

Results of tension band wiring in intra-articular collateral ligament avulsion fractures of the phalanx

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Abstract

Background: Avulsion fractures of the base of proximal phalanx associated with ulnar or radial collateral ligament instability are relatively rare. The small size of the fragment and strong deforming pull of the attached soft tissues make the process of reduction and maintenance difficult.

Objective: The purpose of this study was to assess the functional outcome of tension band wiring in intra-articular avulsion fractures of the base of the proximal phalanx.

Methodology: A prospective study was performed on ten patients with intra-articular collateral ligament avulsion fractures of the proximal phalanx (Jupiter's classification Type III). A tension band construct was performed using a dorsal approach. The functional outcome was assessed at six months with the quick Disability of Arm, Shoulder and Hand score.

Results: The mean age of the patients was 25.8 years (Mean \pm SD: 25.80). Six avulsion fractures were of the ulnar collateral ligament of the proximal phalanx of the index finger, one involved the radial collateral ligament of the ring finger and three, the radial collateral ligament of the little finger suggesting an abduction injury. All fractures had united at three months. Eight patients were graded as excellent and two as good. All patients were satisfied with the surgery and the functional outcome of the injured digit. There were no perioperative complications.

Conclusion: The functional outcome of tension band wiring in intra-articular collateral ligament avulsion fractures of the base of the proximal phalanx was good to excellent.

Key words: Collateral ligament avulsion injury, proximal phalanx, tension band

INTRODUCTION

Intra-articular collateral ligament avulsion fractures are seen most commonly at the attachment of the thumb ulnar collateral ligament (Skier's thumb), followed by the index and little finger¹. Avulsion fractures of the base of the proximal phalanx associated with ulnar or radial collateral ligament instability are relatively rare^{2,3}. They generally occur in the metacarpophalangeal and proximal interphalangeal joints⁴. The mechanism of injury is a forced abduction of the digits often incurred during athletic activities⁵. If the fracture is displaced more than 2 mm, and if around 25% of the joint surface is involved, it should be stabilized with internal fixation⁶. Inadequate reductions can lead to chronic instability, subluxation, deformity, decreased mobility and post-traumatic arthritis.

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The small size of the fragment and strong deforming pull of the attached soft tissues make the process of reduction and maintenance difficult⁷. Many of the described techniques of fixation of these small fragments with their precarious blood supply have inherent problems that may compromise success. Fixation techniques that penetrate the fragment, such as Kirschner wires, compression screw, or pull through wires all risk fragmentation of the avulsed fragment. The additional soft tissue dissection required to accurately place the screw or wires could jeopardise the vascular supply of the fragment⁸. The tension band technique advocated by Jupiter and Sheppard avoids penetration of the fragment⁷. The wire is placed dorsal to the central axis of the bone to function effectively⁹.

The purpose of this study was to assess the functional outcome of tension band wiring in intra-articular collateral ligament avulsion fractures of the phalanges.

METHODOLOGY

A prospective study was performed on adult patients with intra-articular collateral ligament avulsion fractures of the phalanges presenting to our hospital via the outpatient department and emergency room from January 2013 to August 2016. Informed written consent was taken from all patients and ethical approval for the study obtained from the institutional review committee of Kathmandu Medical College.

Adults with closed intra-articular collateral ligament avulsion fractures of the proximal phalanges of the fingers presenting within 2 weeks were included. They were classified by Jupiter's classification⁸ of collateral ligament avulsion fractures and type III was included. Open fractures and comminuted fractures were excluded.

OPERATIVE TECHNIQUE

Radiographs of the affected hand was taken and fractures which were displaced more than 2 mm and involved around 25 percent of the articular surface were included.

