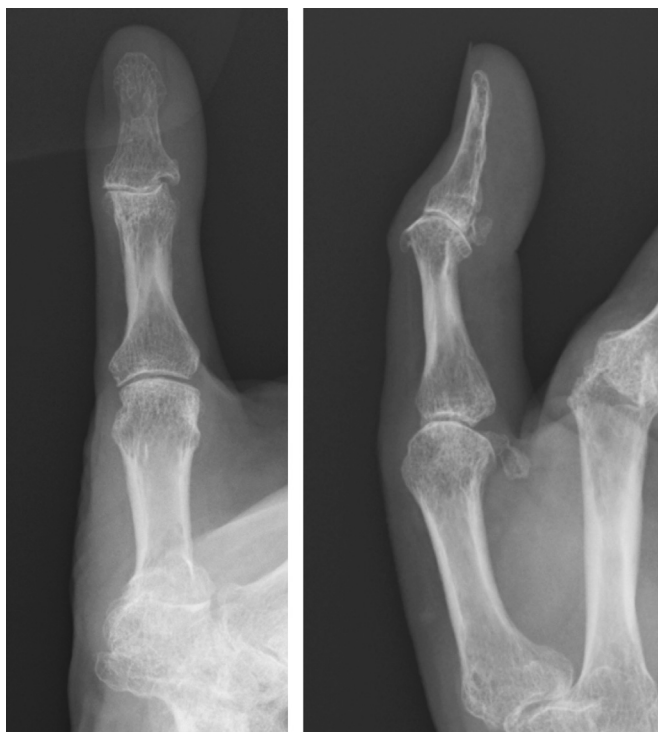
### Pearls, Pitfalls, and Complications

Surgeons should identify and resect the ADP along the palmar aspect of the joint capsule and then adequately separate both

sesamoid bones from the palmar plate. This technique will enable easy extension of the MCP joint. If the release is insufficient, a flexion contracture of the MCP joint will recur even if the extensor mechanism is reconstructed and corrected. In addition, the distally



**Figure 8.** Clinical photograph and plain radiography immediately after the operation. The patient was able to write and open plastic bottle caps at 5 months after surgery.



**Figure 9.** Anteroposterior and lateral plain radiography of the thumb at 18 months after surgery.

transected ADP tendon is trimmed and sutured proximally over the MCP joint to the periosteum of the proximal ulnar collateral ligament attachment of the first metacarpal head with nylon sutures. This operation prevents the recurrence of flexion contracture of the thumb MCP joint. As with soft tissue reconstruction for hallux valgus,<sup>9</sup> this technique may reduce metacarpal abduction, which is a characteristic of type I deformity.

### Case Illustration and Case Series Results

A 45-year-old woman presented with rheumatoid arthritis of 23 years' duration. Under the 4-stage Steinbrocker classification system, she had marked destruction of the joint with severe limitations of normal activities (stage IV, class III). From the use of biologics, the patient demonstrated a slow progression of the right thumb deformity eventually hindering activities of daily living. The right MCP joint of the thumb exhibited a flexion contracture lacking 60° from full extension, the IP joint lacked 5° from full hyperextension, and the deformity was classified as type I/moderate stage under the Nalebuff classification (Fig. 4). Surgery was approached from the ulno-dorsal aspect of the MCP joint, the ADP muscle and sesamoid bone were separated from the palmar plate, and the distal part was transected (Fig. 5). Next, the radio-dorsal aspect of the MCP joint was surgically exposed and the EPB muscle was plicated at its insertion (Fig. 6). The separated adductor muscle tendon was transferred to the proximal ulnar aspect of the MCP joint (Fig. 7). After external immobilization for 3 weeks after the operation, ROM was allowed at 4 weeks. At 18 months after surgery, active range of motion was 10° from full extension to 80° flexion for the MCP joint and 10° from full extension to 50° flexion for the IP joint, and the patient was able to write and open bottle caps (Fig. 8). Plain radiographs at 18 months after surgery showed

good active extension of the MCP joint, and the joint space was well-maintained (Fig. 9).

This procedure has been used on 10 thumbs in 10 patients. We performed IP joint arthrodesis with headless screws (Acutrak 2 standard, Acumed, LLC, Hillsboro, OR) in 1 patient and was combined with EPL elongation in another owing to contracture of the IP joint with hyperextension. In 2 patients, EPB reattachment was performed with anchors (JuggerKnot, Zimmer Biomet, Warsaw, IN). At a mean of 32 months after surgery, ROM improved with no recurrence. Although flexion of the MCP joint decreased by 23°, extension improved by 47°. Flexion of the IP joint improved by 11° and hyperextension was reduced by 41°. At this stage, there were no recurrences and no complications were reported.

### Discussion

Type I thumb deformity, also known as a boutonniere deformity, causes flexion and palmar dislocation of the MCP joint as a result of synovitis; these symptoms subsequently progress toward hyperextension of the IP joint.<sup>1</sup> Rerouting of the EPL attempts to correct flexion of the MCP joint and hyperextension of the IP joint by tenodesis of the EPL on the proximodorsal aspect of the proximal phalanx.<sup>3,10</sup> Terrono and Millender<sup>10</sup> reported a high recurrence rate of 60%, and deformity progression could not be prevented even when adapted for early-stage patients. The high recurrence rate may have occurred because EPL rerouting is not a reconstruction technique that accounts for the mechanism of deformation. Iwamoto et al<sup>11</sup> described a modified EPL rerouting procedure and reported satisfactory results. Results may show further improvement by combining these methods with our technique.

We report a surgical procedure that was developed by combining anatomical and pathological considerations together with the mechanism of occurrence, progression, and completion of a type I thumb deformity. Because this procedure requires no special maneuvers or instrumentation, it can be widely applied to rheumatoid deformity of the distal thumb and would be a useful technique for consideration.

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