

Evaluation of Early Dynamic Splinting *versus* Static Splinting for Patients with Transposition of the Extensor Carpi Radialis Longus to the Extensor Pollicis Longus

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Abstract. We present a group of 20 patients who underwent transposition of the extensor carpi radialis longus to the extensor pollicis longus between April 2003 and September 2007. The group was divided into ten patients with an early dynamic splint and ten patients with a static plaster cast following the standard rehabilitation protocols. We compared these two rehabilitation protocols. The post-rehabilitation total range of motion was 87.5 degrees in the dynamic group and 58.75 degrees in the patients treated by the static protocol. The total time of rehabilitation was 10.2 weeks in the dynamic and 14.2 weeks in the static group. The overall mean follow-up was 12.2 weeks. We conclude that early dynamic splinting brings shorter recovery time, shorter time off work and significantly better movement of the thumb.

The extensor tendons form six discrete compartments on the dorsal aspect of the hand at the level of the wrist. The second and third compartments contain three extensors. More radially, in the second dorsal compartment, there are tendons of the extensor carpi radialis longus (ECRL) muscle and extensor carpi radialis brevis (ECRB) muscle. Both of these are not only powerful wrist extensors but also provide radial deviation. The ECRL inserts on the base of the second metacarpal and the ECRB inserts on the base of the third metacarpal. More ulnarly, in the third dorsal compartment, is the extensor pollicis longus (EPL) tendon that attaches to the base of the distal thumb phalanx. Only this tendon is

capable of providing true hyperextension of the interphalangeal (IP) joint of the thumb (1).

The first report of a spontaneous rupture of the extensor pollicis longus was written by Duplay in 1876. Most chronic ruptures of this tendon occur as a rare complication of Colles' fracture (estimated at one in 300).

If the rupture of the EPL is subcutaneous, this is very easily recognizable as a dropped thumb. The patient is not able to provide hyperextension in the IP of the thumb. Moreover, the patient is hardly able to make any extension of the IP or of the metacarpophalangeal (MP) joint, although some extension can also be obtained by means of the extensor pollicis brevis (EPB) tendon or the intrinsic muscles of the thenar.

Most patients do not seek hospital care immediately on the day of their trauma. If they did, it would be possible to perform primary tendon suture of the lacerated ends, especially when the trauma was caused by a sharp knife. In the study presented here, our patients came to the hospital approximately 20.7 weeks (range one day – two years) after the incident. After such a period tendon transfers must be considered. There are two commonly used tendons: the extensor indicis (EI) tendon and the aforementioned ECRL. The ECRB and the palmaris longus (PL) tendon can be used, especially in plegic patients but very rarely in otherwise healthy patients. According to the literature, the EI is considered as the first choice, because its excursion of 5 cm, fibre length, cross-sectional area and its relative muscle power (2) are more similar to the EPL than is the ECRL. On the other hand, there is a risk of loss of the independent extension of the index finger by using the EI tendon (3) which is the reason why we use ECRL transfer (4).

Recently Bullon *et al.* (5) published an article in which they introduced a completely new technique for restoration of thumb function after EPL rupture, advocating the use of the accessory abductor pollicis longus tendon as an alternative method.

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Key Words: ECRL, EPL, tendon transposition, dynamic splinting.

According to Hoffmann and Meek (6) the transposition of the EIP tendon can be performed as an endoscopic procedure.

We made a retrospective comparative study between two rehabilitation protocols after operating on twenty patients with lesion of EPL. We divided these patients into two groups with different postoperative protocols. The first group followed a postoperative ‘static’ protocol and the second group a ‘dynamic’ one. The goal of this study was to compare postoperative recovery between these two groups.

Patients and Methods

Between April 2003 and September 2007, twenty patients underwent ECRL transfer for EPL function loss. There were six men and 14 women. We divided these patients into two groups with different postoperative protocols according to the date of surgery. We used the static (plaster cast) protocol for ten patients operated on between April 2003 and July 2005 and the dynamic (splint) protocol for the other ten patients operated on between June 2005 and September 2007.

