Early Active Short Arc Motion Following Central Slip Repair

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Open repairs of the central slip have traditionally been treated with 4 to 6 weeks of immobilization, followed by therapy to restore motion. Although rehabilitative efforts were usually directed at avoiding extension lag, loss of flexion was also commonly encountered. Early active short arc motion produces improved range of motion with shorter treatment time compared with static immobilization of the repaired central slip. The technique is straightforward but its success depends on attention to the details of splinting and exercise, and the patient's active cooperation and compliance. *(J Hand Surg 2011;36A:143–146. Copyright © 2011 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Central slip, dorsal hood, short arc motion, early active motion.

The literature regarding tendon repair and rehabilitation is vast, but only a small percentage of it pertains to the extensor tendons, and even less to the specialized termination of these tendons in the dorsal hood. There is general clinical agreement that open injuries of the central slip (extensor tendon zone III) are best treated surgically. The wound itself and the violation of the proximal interphalangeal (PIP) joint usually make this a simple decision. Traditionally, these repairs were treated with 4 to 6 weeks of immobilization of the PIP joint in full extension, followed by therapy to restore motion. Although rehabilitative efforts were usually directed at avoiding extension lag, Newport and coauthors pointed out that loss of flexion may be even more common.[1]

Dynamic rehabilitation protocols were developed for flexor tendon repairs and adapted for use on the extensor surface as well, often with mixed or indifferent results for injuries in the digits compared with traditional static splinting protocols.[2,3] O'Dwyer and Quinton reported promising results using a spring splint on the finger after 2 weeks of immobilization, although many of their patients had only partial lacerations of the "middle" slip, and their evaluation system was liberal.[4] More recently, the salutary effect of active motion on healing and gliding of the repaired tendon was recognized experimentally, prompting the clinical use of active motion protocols. The most thoughtful and complete of these for rehabilitation of the repaired central slip is the method of early active short arc motion (SAM) proposed and studied by Evans and Thompson.[5,6]

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RATIONALE

Evans and Thompson[6] provided a detailed analysis of the factors that support early active SAM and described treatment recommendations in detail. They calculated that approximately 30° of motion will provide the desired 3 to 4 mm of tendon excursion that is generally thought to limit the formation of restrictive tendon adhesions. They calculated the resistance in the tendon as the PIP joint is actively extended from 30° to neutral to be approximately 290 g, although this figure may be higher *in vivo* owing to effects of edema. Newport and coauthors[7] evaluated the biomechanical parameters of various suture techniques in extensor zone IV and concluded that SAM is possible using a modified Bunnell or Kessler suture technique.

The position of adjacent joints during active SAM is carefully considered to limit stress on the repair and maximize tendon excursion.[6] The wrist is flexed 30° to reduce

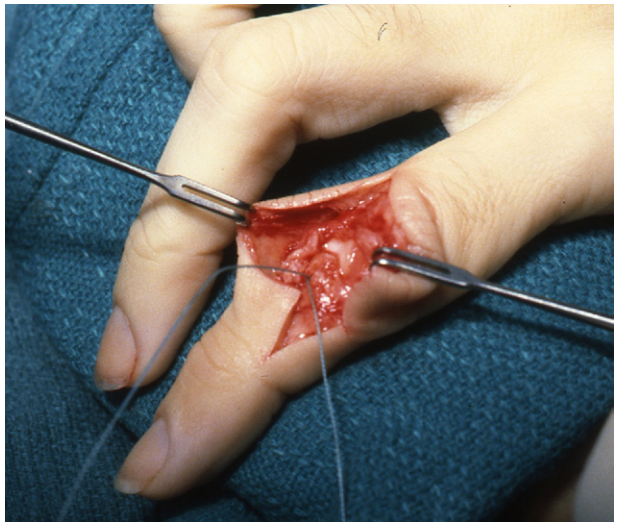

FIGURE 1: Intraoperative photograph of the right index finger shows that the central slip has been skived off the dorsal base of the middle phalanx, exposing the articular surface of the head of the proximal phalanx. The anchor suture can be seen exiting the bone.

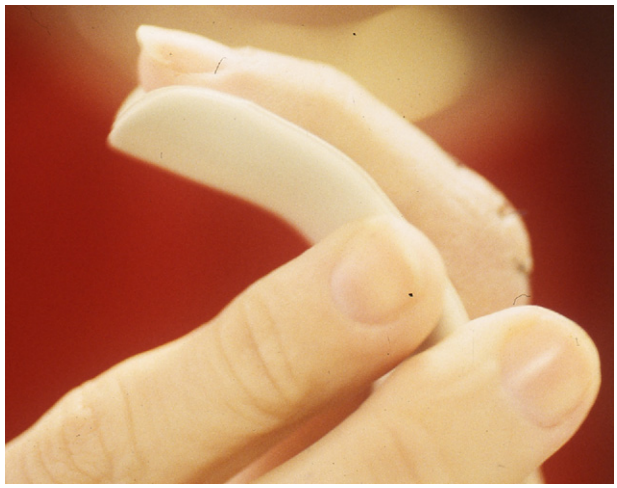

FIGURE 2: The template splint limits active flexion to a predetermined amount that is gradually increased over time. This photograph was taken early in the fourth postoperative week; the PIP joint is allowed 60° of flexion.

viscoelastic force on the flexor tendons. The metacarpophalangeal joint is at neutral (0°) to reduce the work requirement of the extensor digitorum by maximizing lumbrical and interosseous contributions. Distal interphalangeal (DIP) joint flexion while the PIP is maintained in extension creates distal glide of the central extensor in zone IV, thus reducing tension on the repair site in zone III.

