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Original Article

A modified internal suture technique for treatment of the tendinous mallet finger

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Abstract: Objectives: We herein described a modified internal suture technique for the treatment of tendinous mallet finger. Material and Methods: From February 2013 to December 2015, 11 mallet fingers treated by the modified suture technique were included in this retrospective study. Of these patients, 8 were men and 3 were women. The ring finger was the most commonly injured digit (5 cases), followed by the middle (3 cases), little (2 cases), and index (one case) finger. The follow-up period ranged between 4 and 25 months (mean: 14.9 months). Results: During the final follow-up period, patients had a mean extensor lag of 5.5 degrees (range, 0 to 10 degrees) and a mean flexion of 64 degrees (range, 50 to 80 degrees) at the DIP joint. Using Crawford's criteria, 5 digits were graded as excellent, 6 as good. Neither the pin tract infections nor the skin compressive ulcers occurred. Conclusions: The modified internal suture with transarticular Kirschner wire fixation technique provided an accurate anatomical fixation and acceptable treatment modality for the treatment of tendinous mallet finger deformities.

Keywords: Tendinous mallet finger, modified internal suture, anatomical fixation, treatment modality

Introduction

Mallet finger is a flexion deformity of the distal interphalangeal (DIP) joint that results from disruption of the extensor tendon [1]. Typically, this injury is caused due to work or domestic-related tasks and sports activities, wherein the force ranges from a relatively minor trauma to more forceful events [2, 3]. The injury results either as an isolated soft-tissue avulsion or a bony fracture with an extension lag. For tendinous mallet injuries (i.e., those without any attachment at the terminal extensor tendon), conservative splinting is the first choice for many hand surgeons [4]. The methods used for immobilizing the DIP joint in extension include premade plastic splints, custom-molded thermoplastic splints, or aluminum padded splints. However, complications such as self-limited superficial wounds [5], dorsal skin maceration [6], chronic stiffness [7], or prolonged healing process [8] are generating controversies to a certain extent. Hence, this study aimed to present a modification of the internal suture technique for the repair of soft tissue mallet injuries during the early postoperative period.

Materials and methods

A retrospective review of the medical records of patients diagnosed with mallet finger (without bony injury) was performed. This study was approved by the institutional review board, and informed consent was obtained from all participants. From February 2013 to December 2015, 11 patients with mallet finger of tendinous deformity were treated by a modification of the internal suture technique with transarticular K-wire fixation. Patients with no limitation in passive motion of the DIP and proximal interphalangeal joints and no swan-neck deformity were enrolled in this study. Splinting was treated in the elderly patients who did not wish to have surgery, and those who did not require fine manipulative skills in their work. Radiographs were taken for all patients with affected finger and the range of active movement of the distal joint was measured with a finger goniometer. The Crawford's evaluation criteria were used to assess the outcome (**Table 1**).

Surgical technique

The procedure was performed under a brachial plexus block and/or local anesthesia, with digit

Table 1. Crawford's Evaluation Criteria (1984)

Grade	Description
Excellent	Full DIP joint extension, full flexion, no pain
Good	0-10 degrees of extension deficit, full flexion, no pain
Fair	10-25 degrees of extension deficit, any flexion loss, no pain
Poor	More than 25 degrees of extension deficit, or persistent pain

