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Flexor tendon injuries in children: Rehabilitative options and confounding factors

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ABSTRACT

Research pertaining to the rehabilitation of children with flexor tendon injuries is less prevalent than that in the adult population, and most authors agree that immobilization protocols comprise a safe and efficacious choice. This article presents suggested protocols and correlated literature regarding the outcomes of immobilization, early passive motion, and early active motion in the pediatric population. Confounding factors which influence rehabilitative choices, both personal and environmental, are also presented.

Introduction

The rehabilitation of an adult patient following flexor tendon injury includes several fundamental concepts which facilitate clinical reasoning and direct the therapist's efforts in evaluation and intervention. These concepts comprise both necessary information regarding injury and surgery as well as therapeutic parameters that can be modulated by the treating therapist.

Elapsed time is of particular interest in terms of time between injury and surgery, time between surgery and initiation of therapy, and total time elapsed between injury and initiation of therapy. It is postulated that an increase in any of these timeframes will have a negative impact on final outcomes as a delay in gliding of the healing tendon across adjacent structures allows adhesions to form, limiting both proximal and distal excursion for the production of motion.[1–7] Myriad evidence supports the concept that early controlled motion is beneficial to both tendon healing and the accrual of strength, while also decreasing adhesions and work of flexion.[2–9]

Surgical specifics, including the number of strands of suture crossing the repair site and any concomitant injuries and/or repairs help guide rehabilitative choices to facilitate gliding of the repaired tendon within and across adjacent structures. Decisions for post-operative rehabilitation are made in conjunction with the surgeon and include type of orthosis, initiation of controlled motion, and progression of exercise. As important as any surgical or therapeutic influence, the ability of the patient to adhere to the suggested regimen and participate in the rehabilitative process is crucial to final outcomes.

Of particular interest is how these fundamental concepts apply to the rehabilitation of children following flexor tendon injury. Research has suggested that recovery is observed more quickly following pediatric flexor tendon repair and with fewer adhesions.[10,11] Certainly the anatomy and plasticity of a child differs from that of an adult, but what has been studied in terms of the rehabilitative options following flexor tendon repair in the pediatric population? And what confounding factors play in post-operative decision making?

Rehabilitative options

The primary controversy with regard to pediatric flexor tendon outcomes is centered on post-operative immobilization. Converse to the adult population, immobilization following pediatric flexor tendon repair continues to be suggested as producing comparable outcomes with a lessened chance for rupture during the rehabilitative phase.[12–15] Four weeks has been established as the common, agreed upon maximal timeframe for immobilization.[12,13] A collection of studies published between 1994 and 2006 compared

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immobilization protocols with early motion in children without significant differences in outcomes.[13–15] Comparatively, more recent publications include high percentages of good and excellent results using early motion.[16,17] The purpose of this paper is to review the recommendations and research available to hand therapists pertaining to the rehabilitation of children following flexor tendon repair.

Immobilization

An example of a specific immobilization protocol has been offered by Amy Lake and her surgeon colleagues at the Texas Scottish Rite Hospital for Children.[12] This protocol delineates children into two age brackets: those four years and younger and those five years and older. Children in the younger group are immobilized in a long arm "mitten" cast with the wrist positioned in 20–25° of flexion, the metacarpophalangeal (MP) joints in 50–60° of flexion, and the interphalangeal (IP) joints in mild flexion for four weeks. Comparatively, the older group is immobilized in the same position, but only for three weeks.

Both groups of children are progressed in a similar fashion based on number of weeks following the immobilization phase. During the first week after the cast is removed, children are placed in a dorsal blocking orthosis with the wrist positioned in neutral and distal joints maintained as per previous. As rationale for continued positioning in IP flexion, the authors offer a greater concern with attenuation of the repair and resultant swan neck deformities versus IP extensor lags. During this first post-immobilization week, the children and their caregivers are educated on initiation of passive protected extension (Duran's passive range of motion) in the splint, and wrist active motion with relaxed digits to be performed out of the splint.