The mean age of the patients was 49.55 years (range 21-79); it was 52.6 years (range 29-79) for the patients with a plaster cast and 46.5 years (range 21-67) for those patients wearing a dynamic splint.

All patients were operated on at our department and postoperative care was provided by our team. Immobilization in a plaster cast with the wrist and thumb in extension was applied to all patients at the time of surgery.

The first group consisted of ten patients, who followed the postoperative ‘static’ protocol. The static protocol included: immobilization in a plaster cast in extension for four to five weeks without any thumb movement, followed by passive exercises during the first days and by light thumb movements immediately after that. If needed, a short extension splint was applied during the night and sometimes during the day as a support for the repaired tendon.

The second group consisted of ten patients wearing a postoperative dynamic extension splint (Figure 1). Immediately after surgery, a standard plaster cast was applied as in the static group; this was then changed to a dynamic splint on the same day or on the day after. Patients began rehabilitation under the tutelage of the rehabilitation nurse and in most cases the patients were able to perform rehabilitation (a range of ten motions) on their own every two hours. The original plaster cast was only used overnight to prevent failure of the dynamic splint, for more comfort and reassurance during sleep. The dynamic extension splint was worn for the first four to five weeks and then removed. Passive exercises and light thumb movements commenced immediately after the removal. As in the static group, a short extension splint was occasionally used during nights and days.

Standard goniometers were used for measuring the range of motions. All measurements before surgery and follow-up measurements were made by our experienced rehabilitation co-workers independently of the operating team. The scoring Total Active Motion (TAM) system (7) of the American Society for Surgery of the Hand was used.

Results

The cause of EPL rupture for each subgroup is shown in Table I. The most important cause of EPL rupture was associated with a previous fracture of the distal radius.

Table I. Etiology of EPL rupture in the two groups.

	Fall	Fracture	Injury	Arthritis	Iatrogenic
Dynamic	2	5	2	1	0
Static	3	3	2	1	1

Table II. Time (in weeks) between the appearance of dropped thumb and surgery in the two groups.

	No. of patients	mean	min	max	SD
Dynamic	9	16.00	2.00	55.00	17.91
Static	10	25.40	0.00	110.00	38.47

Table III. Time (in weeks) between the appearance of dropped thumb and surgery (patient with two-year history of dropped thumb not included).

	No. of patients	Mean	Min	Max	SD
Dynamic	9	16.00	0.00	80.00	25.90
Static	9	16.00	2.00	55.00	17.91

The mean time between the appearance of dropped thumb and surgery was 20.7 weeks. We took into account only nine patients in the dynamic group, because one patient was operated on after treatment of the complex injury of the hand as a planned procedure. The mean time for each group is shown in Table II. The difference in time between these two groups was 9.4 weeks because one patient was operated on two years after the appearance of clinical symptoms. Excluding this patient, there was no significant difference between the two groups, as shown in Table III.

The mean time of hospitalization is shown in Table IV. Patients wearing the dynamic splint required a day more in the hospital compared to the patients wearing the plaster cast but this was also due to the need for educating the patients about the self-rehabilitation. The hospitalization time, however, is to be considered very approximate and with caution because in the Czech Republic it is not common to admit and dismiss patients during weekends and the patient numbers here are low.

The mean time between surgery and the end of rehabilitation is shown in Table V. The mean follow-up for all patients was 12.2 weeks. One patient wearing a dynamic splint ended rehabilitation with a satisfactory range of motion (TAM 95 degrees) after only six weeks while one patient wearing the static splint finished the rehabilitation after 20 weeks (TAM 50 degrees).

