Original Article

Management of Flexor Pollicis Longus Injury - Experience in BSMMU

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Anatomic consideration: *Flexor pollicis longus (FPL) tendon arises from volar aspect of middle third of radial shaft and from the lateral aspect of interosseous membrane. The anterior interosseous branch of median nerve innervates the muscle in the proximal/mid forearm. Blood supply is predominantly from radial artery.*

Abstract

Purpose: *The purpose of this study was to evaluate the results of repair and one stage reconstruction of FPL injury and to find out complications and rupture rate and effectiveness of repair and reconstruction.*

Method: *This retrospective review was carried out in Bangabandhu Sheikh Mujib Medical University from January 2015 to December 2018. 30 consecutive patients were enrolled in the study. 4 strands core suture with simple circumferential suture were used for repair and reconstruction. Tendon transfer was done in few cases. Power grip, active and passive range of motion, American Society for Surgery of the Hand criteria and Buck-Gramcko criteria were used for outcome assessment.*

Results*: Out of 30 patients, 20 (67%) were male and 10 (33%) were female. Mean age was 30 years. Mean follow up period was 1.5 years. All cases were due to various type of cut injuries. In subjective assessment 40% patients achieved excellent, 50% good, 10% fair results. Our rupture rate was 0%. Mean power grip, pinch grip strength of index and key pinch strength were 87.5%, 68.18% and 86.66% respectively from contralateral normal hand. Active range of motion of IP joint was 64.28% of normal side.*

Conclusions*: Use of 4 strands core sutures and early active motion give good to excellent results in 90% cases of repair, reconstruction and tendon transfer in FPL injuries with 0% rupture rate.*

Key Words:
FPL Injury, Four strands core suture, Early active motion.

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Introduction:

Intrasynovial lacerations of FPL may pose a unique difficulty causing proximal tendon stump frequently retracts deep to thenar musculature making retrival of the proximal end more difficult [41,42].

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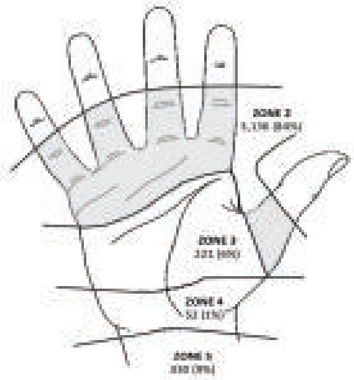
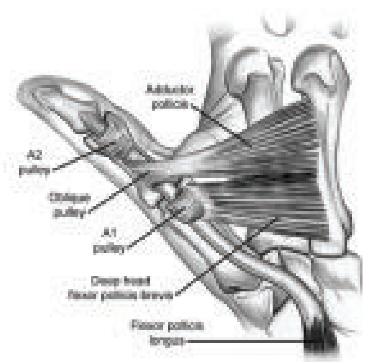
Primary repair of Flexor pollicis longus tendon is generally recommended, except in zone 3 or zone 4 injuries, when primary grafting can be advisable. Decision making depends on many factors, i.e. anatomical peculiarities of FPL tendon, timing of presentation, the plethora of treatment options, by the differing flexion needs of the thumb in different individuals. Treatment options for divided FPL tendon are primary and delayed primary repair, extended primary repair and secondary reconstruction.

Retraction of proximal cut end of FPL is always greater than the finger flexors[1]. due to shortening of the FPL muscle and Murphy believed that this could be due to fact that it is separated from other flexor tendons. Difficulty in attempted repair even a short delay of 48 hours is the cause of higher rupture rate in repaired tendon due to increased

Attachment of FPL



Zones in thumb and fingers.



Pullies of FPL.

tension in the repair area[2]. Muscle configuration (unipennate) of the FPL is also different from other tendons.

Rupture in zone 2 is higher than zone 1 because of lack of extrinsic vascular supply immediately palmer to MCP joint, identified by Lundburg, Hergenroeder and Tubiana[3-5].

Most authors favoured tendon reconstruction by interpositional grafting before 1989 when the presentation is delayed[1,6]. Tendon lengthening either in muscle or tendon at wrist was also used by several authors as an alternative to interpositional grafting[7,8]. Mobilization in that time was usually between 3-5 weeks and result reported were often impressive. Common site of division of FPL is zone 1 and 2[9,10].