These patients underwent fixation under regional anesthesia. A dorsal incision was made over the head of the metacarpal and the base of the proximal phalanx. The adductor tendon aponeurosis was divided at its insertion onto the dorsal extensor tendon expansion. The joint capsule was then incised longitudinally to permit exposure of the fracture, collateral ligament, articular surfaces and palmar plate. The fracture was exposed and the hematoma removed by irrigation and curettage. The soft tissue (extensor tendon) is elevated off the phalanx and a transverse drill hole is made in the phalanx 1 cm distal to the fracture passing through both cortices. A stainless steel wire 26 gauge was passed through the hole. A 20 gauge hypodermic needle was delivered through the ligament adjacent to the avulsed fracture fragment. The wire was then passed as a figure of eight configuration into the drill hole in the proximal phalanx and then inserted into the beveled end of the needle. The needle was then removed and the fragment was reduced and the wire was tensioned. The reduction was assessed by fluoroscopy. A short arm volar slab was applied.

The limb was kept elevated. An intravenous antibiotic was given for 48 hours. Post-operative x-rays were taken, dressings changed after 48 hours and the patient was discharged.

Stitches were removed after two weeks and metacarpophalangeal joint mobilization was started. Weekly hand therapy sessions were commenced starting with early active movements and progressing to passive movements by four weeks. The patients were followed up at 2, 4, 8, 12 and 24 weeks. All patients were followed up for a minimum of six months. The range of motion and stability of metacarpophalangeal joint and grip strength were evaluated. Overall patient satisfaction was rated as excellent, good, fair, or poor. The functional assessment was made at six months using quick Disability of Arm, Shoulder and Hand score (DASH) score¹⁰.

The correlation between the numerical variables (time to surgery, age of the patients and Quick DASH score) was calculated using the Spearman's rank correlation coefficient. The level of significance was set at a level of 0.05. All the calculations were done using the SPSS software version 20.

RESULTS

A total of ten patients underwent open reduction and internal fixation of intra-articular collateral ligament avulsion fractures of the phalanges at our hospital during a period of three and half years from January 2013 to August 2016. Six avulsion fractures were of the ulnar collateral ligament of the proximal phalanx of the index finger, one involved the radial collateral ligament of the ring finger and three involved the radial collateral ligament of the little finger suggesting an abduction injury.

There was one female patient and nine were male. The mean age of the patients was 25.8 years (range: 19-40 years). The left side was involved in three patients and right in seven patients. The mode of injury in four patients was two wheeler accidents, while other four patients fell down and two patients had sports related injuries. The time interval from the injury to surgery was 2.4 days (range: 1-4 days). The post-op hospital stay was 2.8 days (range 2-3 days). Most patients were discharged 48 hours after surgery.

All fractures united in three months. All patients regained full flexion and extension of the metacarpophalangeal joint without any evidence of instability. The average metacarpophalangeal joint flexion was 91° (range: 80°-95°) and average extension of the metacarpophalangeal joint was 5° hyperextension (range: 0°-15°). The average grip strength was 90% compared to that of the uninjured hand. No incidence of infection, tendon adhesion or triggering occurred.

A functional assessment was performed at six months using the quick DASH score. The average quick DASH score was 1.13 (range: 0-4.54). Eight patients were graded as excellent and two as good. All patients were satisfied with the surgery and the functional outcome of the injured digit. There were no perioperative complications.



Figure 1: Pre-operative x-ray showing intra-articular collateral ligament avulsion fracture of the base of the proximal phalanx.



Figure 2: Post-operative X-ray showing fixation with tension band wiring

DISCUSSION

The tension band technique has been frequently used for the treatment of fractures of the patella and olecranon. This technique is based on the biomechanical principle that an eccentrically loaded bone will have compression forces directed on its concave side and distraction (tensile) forces on its convex side¹¹. The initial tightening of this tension wire produces compression at the fracture site. When placed on the tension side of the bone and then physiologically loaded, the tension band will also produce dynamic compression at the fracture site. Thus with this technique, early mobilization proves

beneficial not only for restoration of joint function but also for physiologic enhancement of fracture union⁷.

Other methods of fixation have also been described that involve an interosseous wire or pull out wire encircling the fragment, the fracture fragment is indirectly compressed by tightening the wire or suture against the opposite cortex or soft tissue envelope and not directly compressed at the fracture site⁷. Displacement or rotational mal-alignment can occur and the fixation may not prove secure enough to permit rapid mobilization⁸.

These fractures can be approached through either a dorsal or volar incision depending on fracture location and surgeon preference. A dorsal approach was used in our study. There is support in the literature for either approach¹¹.