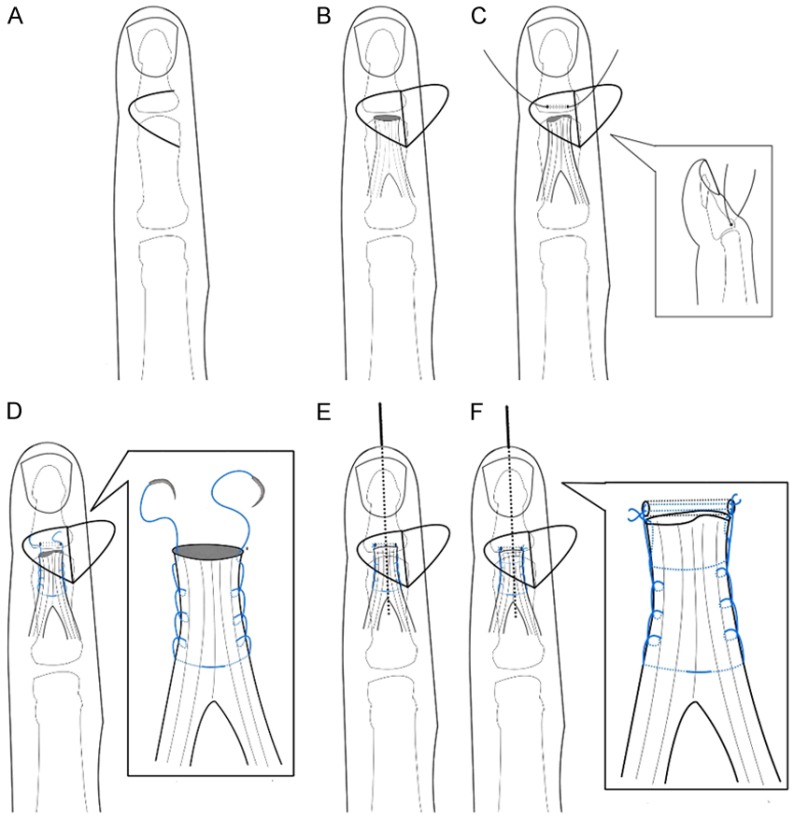

Figure 1. Diagram showing the operative technique procedure of the modified internal suture.

tourniquet and radiographic control. A C-shaped incision was made over the dorsal aspect of the DIP joint. A skin flap was elevated to expose the terminal extensor mechanism. Approximately 2 mm proximal to the DIP joint, a drill hole was made on the base of the distal phalanx that is transversely 2 mm below the terminal extensor tendon insertion point by a 0.8-mm K-wire under fluoroscopy guidance. A 0.8-mm wire was then inserted through the hole to confirm the achievement of an accurate bone tunnel (**Figure 1C**). After that, a Krackow suture with 5-0 Prolene RB-2 needles was passed from the extensor tendon in a modified manner, as one needle was straightened through the hole (**Figure 1D**). Before tying a knot, a 1.0-mm K-wire was advanced longitudinally from the tip of the finger into the middle phalanx to hold the DIP joint in slight extension. The straightened needle was sutured as a loop between the tendon and the bone tunnel in a horizontal position (**Figure 1F**). This was done to verify that the sutures were lying firmly and accurately on the tendon insertion point of the DIP. Intraoperative radiographs were then obtained to confirm the successful wire positioning. Finally, the dorsal skin incision was then closed primarily with 5-0 Prolene stitches (**Figure 2**).

The patients returned to our clinic 2 weeks after the surgery for removal of stitches. Flexion and extension exercises of the proximal interphalangeal and metacarpophalangeal joints were not restricted after surgery, and the K-wire was generally removed at four weeks postoperation. Passive and active DIP joint exercises were encouraged after wire removal.

Results

There were 11 patients, including 8 men and 3 women, with a mean age of 35.8 years (range, 20-56 years). The mean delay between surgery and injury was 6.5 days (range, 1-20 days). Postoperatively, the follow-up period ranged between 4 and 25 months (mean: 14.9 months). Most of the injuries occurred during the industrial and daily sports activities. The ring finger was the most commonly injured digit (5 cases), followed by the little finger (2 cases), middle (3 cases), and index (one case). During the final follow-up, patients had a mean extensor lag of 5.5 degrees (range, 0 to 10 degrees) and a mean flexion value of 64 degrees (range, 50-80 degrees) at the DIP joint (**Figure 3**). The range of motion of the proximal interphalangeal

