Acute Arthrodesis of Interphalangeal Joints of the Hand in Traumatic Injuries

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Abstract

Background Trauma resulting in severe comminution, bone loss, and articular involvement of the fingers is a challenging injury. Osteosynthesis of the digits is nonviable when there is an inability to restore a stable articular surface adequately. Acute arthrodesis of the proximal and distal interphalangeal joints may be an option in such scenarios. The aim of this study is to evaluate the role of finger joint arthrodesis in the setting of trauma, in terms of fusion rates and clinical outcomes.

Materials and Methods Patients with injuries treated via acute finger arthrodesis between 2010 and 2012 at a single institution were retrospectively reviewed. Complete finger amputations requiring replantation were excluded. Finger arthrodesis was performed acutely via intraosseous cerclage wires, Kirschner wires, or tension band wiring. Fusion rates were determined by plain radiography, and clinical outcomes were assessed with the Disabilities of the Arm, Shoulder and Hand (DASH) score.

Results A total of 11 patients were recruited. All patients were males with an average age of 35.3 years (range: 21–63 years). None of the cases involved the thumb, and there was an equal distribution of injury amongst the fingers. Nine of the 11 patients involved the distal interphalangeal joint with the remaining involving the proximal interphalangeal joint. Radiologic union was achieved in 9 out of 11 patients, and the average time to fusion was 75.5 days. The average DASH score for the patients was 16.5 (10.8–22.5). All patients were able to return to their premorbid occupation, with average time to return to work of 104.3 days (59–168 days). There were no cases of infection or reoperation.

Keywords

- acute arthrodesis
- hand injury
- interphalangeal joints

Conclusion We propose that posttraumatic acute arthrodesis of the finger joints is a viable treatment in situations in which there is difficulty in restoring the articular congruity, with early return to work and good function.

Introduction

Finger fractures are common injuries that encompass a broad spectrum of severity. Surgical fixation is indicated in unstable fracture patterns to restore optimal finger function.¹ In fractures associated with adjacent soft tissue injury, inadequate skin cover, significant bone loss, and severe joint surface comminution, achieving a satisfactory result with surgical fixation can be challenging.²

Arthrodesis is well established as a salvage procedure in the elective setting.^{3,4} However, there is a paucity of literature evaluating its usage in acute trauma. When faced with complex and unstable fractures of the finger, a viable alternative may be acute arthrodesis of the small joints of the hand. The aim of this study is to describe our experience with acute small joint arthrodesis of the hand in acute trauma.

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Materials and Methods

This was a retrospective study. Patients who presented between January 2010 and December 2012 with traumatic hand injuries and were treated with acute small joint arthrodeses were recruited. The recruited patients were consecutive patients from a single institution. The exclusion criteria included patients who underwent digital replantation and/or critical revascularization procedures.

Essential clinical information, including clinical data and operative details, was obtained from patient case records. Relevant radiographs were available digitally and used to determine fusion. Clinical outcomes were assessed via physical examination consisting of range of motion (ROM) measurement, as well as patient disability assessment utilizing the validated Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire.

Surgical Technique

All surgeries were performed at a single institution. The surgical technique of choice for performing the arthrodesis was based on surgeon preference. Three surgeons performed the surgeries, and following four different methods of arthrodesis were performed in our series:

1. Cross Kirschner wire (K-wire) technique.
 - 1.0 mm K-wires are passed through the joint in a crossed fashion.
2. Lister's technique.⁵
 - The technique described by Lister involves passing a 26G cerclage wire through the metaphyseal bones on either side of the intended joint for fusion in the sagittal plane, followed by an antirotation wire through that joint.
3. Zimmerman and Weiland technique⁶ 90–90 intraosseous fixation.
 - This technique is similar to that of Lister's but involves passing two cerclage wires in the sagittal and coronal planes.
4. Single screw fixation⁷ (1.5 mm).
 - This technique involves the placement of a single AO lag screw, proximal to distal in a lateral oblique fashion. This allows sufficient proximal bone for screw purchase.

All patients underwent hand therapy postoperatively and were allowed active movement of the involved digits within the first week. Except for K-wires, no implant removal was performed on any of the patients.