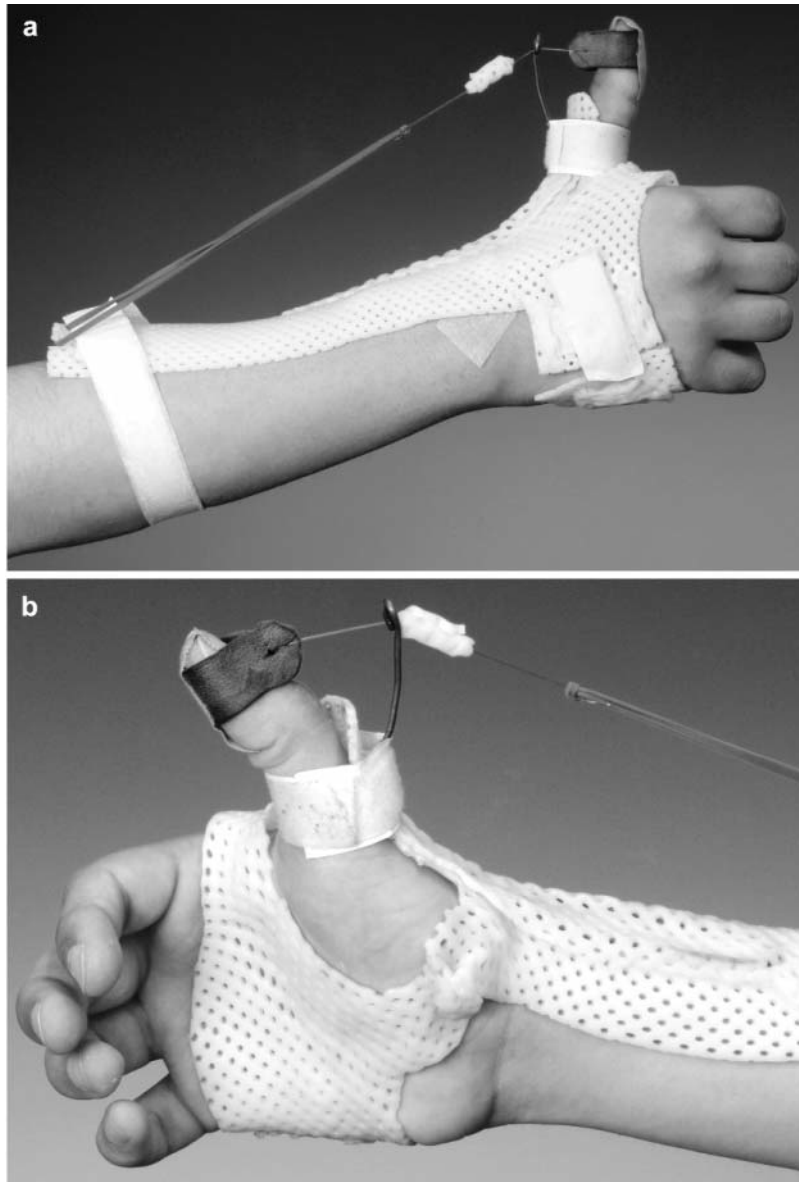


Figure 1. a) View of the dynamic splint. b) View of the dynamic splint showing limited flexion of the IP joint of the thumb.

As regards the range of motion, the results were evaluated after rehabilitation. Two patients in the static group underwent tenolysis three months after the transposition due to the lack of thumb function. Only post-tenolysis measurements were taken into consideration. No patient in the dynamic group needed tenolysis (Figure 2). We focused on the extension lag and the flexion of the IP joint of the thumb. Table VI shows the deficits in extension between the static and dynamic group, whereas Table VII shows the difference in flexion of the interphalangeal joint. Patients with the dynamic splint had a better range of thumb motion than those with the static splint.

Discussion

The EPL is the main extensor of the interphalangeal joint and an important extensor of the MP joint of the thumb. The significant disability after its rupture is the inability to elevate the thumb to the plane of the palm (8).

Primary repair, tendon grafting and tendon transfer have been advocated for rupture of the EPL tendon. Most patients present some time after their EPL rupture, when direct repair is not feasible because of the gap caused by muscle contraction and/or the poor condition of the ruptured tendon ends (9). Free tendon grafting, was first reported by Platt

Table IV. Mean time (in days) of hospitalization.

	No. of patients	Mean	Min	Max	SD
Dynamic	10	3.80	2.00	7.00	1.62
Static	10	3.30	2.00	6.00	1.49

Table V. Mean time (in weeks) between surgery and the end of rehabilitation.