Over the course of the subsequent second through fifth weeks after casting, active flexion is progressed using a percentage approach. The second week engages active flexion to 25% of full effort (fifth to sixth post-operative week), the third week 50% (sixth to seventh post-operative week), fourth week 75% (seventh to eighth post-operative week), and during the fifth week (eighth to ninth post-operative week) the child is encourage to create active flexion with 100% of their effort. The orthosis is typically weaned during the third week after the cast has been removed (sixth to seventh post-operative week).

Outcomes of immobilization following flexor tendon repair in children have been published by Elhassan et al.[15] Using a retrospective comparison of children who had been treated with immobilization and those progressed through early passive mobilization, no significant differences were found in total active motion. Final outcomes of children in both groups included good to excellent results; zone I injuries and those without concomitant nerve repairs were noted as superior. The authors reported two complications, both in the immobilization group, including a two year-old child who sustained tendon rupture and one six year-old who developed joint stiffness requiring tenolysis. Each of these children ultimately achieved good outcomes. This study supports the use of immobilization following flexor tendon repair in children as similar to a more progressive regimen.

Early passive mobilization

Comparatively, Moehrlen et al[16] focused solely on the assessment of early passive mobilization using age groupings: up to four years, four to 10 years, and 10–16 years. Forty nine tendons were repaired in 39 children using a two strand core suture with a modified Kessler technique. The sample was not limited to Zone II injuries. The children were immobilized post-operatively in 45° of wrist flexion with the MPs and IPs in extension; immobilization was extended proximal to the elbow in children younger than four. Rationale for wrist positioning was not articulated by the authors.

Consistent with immobilization protocols, children in this study were progressed through post-operative rehabilitation based on age. Passive mobilization and active-assisted extension via Kleinert traction were pursued during the first three weeks after surgery in all age groups, and children were immobilized in flexion between exercises. The youngest group of children, less than four years old, received assisted finger mobilization during therapy at three weeks and returned to activity at week seven. Those children between four and 10 years old initiated active therapy at four weeks and were encouraged to discontinue the orthosis and resume full activity after 8 weeks. Children greater than 10 years old also initiated active flexion at four weeks and resistance of the exercise was gradually increased through the eighth post-operative week. The oldest children remained in their orthoses until the 10 week point. Moehrlen et al[16] reported good or excellent results in 93% of these cases with no subsequent ruptures. The authors found no statistically significant differences in total active motion or Strickland's percentage between age groups; however, children with zone II injuries were noted to have significantly lower Strickland's percentages than children with injuries in other zones.

Early active mobilization

While cast immobilization through the fourth post-operative week is considered the norm, some authors have reported successful results in pursuing early mobilization following flexor tendon repair in children. Nietosvaara et al[17] completed a retrospective review of 45 fingers in 28 children, including two, four, and six strand repairs. Eleven fingers were treated with an immobilization protocol and casted for an average of 27 days, one was treated using elastic traction, and 33 fingers were treated with an active motion protocol initiated one to three days following repair. The average age of children in this study was 10 years, ranging from 3.2 to 15.9 years and including 21 boys and 7 girls. The active motion protocol included application of a dorsal blocking orthosis with the wrist held in a neutral position, MPs flexed to approximately 60° and IPs held in extension. The orthosis was removed for active exercises four times a day including five repetitions of synergistic exercise: passive wrist flexion with active digital extension followed by wrist extension with active digital flexion. The exercises were completed with passive digital flexion.

According to Strickland's original criteria, good and excellent results were noted in 36 fingers in this study. Ninety-four percent of fingers in the mobilization group achieved these results as compared to only 62% in the immobilization group. Three fingers with two strand repairs sustained tendon rupture; two following cast immobilization and the one patient for which elastic traction was used. All cases of rupture were in male patients. The authors in this study concluded that active motion can be used for children older than five years, and delineated age groupings for number of strands as opposed to length of immobilization. Six strand repairs were suggested for zone one and two injuries in adolescents, while four strand repairs were advocated for younger children and zone five repairs.

The aforementioned literature, while disparate in both surgical and rehabilitative suggestion, does consistently identify age as a factor that influences decision-making in the pediatric population. In both immobilization and early passive regimens, children under the age of four are immobilized proximal to the elbow post-surgically, and those five and older initiate active therapy during the fourth post-operative week.[12,16] The early active mobilization research, in comparison, focused age-related choices on surgical