Early postoperative mobilization started during late 20th century in variation of Kleinert technique of active extension – passive flexion[9,10]. 30Primary FPL repairs with a two-strand modified Kessler suture and a simple running circumferential suture, followed by early active mobilization with the thumb only prevented from free movement had a rupture rate of 17% by David Elliot in 1994[11].Sirotakova and David Elliot when used four-strand Kessler suture with a Silverskiold circumferential suture in 2004 followed by early active mobilization, rupture rate was 0% in FPL primary repair [33]. Two Kessler two strand repairs in planes at 90p to each other were used[12].Using Tang's technique of three Tsuge suture as "core" suture with no circumferential suture is as strong as the more conventional and circumferential suture combinations[14,15] again had 0% rupture rate with early active mobilization using Belfast[16]regimen[13].Tang modified his technique of three Tsuge suture[17] into four strand Tsuge-type repair to make the repair easier and faster[18]. Purpose of this study was to evaluate final clinical outcome of a series 30 FPL injuries.

Patients and Methods: We retrospectively reviewed the results of 30 patients of FPL injuries in Bangabandhu Sheikh Mujib Medical University from January 2015 to December 2018. Out of 30 patients, 20 (67%) were male and 10 (33%) were female. Mean age of the patients was 30 years (18 to 45). Mean follow up period was 1.5 years (1-3 yrs.). Dominant hand was affected in 18 (60%) cases and non-dominant in 12 cases (40%). All the cases were due to various types of cut injuries. Most cases (90%) were due to sharp cut and glass cut injuries. Rest 10 % due to machine cut injury. Bony injuries and soft tissue envelope lacerations were excluded from the study. 3 (10%) cases were in zone 1, 10 (33%) in zone 2, 2 (7%) in zone 3 and 15 (50%) in zone 5. Mean duration of presentation was 7weeks (1 weeks to 4 months). Thumb joints were made supple before surgery by mobilization and physiotherapy. We did delay primary repair in 3 (10%), secondary repair in 5 (16.67%), late repair in 10 (33.33%) and reconstruction in 12 (40%) patients. Out of reconstruction, proximal Z lengthening and advancement in 2 (6.66%), interposition grafting in 4 (13.33%) (Palmaris longus was used as interpositional graft), splitting round the FPL in 2 (6.67%), tendon transfer in 4 (13.33%) patients. Brachioradialis was used in 2 and FDS of ring finger in 2 patients. We used 4 strands core suture and simple circumferential suture in all repair cases. For grafting cases, Pulvertaft weaves were used in proximal ends and 4 strand core suture with simple circumferential suture in distal end. A2 pulley was reconstructed in 2 cases. 4-0 proline was used as core suture and 5/6-0 proline as circumferential sutures. Isolated FPL injury was in 12 (40%) cases and rest 18 (60%) cases were associated with other fingers and wrist flexor injuries. Digital nerve injuries of the thumb were repaired in 3(10%) cases (2 radial,1 ulnar) and reconstructed in 2 (6.67%) (radial) cases. Tension was adjusted by keeping the IP joint of thumb in

30p flexion and CMC and MCP joints in 20p -30p flexion and confirmed by tenodesis of wrist. In full flexion of wrist, IP joint of the thumb was fully extended and in full extension, tip of thumb was on the mid portion of proximal phalanx of index. We used dorsal block splint with 20p of flexion with slight ulnar deviation of the wrist, 20-30p of CMC and MCP and 30p of IP joint flexion of the thumb. Mobilization was started after 48 hours in the form of passive flexion and full active extension for 20 minutes for 5 times a day. After1 week, gentle active flexion was encouraged with 5% of the strength. After two weeks, sutures were removed and strength of active flexion exercise increases to 10-15%. Plaster slab/dorsal block splint was kept for 5-6 weeks. After 4 weeks 30-40% strength in active flexion was encouraged and again after 6 weeks 60- 70% strength and strengthening exercise was started after eight weeks.

Clinical assessment comprised measurement of the range of palmar and radial thumb abduction; passive and active ranges of motion (AROM) of the IP and the MCP joints; opposition to the little finger tip; opposition to the digital palmar crease of the little finger; static power grip at Jamar setting 2 (Jamar, Sammons Preston Inc., Bollingbrook, Illinois, USA); static pinch strength to the pulp of the index finger and to the pulp of the middle finger separately (Baseline Hydraulic Pinch Gauge, Fabrication Enterprises Inc., Irvington, New York, USA); static key pinch grip (Baseline Hydraulic Pinch Gauge, Fabrication Enterprises Inc., Irvington, New York, USA); two-point discrimination and the Moberg pick-up test (Moberg, 1958[40]).