TECHNIQUE

It is preferable to begin active SAM early, within a few days of repair, to limit the deleterious effect of adhesion formation. Judgment must be used, as beginning active motion on the first or second postoperative day in a grossly edematous finger may also be detrimental to the repair.

FIGURE 3: Active extension of the PIP joint is demonstrated early in the fourth postoperative week.

After applying the lightest possible dressing to the wound, 2 splints are fabricated. The palmar resting splint maintains the PIP and DIP joints in full extension at rest, and includes tape or strapping directly over the dorsum of the joints to ensure that they are at neutral extension. This splint is worn at all times for the first 3 weeks, except when performing active exercise using the template splint. The template splint is fabricated to initially allow 30° of PIP joint flexion and approximately 30° of DIP joint flexion. Evans[5] advised that the template splint be used to perform 20 repetitions each hour of flexion to the point allowed by the splint, followed by active extension to neutral. Patients are instructed to apply "minimal active tension" during extension; movement should be careful and deliberate, never forceful. During active exercise, the wrist is maintained in 30° of flexion, and the metacarpophalangeal joint at neutral extension. Active DIP joint flexion with the PIP joint supported in full extension is also performed.

The template splint is gradually altered to allow 40° of PIP joint flexion during the second week and 50° the third week, as long as no extension lag has developed. Distal interphalangeal joint flexion is also gradually increased during this time. Intermittent static splinting is initiated during the fourth week on a gradual basis as

FIGURE 4: Active flexion of the index finger is demonstrated at the conclusion of therapy, 7 weeks after surgery.

FIGURE 5: Active extension of the index finger is demonstrated at the conclusion of therapy, 7 weeks after surgery.

controlled mobilization is continued.[5] The template splint may no longer be needed if progress is good, although some patients prefer to use it as increasing PIP joint flexion is recovered. I prefer to continue static night splinting through week 6. Some patients may require intermittent static splinting or use of a spring splint during the day throughout this time if a slight extension lag is present; others may do well with buddy-taping.

If extension lag is present early (weeks 1–3), a course of static splinting may be attempted, although this is often an indication that the digit will ultimately have substantial motion limitations, no matter the method of rehabilitation.

PEARLS AND PITFALLS

Successful use of the early active SAM protocol depends on the cooperation and compliance of the patient.

Evans[5] postulated that tendon to bone adhesions in zone IV elevate the tension at the zone III repair site when flexion is initiated late (after 3 wk or more). This may result in gapping of the repair (to which the dorsal hood mechanism is sensitive) and produce extension lag that is not recoverable. These considerations highlight the importance of beginning the protocol within the first few days of repair, as soon as edema has declined.

Evans[5] also stressed the importance of performing static splinting at absolute neutral extension. The PIP joint that rests in 10° of flexion in the static splint will seldom be capable of active extension to neutral. Attention to the details of the dressing and splint is critical, and this must begin with the surgeon in the operating room. I incorporate a tongue blade padded with a single layer of gauze into the dressing to be certain that the PIP and DIP joints rest at neutral. Bulky hand dressings and careless splints jeopardize the possibility of success with this technique.

Early restoration of active DIP joint motion is an important part of this protocol. Distal interphalangeal motion prevents adherence of the lateral bands, stretches the oblique retinacular ligaments, and prevents joint stiffness.[8] Reports regarding limitations of DIP joint flexion are common among patients treated with prolonged static splinting. Although Evans and Thompson[6] suggested limiting DIP joint flexion to 30° for the first few weeks if both lateral bands have been repaired along with the central slip, it is uncertain whether this is necessary.

CLINICAL CASE

A 35-year-old woman sustained a laceration to the dorsum of the PIP joint of the right nondominant index finger with a hobby knife. Surgical exploration revealed that the central slip had been skived off the bone, leaving no tendon at the dorsal base of the middle phalanx. There was no injury to the bone, cartilage, or

ligaments of the joint, and the wound appeared clean. After thorough irrigation of the wound and joint, the central slip was repaired back to bone using a suture anchor with a modified Kessler stitch (Fig. 1). The PIP and DIP joints were carefully splinted in full extension in the operating room, and the patient was referred to a certified hand therapist who initiated the early active SAM protocol on postoperative day 3.

Figures 2 and 3 show the template splint still in use early in the fourth week of therapy. Proximal interphalangeal joint flexion is 60° and active extension is full. Figures 4 and 5 show active flexion and extension of the PIP joint 7 weeks postoperatively, at which time therapy was discontinued.

DISCUSSION

The literature regarding central slip repair clearly suggests that complex injuries (those involving the cartilage of the joint surface, bone, or ligament) tend to experience a higher proportion of fair and poor results, whatever the method of rehabilitation.[2–4] It could be argued that the woman in the clinical case example with a sharp injury to the tendon and joint capsule alone would be expected to have a favorable outcome.

Evans[5] compared 38 digits treated with 3 to 6 weeks of conventional static splinting with 26 digits treated with the SAM protocol. There were highly significant ($p < .01$) differences between groups favoring the SAM protocol when comparing the duration of therapy (51 vs 76 d), total active motion (132° vs 111°), and extensor lag (3° vs 8°). These results are particularly impressive given that most patients in both groups (77% of the total) had sustained complex injuries.

Early active SAM after central slip repair is capable of producing good results despite complex injury. The technique is straightforward but its success depends on attention to the details of splinting and exercise, and the patient's active cooperation and compliance.

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