

Early mobilization compared with immobilization after repair of a flexor tendon injury in children: A retrospective long time follow-up

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ABSTRACT

Objectives: To investigate if early mobilization and immobilization regimes influence long-term outcome after repair of a flexor tendon injury in fingers in children.

Methods: A retrospective follow-up study (2003-2009) was conducted in 27 children (1-16 years) with a flexor tendon injury, excluding a flexor tendon injury in the thumb. Early mobilization (n=17) or immobilization (n=10) was used. Range of motion (ROM; expressed in % of contralateral uninjured hand) in MCP, PIP, and DIP joints was measured, grip strength was recorded, and VAS for function and cosmetic was evaluated.

Results: No ruptures or infections were observed. In the early mobilization group there were more boys; they had a higher age, more transection injuries, and more concomitant digital nerve injuries. However, no differences between the early mobilization and the immobilization groups for functional or cosmetic VAS, ROM for MCP, PIP, and DIP joints or for grip strength were found.

Conclusions: The long-term outcome after a flexor tendon repair does not differ between early mobilization in older children and immobilization in younger children, implying that an early rehabilitation program is not necessary in young children.

Key words: Children, flexor tendon injury, mobilization

Introduction

Hand injuries in children, constituting 2-6% of pediatric emergency care [1,2], should not be underestimated because the hand plays a central role in the development of the individual child. Thus, poor results may lead to disability and impaired development. Although most hand traumas are being taken care of at the emergency department or by a general practitioner, more serious injuries, like a flexor tendon injury (annual incidence 3.6 per 100.000 children [3]), usually

caused by knife or glass lacerations [4-6] require a high competence care. One important factor for an impaired outcome is a delay in the diagnosis, whereas 25% of the flexor tendon injuries in children are missed at the initial examination [7]. A flexor tendon injury in a child is a serious and complex injury, where the treatment depends on multiple factors, like the small size of structure, complexity of suture technique, and risk of non-compliance in rehabilitation.

Flexor tendon repair remains a contentious issue

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in hand surgery with a variety of repair techniques described in the literature [8]. The treatment of choice in adults is surgery within 24 hours with a core suture, combined with running epitendinous sutures, and active rehabilitating starting 3-5 days postoperatively [9]. Whether 2- or 4-strand core sutures are being used depends on the size of the tendon and degree of injury. A 2-strand core suture is more likely to rupture. The treatment of flexor tendon injuries in children is in many ways similar, but not identical, differing in the rehabilitation management. Functionally, there is no difference among children in the active range of finger motion between 2- and 4-strand core sutures [10]. A good functional outcome after surgery [11-13] for isolated flexor tendon injuries in children can be achieved, but the results are worse if associated nerve injuries are present [14]. Furthermore, there seems to be no benefit of early mobilization in children compared to immobilization up to 4 weeks, but beyond that an increasing risk of poor results has been reported [15]. Further studies in this area are needed to design rehabilitation protocols for children that give the best results, are easy to follow, and avoid rupture of the tendon.

The aim of this study was to investigate the functional outcome after repair of a flexor tendon injury with early mobilization or immobilization in children.

Patients and Methods

A total number of 50 children with one or several flexor tendon injuries in the hand, excluding injuries to the thumb, were referred to the Department of Hand Surgery for treatment 2003-2009. All children were invited to a follow-up study. Twenty-three patients did not participate in the follow-up for various reasons. Twenty-seven children, aged 1-16 years at the time of injury, were attending and retrospectively evaluated.

The patient, if having an age of 18 years or being older at time of follow-up or if the patient was younger than 18 years, their parents gave their written informed consent. The study was approved by the Ethical Board (Nr 2009/339).

Outcome was evaluated at a median of 4 years (range 1-7 years) after the flexor tendon repair. In the early mobilization group, the evaluation was done at a median of 4 years (range 2-7 years) and in the immobilization group after a median of 3 years (range 1-7 years). Information from the medical notes is presented in Table 1 for both those attending the study and the non-attending ones.