The active range of motion results were assessed by the Buck-Gramcko (Buck-Gramcko et al., 1976[37]) and ASSH (Kleinert and Verdan, 1983[39]) techniques. Hand function was assessed using the DASH score (Germann et al.,1999[38]).

Subjective function of the thumb pre- and postoperatively was assessed by the patients on a scale of 0 to 10, where 10 is normal and 0 indicates no thumb function possible. The numbers in both subjective assessments were later summarised as excellent (9, 10), good (6,7,8), fair (3,4,5) and poor (0,1,2).

Statistical analysis was performed using Student's t-test for paired observations. The level of significance was considered to be P<0.05.

Table 1

Active range of motion of IP and MCP joints.

	Reconstructed thumb ROM in degrees mean range (n= 30)	Contralateral thumb ROM in degrees mean range(n=30)
Maximum IP flexion	55 (40–80)	70 (60–85)
IP extension deficit	10 (0– 25)	1 (0–5)
Active range of motion IP joint	45 (35–75)	70 (60–85)
Maximum MCP flexion	50 (30–70)	54 (40–85)
MCP extension deficit	5 (0–25)	0
Active range of motion MCP joint	45 (25–70)	55 (35–75)
Maximum IP & MCP flexion	105 (70–150)	130 (105–160)
IP & MCP extension deficit	15 (0– 60)	0.6 (0–10)
Active range of motion IP and MCP joints	90 (60 –120)	125 (100–160)

Table-II

Passive and active radial and palmer abduction measurement:

	Recon. Thumb ROM (p) (n=30)	Cont. Thumb ROM (p) (n=30)
Passive radial abduction	58 (40 – 75)	60 (40 -75)
Active radial abduction	55 (35 -75)	60 (40 – 65)
Passive palmar abduction	55 (35 -65)	58 (45 – 70)
Active palmar abduction	45 (35- 70)	55 (40 – 75)

Table-III

Grip and pinch strength

	Recon. Thumb (kg) mean (range) (n=30)	Cont. Thumb (kg) mean (range(n=30)	P value
Mean grip strength	28 (20 – 55)	32 (23 – 60)	0.062
Mean pinch strength to index	4.5 (2.5 – 7)	6.5 (3.5 – 10)	0.001
Mean pinch strength to middle finger	3.5 (2 – 7.2)	4.5 (3 – 8)	0.004
Mean key pinch strength	6.5 (3.5 – 10)	7.5 (5 – 15)	0.004

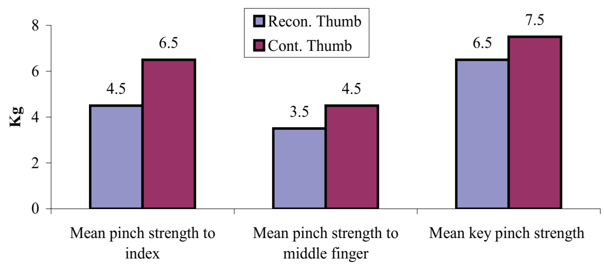


Fig 1: *Bar diagram showing pinch strength to index, middle finger and key pinch strength*

Results:

Mean active range of motion of IP joint for healthy thumb was 70p (range 60p -85p) and 45p (35p - 75p) on the operated hand which was 3p (0-5p) preoperatively. There was a significant improvement of thumb function (p<0.05). All patients were able to oppose the thumb to the tip of little finger comfortably. Opposition to palmer digital crease of little finger was possible in all except in 2 patients and mean distance in them was 3mm (1-3 mm) and the same measurement in healthy side was o mm.The mean power grip of the operated hand was 28 kg (20-55) as compared to healthy hand of 32 kg (23–60), was not significantly decreased (*p= 0.062*). Mean pinch grip strength of index finger was 4.5 kg (2.5–7) which was significantly lesser with contralateral normal side 6.6 kg (3.5 –10 *(p=0.001).* Mean pinch grip strength of middle finger was 3.5 kg (2.0–7.2) which was significantly decreased with contralateral normal side of 4.5 kg (3–8) *(p=0.004)* and mean key pinch of the operated thumb was 6.5 kg (3.5–10) also was significantly decreased with normal contralateral thumb of 7.5 kg (5-15) *(p=0.004).* The median of the DASH score was 9, the mean value was 15 (range 7–23) points. Based on the findings of Jester et al. (2005) the mean value of 15 indicates an only moderately higher DASH score than that found in a non-clinical population on (n=716); with a DASH score of 13.0