Results

A total of 11 patients were included in the study (►Table 1). All the patients were male, and the average age was 35.3 years (range: 21–63 years). Nine of the 11 injuries occurred in the nondominant hand. The predominant mechanism of injury was machinery-related accident. There was relatively equal distribution among the fingers, with none of the cases involving the thumb. Nine of the 11 injuries involved the distal interphalangeal joint (DIPJ), with the remaining two involving the proximal interphalangeal joint (PIPJ). All cases involved severe intra-articular comminution (►Table 2). There was injury of adjacent soft tissues, such as the neurovascular bundle and tendon lacerations, in almost all the cases (10 out of 11). Concomitant injuries to other digits occurred in six patients.

The most common surgical technique used for fusion was a cross K-wire technique (one proximal interphalangeal joint [PIPJ] and five distal interphalangeal joint [DIPJ]). Lister's technique for arthrodesis was used in three cases utilizing a 1.0-mm K-wire and 26G intraosseous cerclage wire (two PIPJ and one DIPJ) (►Fig. 1). In one patient, a 24G cerclage wire was used across the DIPJ in a 90–90 intraosseous fashion to achieve fixation (►Fig. 2). The remaining case was performed with a single oblique 1.5-mm screw across the DIPJ (►Fig. 3A, B).

Patients were followed up for an average of 244.6 days (59–536 days) after surgery. Radiologic union was achieved in

Table 1 Distribution of finger injuries

Patient	Age (y)	Dominant hand	Hand involved	Mechanism	Finger involved	Joint involved
1	21	Right	Left	Crush injury (tow bar)	Ring finger	DIPJ
2	63	Right	Right	Road traffic accident	Little finger	PIPJ
3	51	Right	Right	Crush injury (door)	Little finger	DIPJ
4	24	Right	Left	Machinery (wood saw)	Ring finger	PIPJ
5	57	Right	Left	Road traffic accident	Ring finger	PIPJ
6	21	Right	Left	Machinery (metal cutter)	Index finger	DIPJ
7	22	Right	Left	Road traffic accident	Middle finger	DIPJ
8	27	Right	Left	Machinery (metal cutter)	Little finger	DIPJ
9	27	Right	Left	Machinery (metal cutter)	Index finger	DIPJ
10	32	Right	Left	Machinery (metal molding)	Middle finger	DIPJ
11	43	Left	Right	Machinery (metal cutter)	Index finger	DIPJ

Abbreviations: DIPJ, distal interphalangeal joint; PIPJ, proximal interphalangeal joint.

Table 2 Distribution of surgical procedures

Patient	Osseous involvement	Adjacent soft tissue involvement	Presence of concomitant injuries to other digits	Method of fixation
1	P2 condyle comminution	Ulnar NVB Extensor and flexor tendons	No	Lister's technique
2	P2 base comminution	Nil	Yes	Lister's technique
3	P3 base comminution	FDP insertion	Yes	Oblique screw
4	P1 condyle and P2 base comminution	Radial NVB Extensor tendon	Yes	K-wire
5	P1 condyle comminution	Extensor tendon	Yes	Lister's technique
6	P3 base comminution	Extensor tendon	No	K-wire
7	P2 condyle comminution	Radial NVB Extensor tendon	Yes	90–90 cerclage
8	P2 condyle and P3 base comminution	Extensor tendon	Yes	K-wire
9	P3 base comminution	Extensor tendon	No	K-wire
10	P2 condyle comminution	Extensor tendon	No	K-wire
11	P3 base comminution	Radial NVB	No	K-wire

Abbreviations: FDP, flexor digitorum profundus; NVB, neurovascular bundle.

9 out of 11 patients, with the average duration to fusion in these 9 patients being 75.5 days (55–108 days). In two patients, radiologic union was not achieved prior to return to work, and the two patients subsequently defaulted follow-up (one PIPJ, one DIPJ). The residual ROM at the joints that underwent nonunion was 20 degrees. Despite the nonunion, there was minimal complaint of pain at the nonunion site by both patients; the clinical DASH scores were 13.3 and 15.8, respectively (►Table 3). It is likely that the extensive soft tissue trauma and devascularization resulted in the nonunion despite the presence of stable fixation. For future cases, the authors would consider early bone grafting with revision fixation.