Experienced hand surgeons operated on all children. The tendons were approached through a palmar zigzag extension of the skin laceration in all cases. Preferably, we used a non-absorbable 4/0 braided or monofilament suture as a core suture, combined with 5/0 or 6/0 running epitendinous suture. Twenty-five tendons were sutured with 2-strand core sutures and 24 tendons with 4-strand core sutures. Five tendons were sutured with steel thread because of the distal origin of the injury. The suture techniques used were decided by the responsible surgeon based on the condition. The strategy of flexor tendon rehabilitation was decided by the surgeon according to the expected cooperation of the patient and parents. Active early mobilization (n=17) was initiated at 3-5 days after surgery, according to the protocol used for adults at the department and in detail described by Small et al. [16]. In 10 patients the hand and wrist of the patient were immobilized in a cast for 3-4 weeks, where the child was allowed to use the hand freely. After having removed the immobilizing bandage and cast, the children and parents were instructed to passively move the injured finger and to make active flexion and extension with all fingers like a mass movement.

A visual analogue scale (scale: 0-100; 100: best) was used to evaluate functional (VASf) and cosmetic (VASc) outcome. Any present problems with the scar were asked and registered. Measurements of grip strength were conducted by a physiotherapist using a dynamometer Grippit R (Detektor AB, Gothenburg, Sweden). Three measurements were made and the mean value for the maximal grip strength (Newton) was calculated and expressed in % of the contralateral-

al uninjured hand (grip strength %). Range of motion (ROM) of MCP, PIP, and DIP joint was measured by the physiotherapist and expressed in % of the contralateral uninjured finger (ROM %).

All values are expressed as median (range, i.e., min-max) if not stated otherwise. The Chi-square method was used for categorical data and the Mann-Whitney U test was used for the non-parametric variables.

Results

Participants

The median age for 27 participants was 10 years (range 1-16 years) and the majority of the participants were boys (n=15; Table 1). In total 30 fingers were injured in 27 participants, with the index finger (n=11) most commonly affected. Forty-five tendons were sutured, with 30 tendons of the flexor digitorum profundus (FDP) and 15 tendons of the flexor digitorum

superficialis (FDS) muscles. Digital nerve injuries were found in 21 patients and a digital artery injury was found in 11 patients, with two patients needing revascularization procedure. One patient had a fracture of the middle phalanx.

Twenty-three of 27 patients were operated on within the first twenty-four hours. Three patients had a delayed diagnosis and were operated on 4, 6, and 26 days after the injury. One patient had a delay in surgery, that is, 21 days, due to an infected wound after a dog bite.

There were no postoperative ruptures found of any of the flexor tendon repairs. One patient was operated on with a tenolysis 6 months after the primary suture of tendon. No postoperative infection was observed. No scar problems were detected.

Range of Motion

The ROM % for the MCP, PIP, and DIP joint in the

Table 1a. Characteristics of participants and non-participants with repaired flexor tendon injuries.

	Early mobilization (n=17)	Immobilization (n=10)	P value	Participants (n=27)	Non- participants (n=23)	P value
Age (years)	12 (7-16)	5 (1-13)	0.001	9 (1-16)	10 (1-16)	0.423
Gender (n) Boys/girls	12 / 5	3 / 7	<0.001	15 / 12	14 / 9	0.668
Cause of injury Cut (n)/crush (n)	16 / 1	8 / 2	<0.001	24 / 3	19 / 4	0.585
Injured finger (n) (index/long/ring/little)	8/1/3/5	3/4/1/2	0.062	11/5/4/10	4/6/5/9	0.409
Zone of injury (n) Zone I/II/III	5/12/0	5/4/1	0.235	10/19/1	8/15/1	0.987
Injured tendon (n) FDP+FDS/FDP	9 / 8	3 / 7	0.097	15 / 15	14 / 10	0.542

Table 1b. Characteristics of participants and non-participants with repaired flexor tendon injuries.

Digital nerve injury Yes (n)/no (n)	16 / 1	5 / 5	<0.001	21 / 6	13 / 11	0.056
Digital artery injury Yes (n)/no (n)	7 / 10	4 / 6	0.952	11 / 16	8 / 15	0.665
Tendon repair						
2-strand (n)	8	7		18	7	
4-strand (n)	7	2	0.443	9	15	0.051
Reinsertion (n)	2	1		3	2	

Differences between the groups (early/late and participants/non-participants) are expressed with p values based on the Mann-Whitney U test and the Chi-square analysis for categorical data. Bold font indicates significant difference (p<0.05).

Table 2. Outcome after repaired flexor tendon injuries.