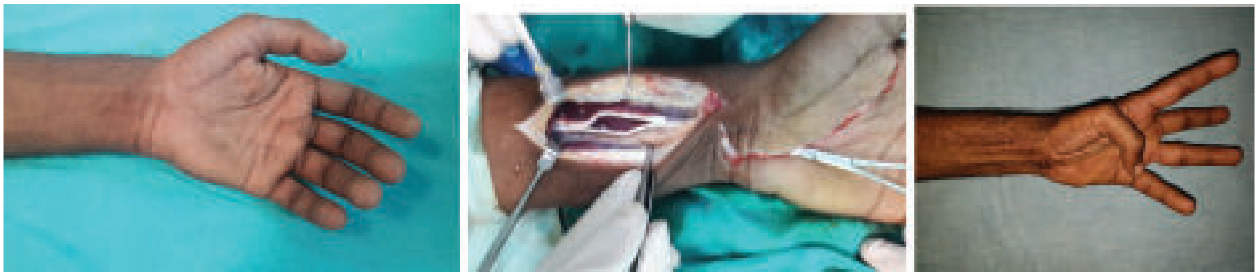
The results of assessment by the Buck- Gramco and ASSH methods are shown in Table 4.

1. Subjective function of the thumb pre- and postoperatively was assessed by the patients on scale of 0 to 10, where 10 is normal and 0 indicates no thumb function possible. These numbers were summarised as excellent (9,10), good (6,7,8), fair (3,4,5) and poor (0,1,2). 2 The final result of overall hand function was assessed by the patient on a scale of 0 (no function) to 10 (normal function). These numbers were summarised as excellent (9,10), good (6,7,8), fair (3,4,5) and poor (0,1,2).

Table IV

Buck- Gramco, ASSH and Subjective assessments:

	Buck-Gramcko assessment (n=30)	ASSH assessment(n=30)	Subjective assessment of function of thumb[1] (n=30	Subjective assessment of overall hand function[2](n=30)
Excellent	10	9	12	11
Good	16	15	15	14
Fair	4	6	3	5
Poor	0	0	0	



25 years old male, 2 and half month old machine cut injury in thumb zone 3. Proximal lengthening and distal advancement was done. At 3 months post op. Full function of FPL was achieved (active IP ROM (0p -80p).

13 yrs. old girl, 3 months old cut injury in zone 2. Interpositional palmaris longus grafting done. At 2 months post op. Active ROM 0p -50p .

The pre to postoperative difference of subjective function of the thumb indicated a mean improvement of 6 points on Visual Analogue Scale (0-10, where 10 is normal). All patients said they would undergo the surgeryagain. No patient undergone re-operation because of complications. 2 (6.66%) patients develop superficial infection which healed by dressing and antibiotics. Rupture rate was 0% in our series. One patient (3.33%) had mild pulley insufficiency, which did not require operative treatment. No patient develops carpal tunnel syndrome and complex regional pain syndrome. 3 (10%) patients developed mild stiffness in the thumb joints which improved on mobilization and physiotherapy but was not totally supple. All patients return to their previous jobs. In subjective assessment 12 (40%) patients were in excellent, 15 (50%) were in good and 3 (10 %) were in fair groups. In Buck-Gramcko assessment, excellent result was found in 10 (33.33%), good in 16 (53.33%) and fair in 4(13.33), but in ASSH assessment excellent was in 9% (30%), good in 15(50%), and fair in 6(20%). No poor result in any assessment. This fair results mostly were in non- compliant patients with poor follow up.

Discussion: For precise function, a mobile IP joint and a working FPL function are necessary. Hume et al studied the functional range of motion of the joints of the hand while performing activities of daily living[32].They found that the range of motion of the IPJ while performing activities of daily living ranged between 2 and 43 degrees, with an average of 18 degrees. Mean active IPJ motion in our series was 45p (35p –75p), which were more than sufficient for activities of daily living.

IPJ fusion had no significant effect on pinch strength measurement[31].As such, reconstruction of FPL function is desirable to restore IPJ flexion and improve pinch strength. A simple IPJ arthrodesis without re-establishing continuity of the tendon will stabilize IPJ but will result in significant loss of pinch strength. Interphalangeal joint arthrodesis alone is not the treatment of choice in patients with a high functional demand of the hands, owing to the decrease in pinch and grip strengths. We did not do any IP joint arthrodesis in our series.

