Original Research Article

Surgical management of Bony mallet finger by delta wire technique - A prospective study

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Abstract

Background: Common treatment method for mallet fractures is Extension-block pinning but it has several pitfalls. Transfixation Kirschner wires may cause iatrogenic nail bed injury, rotation of bone fragment, cartilage damage, or arthritis. The objective of this study was to determine the result of the delta wiring technique in mallet fractures with fracture fragment involving more than one-third of the distal phalanx articular surface. We are reporting 10 cases of mallet fractures treated with delta wiring technique with excellent to good functional and radiologic outcomes evaluated on the basis of postoperative and follow-up x-rays and functional outcomes were evaluated using Crawford's criteria. Ten patients (8 males, 2 females) with a mean age of 30 years (ranging from 20 to 33 years) were included. The mean time between the injury and surgery was 7 days (ranging from 3 to 15 days), and the mean follow-up period was 8 months (range, 6 to 10 months). Radiographic bone union was achieved in all patients within an average of 6.4 weeks (range, 6 to 7 weeks). At the final follow-up, the distal interphalangeal joint had an average degree of flexion of 74 degrees (ranging from 70 to 75 degrees) and an average extension deficit of 3.5(ranging from 0 to 8 degrees). According to Crawford's criteria, 6 patient had excellent results and 4 patients had good results. No patient reported pain at the final follow-up with a visual analog scale score mean of 0.5 (range, 0 to 2). Satisfactory clinical and radiologic outcomes were obtained with the delta wiring technique. However future prospective and randomized studies are justified to confirm the efficacy of this technique.

Key Words: extension-block pinning, bony mallet finger, delta wire fixation, transfixation pin.

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INTRODUCTION

A mallet fracture is the damage to the terminal extensor mechanism due to avulsion of extensor tendon. Most commonly, only the tendon is avulsed and in a smaller subset of these injuries involves distal phalanx base bony avulsion Such which result from forced flexion of the extended distal interphalangeal (DIP) joint most of the time.[1] Treatment of mallet finger injuries includes nonoperative and operative management, the optimal treatment continues to be a subject of debate.[2–5] However, surgery is usually advocated when the dorsal fragment involves more than one-third of the articular surface or when there is volar subluxation.[6–8] Main surgical options are Kirschner wire fixation,[9] tension band wiring,[7] micro screws,[10] pull-out wire fixation,[11] small external fixator,[2] or extension-block fixation.[8,13–16] Ishiguro *et al.*[13] reported the extension-block pinning technique methods for mallet fractures but is associated with several complications. Transfixation Kirschner wires used to fix the DIP joint may cause iatrogenic nail bed injury, rotation of bone fragment, and cartilage damage that might cause arthritis. Furthermore, the need for prolonged immobilization may cause flexion contracture of the DIP joint.[12] Technique demonstrated here is a simple and minimally invasive delta wiring technique reported by Kim *et al.*,[17] for the management of mallet fractures, which not only helps in early joint motion and also providing strong compression force on the fracture fragment continuously.

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INCLUSION AND EXCLUSION CRITERIA

The Inclusion Criteria

1. Patients with bony mallet fractures involving the distal phalanx articular surface
2. Patient who had given written, informed consent.

