ACHIEVING IMMEDIATE ACTIVE MOTION BY USING RELATIVE MOTION SPLINTING AFTER LONG EXTENSOR REPAIR AND SAGITTAL BAND RUPTURES WITH TENDON SUBLUXATION

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In compliant adult patients with extensor tendon laceration(s) in zones V to VII, relative motion splinting of the lacerated tendon(s) provides support from the intact tendon(s), allowing immediate active motion and a less morbid course. Cadaver study shows how this simple splint allows full-finger interphalangeal and metacarpophalangeal active motion, except for 10° to 15° less metacarpal phalangeal total active motion of the repaired digit(s). Relative motion splinting also permits immediate active motion after tendon graft reconstruction of extensor subluxation from sagittal band rupture at the metacarpophalangeal joint, creating a centralizing pulley with the graft.

The hand is an organ; one injured part elicits a response in the entire organ. Extensor tendon lacerations may suffer the greatest morbidity and the least attention of any hand injury. This is because of changes that occur in the uninjured adjacent structures rather than in the lacerated tendon itself. Macrophages activated by an injured tendon do not discriminate between the uninjured volar plate, the collateral ligament, and the intact joint capsule adjacent to the injury. These structures undergo fibroplasia and remodel so that loss of motion occurs, even though there is successful tendon repair and extension. In fact, loss of flexion after repair and immobilization, not loss of extension, is reported as the most common complication. Dynamic splinting preserves active flexion and passive extension, but it is cumbersome, therapy-intensive, and does not allow much function. For over 20 years we have used relative motion splinting, which permits immediate active motion and functional use in reliable patients, whom we encourage to return to work.

RATIONALE

The extensor digitorum communis functions as a single muscle system with 4 tendons, and the independent extensor indicis proprius and digiti quinti function synergistically, so essentially, the long finger extensors function as a single motor unit. This provides opportunity to reduce tension in repaired tendons by placing them in 10° to 15° more extension than their intact neighbors. The resultant slack allows active extension by reducing suture line tension, regardless of the active motion at the metacarpal phalangeal (MP) and interphalangeal joints (Figs 1 and 2). Full active finger flexion (except for 10° to 15° less at the MP joint in repaired tendon[s]) is encouraged. However, to avoid passive tension, the wrist is splinted to prevent full wrist flexion at the time of full finger flexion (Fig 2). Cadaver study demonstrates the effectiveness of this splinting technique (Fig 3). One can also demonstrate its effectiveness by placing a sterile tongue blade beneath the freshly repaired digit and above the adjacent digits and watching the repair as the patient flexes and extends the digits under local anesthesia. This management technique has also been used for immediate motion and use after centralizing subluxating extensors with a tendon graft or pulley reconstruction.

INDICATIONS AND PROTOCOL

Relative motion splinting is indicated in adult patients with 1 to 3 long extensor tendon lacerations, who are willing to remain in a splint that supports them by means of the remaining intact tendons. This treatment is not applicable when all extensor digitorum communis tendons are lacerated. In that situation dynamic splinting is usually the best management method. A study of 180 patients over a 10-year interval showed that the results were significantly better if the tendon was repaired and the patient splinted within 5 days of injury.

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Fig 1. The extensors function as a single motor system, so placing the injured digit in 10° to 15° more extension allows active motion.

Fig 2. Full active flexion and extension is encouraged immediately after repair and splinting.

Fig 3. Pull on the cadaver extensor digitorum communis muscle belly demonstrates lack of tension on the lacerated splinted tendon.
Our protocol is adjusted for each individual patient. However, the protocol generally used is as follows:

- First 3 to 4 weeks: Two splints used (Fig 4), with wrist splinted at approximately 25° of extension and finger splinted with the injured digit in 10° to 15° more extension than the adjacent digits at the MP joint. The splint passes beneath the proximal phalanx of the injured digit and on the top (dorsum) of the proximal phalanges of digits with intact long extensors (Fig 2). With injured perimeter digits (index or fifth finger), the splint passes above the central 2 digits (Figs 5 and 6). Patients are encouraged to resume full work activity with the limitations imposed only by the splint.

- 4 to 6 weeks: The wrist portion of the splint is discontinued, but finger pan is continued (or a buddy splint is used in the last week).

- 6 weeks: No further splinting is usually needed, and full splint-free activity is resumed.

Saldana compared dynamic and relative motion splinting techniques after extensor repair and prefers the latter. However, he used the relative motion splinting technique for only 4 weeks without complications, so our 6-week regimen may be unnecessary.

**EXTENSOR SUBLUXATION DUE TO SAGITTAL BAND DISRUPTION**

For nonrheumatoid patients who develop subluxation of the extensor tendons at the MP joint due to trauma, degeneration, epilepsy, congenital factors, or spontaneous cause, conventional treatment has included protecting the tendons from use for 8 to 10 weeks. Tendon use is restricted by either a dorsal tenodesis from adjacent tendon or a sling from the subluxating tendon to the adjacent intrinsic. Both require 10 weeks during which unprotected use is not permitted. In a unique case in which an elderly patient subluxed both radially and ulnarly (Fig 7), conventional techniques were not applicable, and the use of relative motion splinting allowed immediate active motion and use after centralization with a tendon graft pulley (Figs 8 and 9). The splint protected the pulley repair. This treatment has now become our procedure of choice for subluxating tendons, and we have had success also in trauma cases.
Fig 6. For perimeter digit repairs (index and fifth fingers), the central 2 digits are beneath the splint.

Fig 7. Painful extensor subluxations to both radial and ulnar sides with a history of steroid injection.
Fig 8. Drill holes were connected in the metacarpal head, and a juncturae tendinum graft was passed through the bone and around the tendons to centralize it with a pulley, with the graft suture line rotated into the bone.
Fig 9. Relative motion splinting prevented tension on the pulley graft to allow immediate motion and use while keeping the tendon centralized.

Fig 10. Patients who are not permitted to wear splints at work may particularly enjoy the advantages of relative motion splinting.
DISCUSSION

In a series of 180 patients with 1 to 3 lacerated extensor tendons studied over a 10-year interval, relative motion splinting permitted 98% recovery of flexion and 96% recovery of total active motion compared with the normal uninjured side. There were no ruptures and no cases of reflex dystrophy. Our best results were in those patients who were repaired and splinted within 5 days of injury, with results in patients treated later more comparable to conventional immobilization techniques. The greatest advantage of this technique was the immediate active use and encouragement to return to work with overall less therapy needed (Fig 10). Therapists were asked to check the patients within a few days after splinting to be sure that full active flexion was recovered and to continue checking once a week until splinting was discontinued. If patients were reluctant to recover flexion, a more active therapy program was used. This management method fulfills the axiom, “The greatest challenge in treating hand injury is to preserve function in all of the structures not directly injured.” Because this splinting technique results in much less morbidity, we have been pleased with it and recommend its use.

REFERENCES

3. Saldana M: Comparison of the “Merritt” splint to dynamic splinting following extensor tendon repair. American Association for Hand Surgery Annual Meeting Proceedings, Phoenix, AZ, Fall, 1997 (abstr)