Patients presenting after significant delay, management by doing nothing, particularly if the carpometacarpal (CMC) and metacarpophalangeal (MCP) joints are functioning normally is generally only suggested as suitable for elderly[22]. Even younger-than-elderly when presented late, are also happy with the function of the thumb for their needs and when the option of complicated operation and rehabilitation period is explained as the logical treatment of their problems, have declined any treatment. Doing nothing or a relatively simple procedure of distal fixation (arthrodesis) to prevent hyperextension of IP joint, if causing problem in pinching, is definitely an option to be discussed with all patients[11].

Some degree of movement in IP joint is critical for musician, surgeons, craftsmen, mechanics and electricians, because of difficulties with fine pinch function. The goal of achieving 30p - 40p of IP movement is crucial to provide good function of thumb as stated by previous generation of surgeons[19,20]. We achieved mean active flexion of IP joint 45p (35-75p).

The FPL has a functional amplitude of excursion of 5.5 to 6 cm [24]. If the passive stretch of the muscle fibers, measured at wrist is 3-4 cm, full restoration of function may be expected[21]. Even with 1 to 1.5 cm of passive stretch, result is likely to be adequate. If less than this, Matev (1983) advised using another motor. Although some authors recommended interposition of short segment of graft to bridge the gap [23,25]. Elliot believe that it is more logical in most situation to use long grafts from wrist to distal insertion of FPL (distal phalanx) tendon to avoid suture lines within narrow confines of the digital sheath or the thenar muscles or both. We used longer graft in 4 (13.66%) patients in our series in whom good IP flexion was achieved (35p , mean)

When function of FPL muscle in in doubt or badly damaged on exploration, tendon transfer is needed for thumb function. FDS of ring finger is widely used without supplement by a tendon graft and without need of re-education [23]though other options are there, like FCR, brachioradialis and palmaris longus. We used FDS of ring in 2 (6.66%) and BR in 2 (6.66%)for tendon transfer in 4 (13.33%) cases and results were quiet satisfactory (mean active IP flexion 40p).We did not encounter swan necking and decrease in grip strength in any patients when FDS was used.

Most authors recommend single stage reconstruction of the FPL where suture lines are placed at wrist and distal phalanx and not with in digital tendon sheath and thenar muscles. However, there are circumstances in which two stage reconstruction can be useful or advisable when there is badly scared sheath and/or damage of the pulley or failure of primary surgery or in complex thumb injuries with major loss of palmar soft tissues[27,28].Two recent reports[29,30] of two stage FPL grafting achieved 30p -40p IP motion but there results were disappointing compared to extraordinary results mentioned earlier by Pulvertaft whose average age of patients was 18 years[19].We did not do two stage reconstruction in any of our patient. We did A2 pulley reconstruction in two cases from discarded tendon in one stage reconstruction and results in those cases were satisfactory with mild bowstringing in one case.

We did not encounter any rupture in our series as we used four strands core suture in all our cases. Full free and fast movements of the IP joint are the goal of long-term of FPL surgery and we achieved excellent and good results in 90% of our cases.

Tang[34]described his approach to wide-awake primary flexor tendon repair in which he asked the patient to perform an intraoperative active digital extension-flexion test immediately after the repair. This test is performed to validate the strength of repair and the ability of the patient to tolerate early active digital motion during rehabilitation. This test allows for a postoperative orthosis to be placed in a more neutral position of 20p to 30p at the wrist. Early active motion is combined with passive - active motion on days 3 to 5 after surgery. Active finger flexion is limited to one-third the total ROM during weeks 1 and 2, two-thirds during weeks 3 and 4, and full ROM after week 4. Passive digital motion of 10 to 30 repetitions is performed before active digital motion of 20 to 30 repetitions during each session, at least 5 times daily, for a minimum of 10 to 12 weeks[34]. Our rehabilitation protocol of gentle early active motion is almost similar with this protocol of Tang.

Reports of these advances of increased strands in core repair, resulted in a 0% postoperative rupture rate with early active mobilization in zone T-I and zone T-II repair of FPL[35,33] This compared with approximately 15% rerupture reported earlier by Sirotakova and Elliot[33]after early active mobilization with protocols similar to zone II repairs. Most recent published case series similarly used an adaptation of either early active motion or the Kleinert technique. Elliot and Southgate[36] reviewed several published case series and concluded that either protocol is effective.

Conclusion

Use of 4 strands core sutures and early active motion give good to excellent results in 90% cases of repair, reconstruction and tendon transfer in FPL injuires with 0% rupture rate.

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