The Exclusion Criteria

1. Patients presented with >4weeks after trauma
2. Open injuries.

TECHNIQUE

The procedure was conducted on day care basis under digital block with fluoroscopic guidance. The appropriate reduction is confirmed on a lateral x-ray with slight flexion with suspension. 18 gauge needle is used percutaneously to reduce the fragment to the fracture bed as shown in the picture below. The needle helps to maintain reduction by sustained gentle pressure against fracture fragment. 0.8 mm Kirschner wire is passed through the needle which pierces the articular fracture fragment which is progressed further into the distal phalanx to exit from volar aspect. A hook is made on the dorsal end of Kirschner wire and advance the Kirschner wire through the distal phalanx with counterforce. Cut the Kirschner wire saving 2-cm length at the palmar end which is now come out from the skin of palmar side penetrated through the fracture fragment, distal phalanx and make another hook. Insert another Kirschner wire 1 mm along the long axis of distal phalanx intramedullary. Make an acute angle and another hook leaving 5 mm of distance from previous Kirschner wire. Hang the 2 hooks so that intramedullary Kirschner wire with the hook will create tension in initial Kirschner wire and this tension will convert to compression force on the fracture site and that will further decrease the risk of reduction loss. After this step just confirm the reduction under fluoroscopy in both DIP passive flexion and extension and apply a dressing over them to prevent further injury (Fig. 2 A-I), allowing the DIP joint to have free movement. The patients were discharged on the day of surgery and advised to return for weekly review. the Kirschner wires were removed after Clinical and radiologic conformation of union around 6-8 weeks. For removal first step is to untie the hook, then axial intramedullary wire pulled out easily, the first wire was just pushed back slight dorsally, and the hook was cut, then from the palmar side the first wire pulled out. Lateral and AP X Rays were taken immediately after fixation and weekly for first month and every fortnight in second month. Immediately after the surgery, active range of motion exercises was initiated. Clinical and radiographic evaluations were conducted in all cases. Fracture union was defined as the x-ray presence of bridging trabeculae and the absence of any radiolucent line at the fracture gap. Functional outcomes were evaluated using Crawford's criteria. Radiographic bone union was achieved in all patients within an average of 6.4 weeks (range, 6 to 7 weeks). At the final follow-up, the distal interphalangeal joint had an average degree of flexion of 74 degrees (ranging from 70 to 75 degrees) and an average extension deficit of 3.5(ranging from 0 to 8 degrees). According to Crawford's criteria, 6 patient had excellent results and 4 patients had good results. No patient reported pain at the final follow-up with a visual analog scale score mean of 0.5 (range, 0 to 2). The active range of motion and extension lag of the DIP joint was measured with a goniometer. Full flexion was considered as achieved when the angle of the injured side reached that of the opposite side at follow-up. Functional outcomes were evaluated using Crawford's criteria (Table 1).[18]

RESULTS

Ten patients (8 males, 2 females) with a mean age of 30 years (ranging from 20 to 33 years) were included. The mean time between the injury and surgery was 7 days (ranging from 3 to 15days), and the mean follow-up period was 8 months (range, 6 to 10 months). Radiographic bone union was achieved in all patients within an average of 6.4 weeks (range, 6 to 7 weeks). At the final follow-up, the distal interphalangeal joint had an average degree of flexion of 74 degrees (ranging from 70 to 75 degrees) and an average extension deficit of 3.5(ranging from 0 to 8 degrees). According to Crawford's criteria, 6 patient had excellent results and 4 patients had good results. No patient reported pain at the final follow-up with a visual analog scale score mean of 0.5 (range, 0 to 2). Miranda *et al.*[23] described a simple technique to improve intraoperative bony mallet reduction and avoid complications, such as articular cartilage damage, nail bed damage, and dorsal skin necrosis. They used a blunt needle as a joystick to reduce the bony fragment of a stab incision. After reduction was achieved, a dorsal splint was applied holding the DIP joint in 15 to 30 degree extension. They achieved and maintained satisfactory reduction, and reported their technique as a less-invasive management option for bony mallet fractures. Criticism of this technique focused on the difficulty of maintaining the reduction of the unstable fragment with the dorsal splint alone because of the strong extensor tendon pulling force on the bony fragment. Patients who have rotational deformity may benefit from direct reduction techniques and more rigid fixation. Closed reduction by extension-block Kirschner wire fixation and also by delta wiring is a relative contraindication in bony mallet fractures older than 5 weeks. The reduction may not be achieved because of early collagen formation or fibrous tissue that prevents closed reduction in these fractures.[13] Open reduction to restore the congruity of the articular

surface is indicated in such cases.[14] Pegoli *et al.*[8] used percutaneous curettage with an Ishiguro extension-block Kirschner wire technique to treat mallet fracture cases older than 5 weeks. All the patients in this study were treated in the early period with the latest presentation at 3 days after trauma. Patients with open injuries were also excluded from our study. This study has several limitations. Of note, we only included a small sample that was limited to patients with mallet fractures involving more than one- third distal phalanx articular surface. Further research will be essential to assess the efficacy of this approach with fracture fragments that involve less than one-third of the articular surface. Finally, the follow-up period is also too short to observe long-term adverse outcomes.