	Early mobilization (n=17)	Immobilization (n=10)	P value
ROM (degrees)			
MCP	95 (68-112)	102 (95-118)	0.053
PIP	93 (28-116)	93 (37-111)	0.708
DIP	86 (52-113)	61 (0-100)	0.331
Grip strength (% contralateral)	95 (53-116)	94 (78-112)	0.429
VAS			
Function	81 (50-100)	76 (10-100)	0.918
Cosmetic	77 (20-100)	75 (10-100)	0.878

Range of motion (ROM) and grip strength are expressed as ratio between the injured and the contralateral uninjured side (%). Differences between the groups are expressed with p value based on the Mann-Whitney U test.

early mobilization group was statistically not different from the corresponding ROM % values for the immobilization group (Table 2). Two patients had the DIP joint fixed with arthrodesis and were excluded from the evaluation of the ROM %.

Grip Strength

No statistical difference was found in grip strength in the early mobilization and the immobilized groups (Table 2).

Subjective Outcome

No significant difference was found in VASf or VASc in the early mobilization and in the immobilized groups (Table 2).

Non-Participants

We found no differences between the patients attending and not attending the study (Table 1). No postoperative ruptures of any of the flexor tendon repairs or infections were reported among the non-participants. No patient had been operated on with a tenolysis among the non-participants.

Discussion

The study shows that there are no differences in the subjective or functional outcomes after a flexor tendon repair between early mobilization regimes in older

children compared with an immobilization regime in younger children. There was no statistical difference in ROM of the MCP, PIP, and DIP joints between the group of early mobilization and the immobilized group. No significant difference in any of the parameters was found between the participants and the non-participants in the study.

A flexor tendon injury is a serious and complex injury and an excellent outcome depends on multiple factors. A delayed diagnosis, a poor suture technique, or an inappropriate rehabilitation regime can lead to disability. In the present study, we could not detect a worse result even if the tendon repair was done more than three weeks after the injury. We have not found any difference if a two- or four-strand core suture was used. As pointed out earlier [12,17] in the late mobilized group, there is no need for more than a two-strand core suture. The suture technique chosen by the surgeon is dependent on the tendon size and mobilization regime. This study is limited depending on the number of included children and the result for both the late repair and suture technique may change if the number of children had been higher. Children are considered to have better ability to heal more rapidly and with less adhesions compared to adults [9,11], which is a reason to immobilize the hand and wrist after a flexor tendon injury in children and still achieve good result after mobilization. As with nerve injuries, the brain plasticity might also have an important role in the rehabilitation after a flexor tendon injury and explain to some extent the good results after flexor tendon repair in children [18].

Previous studies in adults have stressed the importance of early mobilization [19,20], with a decreased risk of tendon adhesion, but the risk is considered to be less in children [11]. In contrast to adults [21], we did not observe any tendon rupture among any of the patients and only one patient had a tenolysis, indicating that the present regime is appropriate for flexor tendon repair in children.

In the early mobilization group, a higher rate of boys was found probably due to the fact that with increasing age boys are more prone to injuring their hands than girls [22,23]. We also found a higher age in the early mobilization group with the youngest 7 years of age. If we have used a more age-adapted rehabilitation program we might have been able to decrease the age in the early mobilization group [24].

We also found more digital nerve injuries in the early mobilization group who might have a worse prognosis [14]. However, there were also more cut injuries and that may indicate a more favourable injury.

Recently, others have found similar results that different mobilization regimes, including initial immobilization, give excellent results in children [17]. However, in the study by Cooper et al., they also included tendon injuries in zones 3, 4, and 5. In another article, they present different mobilization regimes for flexor tendon injuries [25]. They concluded that studies have showed promising results for a more active mobilization regime in children, but it requires a careful analysis of age, developmental maturity, and the care givers possibility to give support [25]. However, they also state that an initial immobilization regime is still the most supported mobilization regime [25].

A limitation of the study is that we were only able to include 27 (54%) children in the study. Several reasons were given not to attend: moving from the region, having difficulties to spare the time for travelling to our department, some being happy with the result, and some simply expressing that they were not interested. Potential other bias could exist though it is difficult to get a homogenous group in these rather rare injuries.

The findings implicate that initiation of an early rehabilitation program after flexor tendon repair in young children is not necessary. We recommend start with an active early mobilization program only for those children who are cooperative and have good family support.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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