	No. of patients	Mean	Min	Max	SD
Dynamic	10	10.20	6.00	18.00	3.33
Static	10	14.20	10.00	20.00	3.19

Table VI. Difference in extension lag between static and dynamic group.

	Valid	Mean	Min	Max	SD
Dynamic	10	1.50	0.00	10.00	3.75
Static	10	12.50	0.00	40.00	14.88

Table VII. Difference in degrees of flexion of IP between static and dynamic group.

	Valid	Mean	Min	Max	SD
Dynamic	10	51.00	30.00	70.00	13.90
Static	10	43.75	0.00	80.00	25.74

(10), who used a length of toe extensor. Other authors recommended use of the PL (11-13).

Grafting cannot be used if the motor of the long extensor tendon no longer is functional. Moreover two tendon anastomoses are required; one of these junctions may fail, as reported for one of the 21 patients reviewed by Magnell *et al.* (12).

Tendon transfer is the most frequent treatment applied to this lesion. Various tendon transfers have been used. Objections to the use of EIP centre around extensor lag or residual weakness of the index. Russell Moore *et al.* (14) disputed this, reporting 27 EIP transfers with no cases of index finger lag, but Browne *et al.* (15) recommended repair of the extensor hood. Riddell (16) compared EIP and ECRL transfer, finding more loss of thumb extension with ECRL because of its shorter excursion; as a matter of fact, the excursion of EIP is about 5 cm, ECRL is about 3 cm (2).

As Riddell (16) and Low *et al.* (17), we feel that the transfer should be tight enough to give full thumb extension

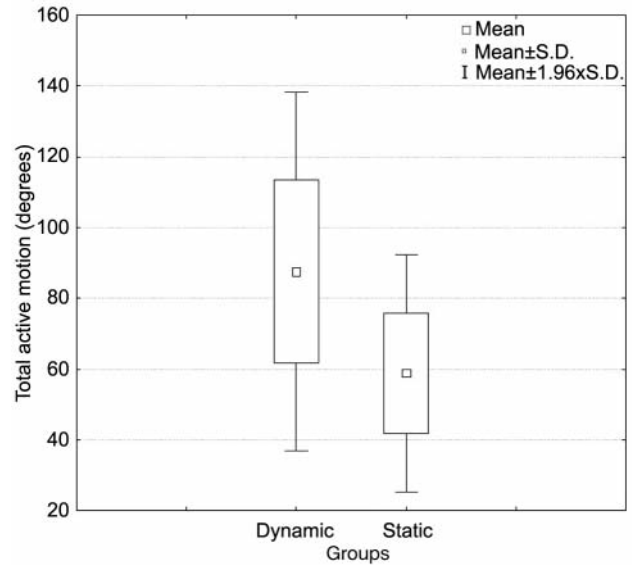


Figure 2. Total active motion in the groups of dynamic and static splinting.

and that immobilization in this position gives the best results. Although there is a loss of half the strength of extension of the thumb using the EIP tendon transfer, no patient complains of weakness. We performed the transfer of the ECRL tendon that is relatively more powerful than the EIP muscle. The relative muscle power of the ECRL to the flexor carpi radialis (FCR) is 1.0, the EIP to the FCR is 0.5 (2).

We have found only one article on this specific type of tendon transfer (18) mentioning a comparative study between the use of dynamic splint and static splint for the restoration of thumb function after EPL rupture; the conclusion of this study shows benefits of dynamic splinting in terms of recovery time but no difference in range of motion. Other articles concerning extensor tendon repair in this zone (19, 20) recommend dynamic splinting as a more effective method than static splinting.

The results in the present study show that dynamic splinting after the transfer of the ECRL to the EPL is an established technique that brings shorter recovery time, shorter time off work and significantly better range of motions in the MP and IP joint of the thumb. We could say that the overall recovery time using the dynamic splint is halved compared to the use of plaster cast.

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Received February 9, 2009

Revised July 20, 2009

Accepted August 12, 2009