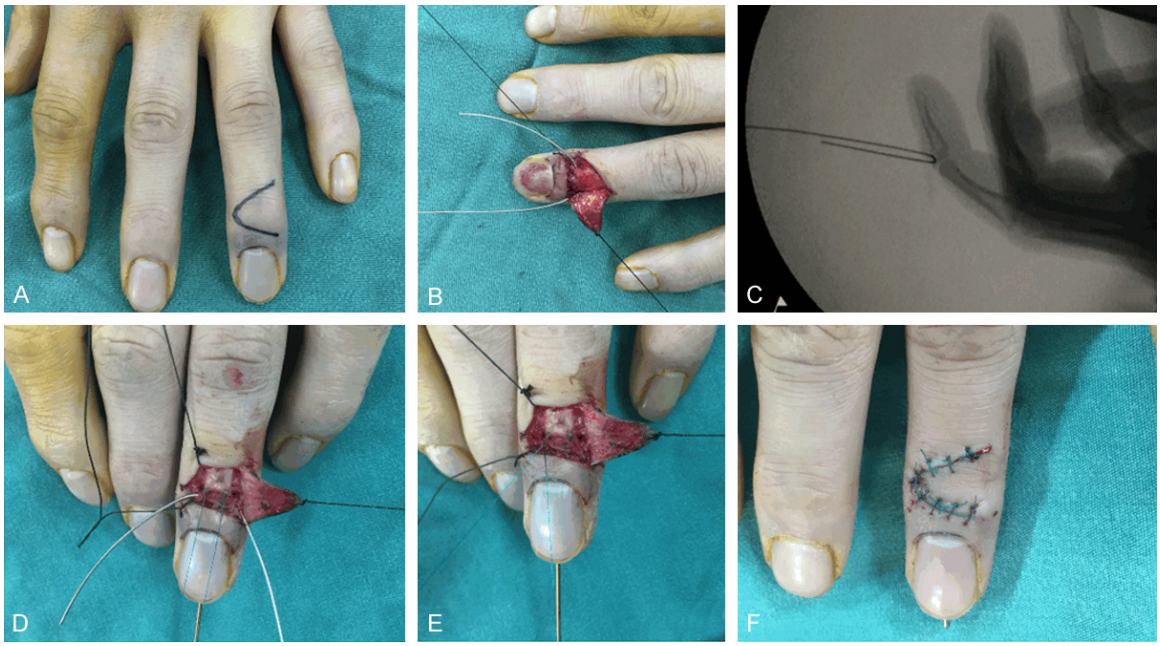

Figure 2. Case 1. A. The C-shaped incision was made over the dorsal aspect of the DIP joint. B and C. A 0.8-mm wire was inserted through the hole to confirm that it is accurately placed in the bone tunnel. D. The modified Krackow suture with 5-0 Prolene RB-2 needles was passed from the extensor tendon. E. Before tying a knot, a 1.0-mm K-wire was advanced longitudinally from the tip of the finger into the middle phalanx to hold the DIP joint in slight extension. F. The dorsal skin incision was then closed primarily with 5-0 Prolene stitches.

Figure 3. Case 1. A. Preoperative view of the patient with tendinous mallet finger deformity. B and C. Photographic view taken at 4 months postoperatively.

and metacarpophalangeal joints of the injured digits was normal in all patients (**Table 2**). All mallet fingers showed excellent to good results. According to the Crawford's criteria, 5 digits were graded as excellent and the remaining 6 were graded as good. Almost all patients had satisfactory outcomes and there were no flap necrosis, subjective pain, infections or nail deformities (**Figure 4**).

Discussion

Soft-tissue mallet fingers are avulsions of terminal extensor tendon from the base of the distal phalanx without a bony fragment [9]. These injuries might be easily overlooked at first examination, and immediately after trauma, resulting in chronic deformities. Generally, soft-tissue mallet injuries, as well as small avulsion fractures including less than one-third of the articular surface are treated by an uninterrupted splint with an extension or by slight hyperextension of the distal interphalangeal joint (DIPJ). However, it is worth pointing out that when the diagnosis of mallet finger is made and the finger is treated correctly by splinting in the extension, premature removal of the splint also results in chronic mallet finger that can develop aesthetic and/or functional complications as extension deficits or swan-neck deformities.