Figure 1: Pre-operative X Rays

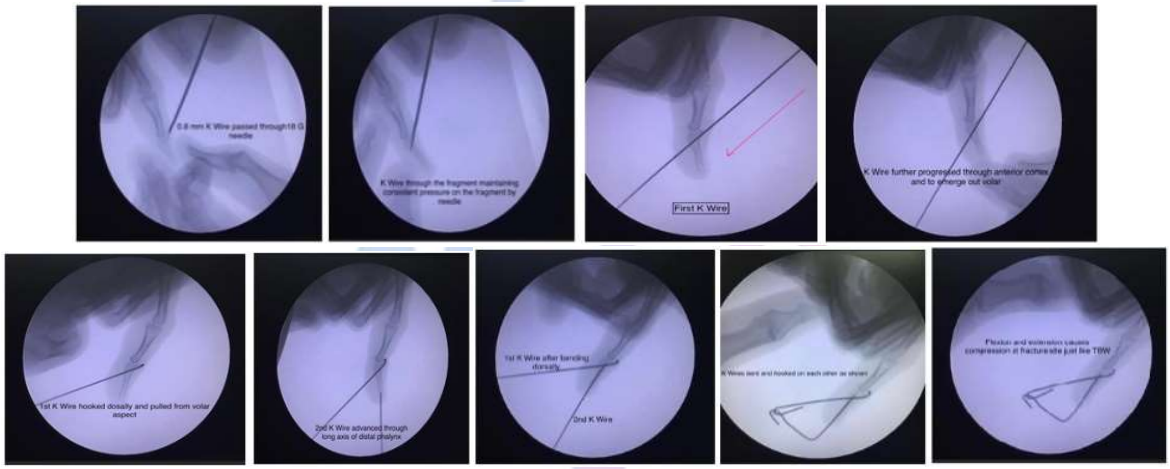

Figure 2: Steps involved in the technique of delta wire fixation

Figure 3: Per operative pictures

Figure 4: Post-operative X Ray

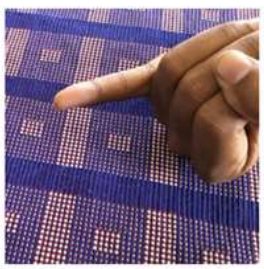

Figure 5: Follow up at 3 months

DISCUSSION

There is a range of potential treatments that are considered appropriate.[14] in the treatment of mallet finger injuries; Ishiguro *et al.*[13] first described extension-block pinning as a simple and reliable method, and it has since become one of the most popular methods of treating mallet fingers. Most of these techniques involve the use of Kirschner wire fixation across the DIP joint, despite awareness that it is difficult to insert a temporary transfixation pin through the DIP joint. Potential disadvantages associated with repeated attempts during insertion include articular cartilage damage that can lead to secondary osteoarthritis, especially if >1 attempt during pin insertion is needed and iatrogenic nail bed injury. However, the present technique described[17] did not require that a transfixation pin be inserted through the joint, which reasonably be expected to decrease the risk of secondary arthritis. Indeed, we observed no complications like nail deformity, volar subluxation, or DIP joint osteoarthritis in any case during the 8.6-month

mean follow-up period. The early union has previously been reported in 5 to 7 weeks with extension-block fixation[13,15,16] and the results of this study compared favorably. Miura2 described a modified version of the extension-block fixation method that was designed to achieve accurate reduction, and stable fixation by controlling the dorsal rotation of the fragment with an external fixator. Twelve acute mallet fractures were treated with this method and not only were all united after an average of 5 ± 1 weeks, but there were no arthritic changes after an average follow-up of 4 months. However, that design required a bulky fixator and a DIP joint splint for an average of 6 weeks. It also required increased surgical time, increased radiation exposure, and a second surgical procedure to remove the fixator. We achieved comparable results with a less-invasive method

Crawford Criteria for the Assessment of Mallet Finger outcome

Table 1

Grade	Characteristics of DIP Joint
Excellent	Full extension
	Full flexion
	No pain
Good	Extension deficit 0-10 degrees
	Full flexion
	No pain
Fair	Extension deficit 10-25 degrees
	Any flexion loss
	No pain
Poor	Extension deficit >25 degrees
	Persistent pain

CONCLUSIONS

In conclusion, the technique followed here reduces the risks of iatrogenic chondral injury, joint degeneration, and nail bed injury, and fracture displacement because of continuous compression on the fracture fragment unlike other methods. Delta wiring technique may, therefore, be a useful alternative method for the treatment of mallet fractures, benefiting from being less invasive and easy to perform, and without damaging key anatomic structures.

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