The anatomy of the metacarpals and phalanges are such that predominant forces during functional use are tension on the dorsal and compression on the palmar sides. So, one could consider using a tension band technique on the dorsal aspect of the finger¹². Although it can be placed as a simple loop, the figure of eight configuration ensures that the wire is dorsal to the bone and thus functions biomechanically as a tension band wire.

Some authors suggest the use of volar approach for avulsion fracture of the metacarpophalangeal joint because it is a more direct approach to the fracture. However, the use of a volar A1 pulley approach needs a more experienced hand surgeon¹³. Dorsal approach, on the contrary, needs only gentle surgical technique⁴.

The sample sizes of patients with these injuries published in literature is small. In our study also, the sample size was small as the incidence is rare and this is a limitation of our study. Bischoff and Buechler¹² reported that six of their eight patients had excellent results. The other two patients had satisfactory results with pain that did not interfere with their daily activities. All patients achieved full range of motion at the metacarpophalangeal joint. Jupiter and Sheppard⁸ classified these injuries and in their study and concluded that the method of tension band wiring for these avulsion fractures is reproducible and avoids many of the inherent pitfalls associated with other methods of internal fixation.

CONCLUSION

The functional outcome of tension band wiring in intra-articular collateral ligament avulsion fractures of the phalanx was good to excellent. The technique is simple and reproducible.

REFERENCES

1. Ritting AW, Baldwin PC, Rodner CM. Ulnar collateral ligament injury of the thumb metacarpophalangeal joint. *Clin J Sport Med.* 2010 Mar 5; 20(2): 106-12.
2. Ishizuki M, Nakagawa T, Ito S. Hyperextension injuries of the MP joint of the thumb. *J Hand Surg.* 1994 June 1; 19B: 361-7.
3. Sakuma M, Nakamura R, Inoue G, Horii E. Avulsion fracture of the metacarpophalangeal joint of the finger. *J Hand Surg.* 1997 Oct; 22B: 667-71.
4. Bekler H, Gokce A, Beyzadeoglu T. Avulsion fractures from the base of phalanges of the fingers. *Tech Hand Up Extrem Surg.* 2006 Sep 1; 10(3): 157-61.
5. Lattanza LL, Choi PD. Intra-articular injuries of the metacarpophalangeal and carpometacarpal joints. 1st ed. In: Berger RA, Weiss APC, eds. *Hand Surgery*, Philadelphia: Lippincott Williams & Wilkins, 2004: 176-95p.
6. Stern P. Fractures of the metacarpals and phalanges. 4th ed. In: Green DP, Hotchkiss RN, Pederson WC, eds. *Green's operative hand surgery*, New York: Churchill Livingstone, 1999: 711-71p.
7. Kozin SH, Bishop AT. Tension wire fixation of avulsion fractures at the thumb metacarpophalangeal joint. *J Hand Surg.* 1994 Nov; 19A: 1027-31.
8. Jupiter JB, Sheppard JE. Tension wire fixation of avulsion fractures in the hand. *Clin Orthop Relat Res.* 1987 Jan; 214: 113-20.
9. Jones WW. Biomechanics of small bone fixation. *Clin Orthop Relat Res.* 1987 Jan; 214: 11-8.
10. Hudak PL, Amadio PC, Bombardier C. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand). The Upper Extremity Collaborative Group (UECG). *Am J Ind Med.* 1996 Jun; 29(6): 602-8.
11. Greene TL, Noellert CR, Belsole RJ. Treatment of unstable metacarpal and phalangeal fractures with tension band wiring techniques. *Clin Orthop Relat Res.* 1987 Jan; 214: 78-84
12. Bischoff R, Buechler U, Roche RD, Jupiter J. Clinical results of tension band fixation of avulsion fractures of the hand. *J Hand Surg.* 1994 Nov; 19A: 1019-26
13. Kuhn KM, Dao KD, Shin AY. Volar A1 pulley approach for fixation of avulsion fractures of the base of the proximal phalanx. *J Hand Surg.* 2001 Jan 23; 762-71