Table 2. Patient Data and Outcomes

Case	Sex	Age (y)	Mechanism of Injury	Affected Finger	Time Since Injury (d)	Follow-up (mo)	Postoperative Outcome Based on Crawford Criteria (Extensor lag/Range of Active Flexion)	Complicatioms
1	M	35	Industrial	Left ring	7	12	Excellent (full extension/70 degrees)	-
2	F	28	Daily	Right middle	3	19	Excellent (full extension/80 degrees)	-
3	M	50	Fighting	Right little	5	15	Good (10 degrees/55 degrees)	-
4	M	48	Industrial	Right index	12	18	Good (10 degrees/50 degrees)	-
5	F	30	Sprain	Left middle	6	13	Good (10 degrees/60 degrees)	-
6	M	25	Basketball	Right ring	1	16	Excellent (full extension/70 degrees)	-
7	M	55	Daily	Left ring	20	25	Excellent (full extension/70 degrees)	-
8	M	20	Basketball	Left middle	2	4	Excellent (full extension/60 degrees)	-
9	F	36	Industrial	Right ring	3	14	Excellent (full extension/65 degrees)	-
10	M	41	Industrial	Right index	8	21	Good (10 degrees/65 degrees)	-
11	M	26	Industrial	Left little	5	7	Good (10 degrees/60 degrees)	-

F, female; M, male.

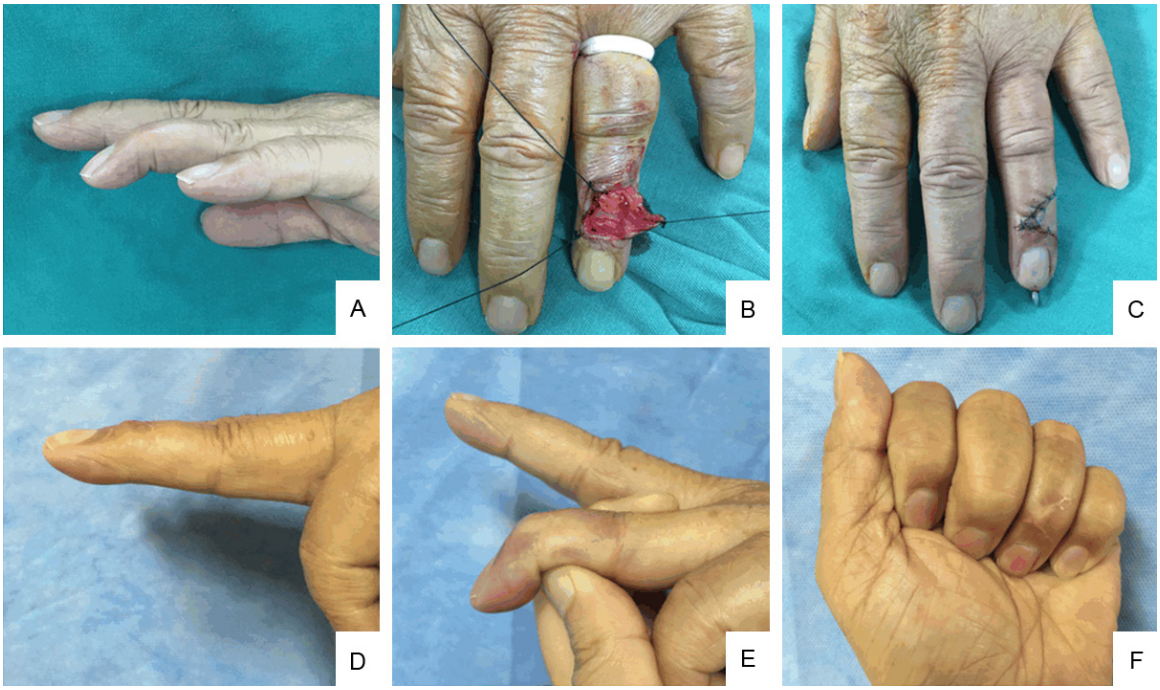

Figure 4. Case 7. A and B. Preoperative view of the patient with mallet finger deformity of tendinous origin. C. Closure of the dorsal skin incision. D-F. Postoperative view at 13 months, showing the range of DIP joint motion.

