Factors That Influence the Outcome of Zone I and Zone II Flexor Tendon Repairs in Children

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Purpose: To evaluate the factors that influenced the clinical results of zone I and II flexor tendon repairs in children at a single institution.

Methods: Forty-one fingers (35 patients) in patients ages 2 to 14 years with zone I or II flexor tendon injuries were identified. There was a zone I tendon injury in 16 fingers and a zone II tendon injury in 25 fingers. Concomitant injuries to the digital nerves were seen in 18 fingers. Primary repair was performed within 1 week in 35 fingers and delayed repair (2–9 wk) was performed in 6 fingers. After surgery 22 fingers (21 patients) were treated with early controlled mobilization and 19 fingers (14 patients) were treated with plaster immobilization.

Results: All patients were available for evaluation at a mean follow-up period of 42 months. Patients were subdivided into 2 age groups: (1) 0 to 7 years and (2) 8 to 15 years. Digital performance was evaluated by determining the percentage return of normal finger function according to a total active motion formula. Functional evaluation of all digits in both groups showed excellent or good results. Zone I repairs had better results than zone II repairs and isolated tendon repairs had better results than those with associated nerve repairs. The age of the patients nor postoperative protocol did not influence the final digital motion.

Conclusions: A good outcome can be expected after repair of zone I or II flexor tendon injuries in children. (J Hand Surg 2006;31A:1661–1666. Copyright © 2006 by the American Society for Surgery of the Hand.)

Type of study/level of evidence: Prognostic III.

Key words: Flexor tendon, injury, children, zone I, zone II, outcome.

Improvement in the results of flexor tendon repairs in adults, especially those injuries involving zone II, has been reported over the past 2 decades.[1–9] Fewer studies[10–19] are reported in the literature on the outcome of zone I and II repairs in children. The results and the postoperative therapy in these reports have varied despite the good healing potential in children. This is in part related to the limited ability to implement a structured rehabilitation program in children.

Postoperative immobilization protocols in children with flexor tendon injuries have been recommended by many investigators[14,15] and have been shown to improve the final result. Such findings suggest that the concept of early digital mobilization does not necessarily apply to children. In fact, some investigators[16,17] believe that despite immobilization, primary repair of flexor tendon injuries in children produces better results than in adults. It has been suggested that the superior results seen in some series may occur because children heal more rapidly, have a better blood supply, and have greater ability to remodel scars and adhesions.[18]

In most published reports in the literature on flexor tendon repairs in children, specifically involving zones I or II, the multiple variables that might have affected the repair outcome were not all determined. This article evaluates the factors influencing the clinical outcome of zone I and II flexor tendon repairs in children at our institution. The effects of age, postoperative mobilization protocol, zone I versus zone II injury, whether one or both tendons were lacerated in zone II injuries, and associated digital nerve injuries were evaluated to determine their influence on prognosis and outcome.

Materials and Methods

A retrospective clinical review was performed at our institution of all flexor tendon injuries that occurred from 1988 to 2002 in children younger than age 16. The study was approved by the Internal Review Board of our institution. Only lacerations occurring in flexor tendon zones I and II were evaluated. Partial lacerations, crush injuries, associated fractures, and amputations were excluded from evaluation. Forty-one fingers (35 patients) in patients ages 2 to 15 years (mean age, 7 y) with zone I or II flexor tendon injuries were identified. The injuries involved 7 index, 7 middle, 11 ring, and 15 small fingers.

Zone I flexor tendon injury, defined as an isolated flexor digitorium profundus FDP injury distal to the insertion of the flexor digitorium superficialis FDS, occurred in 15 digits, whereas zone II was involved in 26 digits. Among the zone II injuries, 10 digits had an isolated FDP injury and 16 digits had combined injury to the FDS and FDP. Associated nerve laceration was identified in 18 fingers (44%), with involvement of both digital nerves in 7 fingers (17%). Eight (19.5%) digital nerves were injured in zone I and 10 (24.5%) were injured in zone II.

Three different hand surgeons performed the flexor tendon repairs. Primary repair was performed within 1 week in 35 fingers and delayed repair was performed within 2 to 9 weeks in 6 fingers. Flexor tendons injured in zone 2, including the FDP and the FDS, were repaired with a modified Kessler technique using 2 or 4 strands for the FDP (depending on the size of the tendon) and 2 strands for the FDS of 4-0 braided suture combined with a peripheral circumferential running epitendinous repair with a 6-0 monofilament suture at the completion of the tendon repair. In zone 1 flexor tendon injuries a Bunnell[20] pull-out repair was performed using a 4-0-monofilament suture.

The patients were evaluated by the primary surgeons or their fellows after surgery. The rehabilitation protocol after surgery was determined randomly by each treating surgeon. Twenty-two fingers (21 patients) were treated with early controlled mobilization (Duran and Houser[21] protocol), and 19 fingers (14 patients) were treated with plaster immobilization. The Duran and Houser[21] protocol consisted of the application of a dorsal wrist brace with the wrist in 30° of flexion, the metacarpophalangeal joints in 70° of flexion, and the interphalangeal joints in mild flexion (5°–10°). The patient and the family were instructed to start passive flexion of the fingers on the first day after surgery. If the patient could follow commands due to age, he/she would perform their own exercises, occasionally supervised by their parents. If they could not cooperate adequately then the parents would help them perform their exercises. The exercises consisted of maximum manual passive flexion of the fingers as tolerated followed by active extension of the fingers. The exercises were performed for 10 minutes, 6 times per day. This regimen was continued for 4 weeks. The patients then were allowed to start active flexion while still in a brace for 1 week, and then the brace was discarded at 5 weeks, at which point the patients were allowed full, active, unrestricted range of motion of the fingers without support. For the group of patients who were immobilized after surgery, a long-arm cast was applied to all noncompliant patients and patients younger then 7 years. The rest of the patients from this group received a short-arm cast. The cast was removed at 3 weeks after surgery for patients younger than 7 years and at 4 weeks after surgery for the rest. All patients then were started on immediate, active, unrestricted range-of-motion exercises of the fingers.

Follow-up evaluation included the determination of total active motion (TAM) as described by Strickland and Glogovac.[19] In this formula, the sum of the active flexion at the PIP and DIP joints minus the summed extensor deficits at these same joints is divided by 175 and multiplied by 100. [PIP flexion + DIP flexion] – [PIP extensor lag + DIP extensor lag]/175 × 100 = the percentage of normal active proximal interphalangeal and distal interphalangeal motion. Results obtained using this formula are stratified into excellent (75%–100%), good (47%–50%), fair (25%–49%), or poor (0%–24%). In a compliant patient, the measurement of TAM is straightforward even in a child; however, in the noncompliant patient, measurement can be difficult. We used different techniques to encourage the reluctant child to perform finger motions in our efforts to assess extension lag and TAM. For example, showing the child a toy and asking them to try to catch it or giving the child a pen and paper and letting them try to scratch and draw, during which the necessary angles were measured using a digital goniometer.

The patients then were subdivided by age into 2 groups: 0 to 7 years (23 digits) and 8 to 15 years (18 digits), and the effect of their age at the time of the

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