Many splint variations and surgical techniques have been reported over the past decades, but the optimal treatment for mallet finger injury still remains to be controversial. No therapeutic consensus exists. Although studies have shown that soft-tissue mallet finger can be managed without surgery [10-12], surgery was advocated when reduction is not possible. The surgical procedures, such as scar excision and end-to-end tenorrhaphy [13], central slip tenotomy [14, 15], tenodermodesis [16], suture technique [17-19], the use of a micro arc bone anchor [20], deepithelialised pedicled skin flap technique [21], tenodesis with palmaris longus tendon [22] have been reported. Nakamura K [23] et al advocated surgery to be a better option than conservative therapy for treating fresh mallet fingers in fine manual dexterity. Jiang B [19] et al reported that 15 patients used a modified internal suture technique for the treatment of tendinous mallet finger deformity but had only one fair result. In our study, the modified

method also achieved satisfactory treatment outcomes along with surgical reduction.

Splints hold the affected distal interphalangeal joint in slight hyperextension for 6 to 8 weeks, followed by 2 to 4 weeks of nighttime splinting, ensuring effective apposition of the ruptured terminal extensor tendon [11, 24]. So, it is necessary for full-time immobilization to successfully treat these injuries with splinting. Patients may be unable to comply with a splinting regimen. As surgery tends to promote extension contracture, most of the surgeons started exercising the distal interphalangeal joint at 3 weeks after the operation. In contrast, most of the scholars recommend immobilization for a minimum of 6 weeks of conservative therapy. The fixation in this study was 3 weeks for young patients and 4 weeks for the elderly. Depending on the location and strength of the fixation material, the mobilization strategy varied from direct immobilization after surgery to complete mobilization for a 6-week period.

Both non-operatively and operatively treated mallet fingers were reported to have complications related to the treatment methods [25]. Complications of splinting include dorsal ulceration, skin maceration and nail deformities such as a transverse groove in the fingernail, as reported in 45% of patients in a study. In addition, high complication rates, ranging from 59 to 70 percent, has been reported with closed treatments [3, 5].

The surgical technique that we presented in this study used a modified Krackow suture that was passed through the bone tunnel on the base of the distal phalanx. In our series, accurate and stable terminal tendon-bone relationship was achieved under direct vision. As long as the knot was tightly bound, the pull-in suture cannot be loosened. This modified suture was utilized to restore anatomical relationship, providing a greater contact area with a stronger fixation. So, there was no requirement for an external button, which remains an inconvenient and prone to infection method, resulting in increased patient comfort and decreased complications. In our cases, no severe complications, such as skin necrosis or subjective pain, were observed. The results showed that all patients achieved a satisfactory treatment outcome with a mean extensor lag of 5.5 degrees and a mean active DIPJ flexion of 64 degrees. This modification appeared to be more functional and reliable than the original method.

However, there were some limitations to our study. Firstly, during the study period, other methods were not used and so no comparison between techniques could be made. Secondly, this study included only a small sample size and has an average follow-up time of 14.9 months, which is very short. Further studies with larger sample size should be performed. Thirdly, it is technically demanding to drill a bone hole on the dorsal of the distal phalanx.

In conclusion, this modified internal suture technique is effective in providing an accurate anatomical fixation and acceptable treatment modality for the treatment of tendinous mallet fingers. Although it technically demands drilling, the modified method seems to be a stronger alternative with successful treatment outcomes and high patient satisfaction.

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