All patients achieved good ROM at the metacarpophalangeal joints (MCPJs), with an average of 91.4 degrees (range:

70–100 degrees). All eight cases of DIPJ fusion also showed good ROM at the PIPJ, with an average of 93.8 degrees (range: 70–100 degrees). In one of the patients, the length of the K-wire used to arthrodesis the PIPJ was too long and resulted in DIPJ immobilization, and subsequent ankylosis. This patient had a final DASH score of 17.5, with an MCPJ ROM of 100 degrees. There were no cases of infection or complex regional pain syndrome (CRPS).

The average DASH score for the patients was 16.5 (10.8–22.5). In terms of return to work, all patients were able to return to their premorbid occupation, with the average

Fig. 1 Anteroposterior and oblique radiographs showing Lister's technique for ring finger proximal interphalangeal joint arthrodesis.

Fig. 2 Anteroposterior and lateral radiographs showing 90–90 cerclage wiring for ring finger distal interphalangeal joint arthrodesis.

Fig. 3 (A) Anteroposterior and lateral radiographs showing a comminuted, intra-articular fracture involving the right little finger distal interphalangeal joint. (B) Anteroposterior and lateral radiographs showing the single oblique screw method for little finger distal interphalangeal joint arthrodesis.

duration of 104.3 days (59–168 days). Almost half of our patients were involved in manual labor.

Discussion

Optimal surgical fixation of comminuted intra-articular fractures of the digits with both bone and joint surface comminution is challenging.² Though anatomical reduction of the joint with early ROM is ideal, this may not always be possible. In a series by Duteille et al, only 56% of patients achieved anatomical articular restoration.⁸ Even if a satisfactory reduction is achieved, the fixation may not be rigid enough to allow early mobilization.^{9,10} As such, it is critical for the surgeon to have an alternative surgical treatment strategy when faced with challenging fractures of the finger.

Stern et al proposed arthrodesis of the small joints of the hand when there were gross instability, deficient bone stock, and inadequate soft tissues for coverage.¹¹ In our approach to the management of similar injuries, we adopt the same philosophy. In traumatic digital injuries, when there is significant bone loss, coupled with significant articular surface loss, there is difficulty in stabilizing the osseous injury with a satisfactory joint. Free vascularized joint transfer and arthroplasty options are not ideal for the typical patient who presents with such an injury—a manual laborer who requires to return to work early and is expected to continue with activities involving power grip.¹² In such cases, we consider acute arthrodesis of the interphalangeal joints, particularly if there is significant soft tissue loss, where shortening and arthrodesis can overcome the need for multiple soft tissue

Table 3 Distribution of results of finger arthrodesis

Patient	Days to fusion	MCPJ ROM	PIPJ ROM	DIPJ ROM	Days to work	DASH scores
1	81	0–90	0–100	Fused	150	16.7
2	87	0–100	Fused	0	101	17.5
3	108	0–100	0–90	Fused	73	11.7
4	93	0–90	Fused	0–30	168	12.5
5	Nonunion	0–90	20–40 Attempted arthrodesis	20–40	61	13.3
6	Nonunion	0–100	0–100	0–20 Attempted arthrodesis	65	15.8
7	61	0–70	0–100	Fused	158	20
8	55	0–85	0–100	Fused	150	22.5
9	59	0–90	0–90	Fused	59	10.8
10	73	0–90	0–70	Fused	132	19.2
11	63	0–100	0–100	Fused	90	21.7

Abbreviations: DASH, Disabilities of the Arm, Shoulder and Hand; DIPJ, distal interphalangeal joint; MCPJ, metacarpophalangeal joint; PIPJ, proximal interphalangeal joint; ROM, range of motion.

reconstruction, especially digital nerves, tendons, ligaments, and skin.

There are several documented techniques to achieve fusion in the interphalangeal joints. The essential components of arthrodesis involve surface preparation and fixation. Surface preparation may be achieved via the “cup and cone” method or via flat surface osteotomies.¹³ Fixation, however, may be attained by an array of techniques, such as screws and plating, K wiring, and intraosseous wiring.

Interphalangeal joint fusion in acute traumatic situations requires two considerations:

- As there is significant devascularization from the trauma, further exposure of bone for the purpose of fusion may not be ideal. Therefore, instead of fusion with plates, we prefer methods that require minimal further preparation of bone surface. Commonly, we use Zimmerman and Weiland technique of 90–90 cerclage wiring, Lister's technique, and K wiring.
- The angle of fusion is often dependent on the digit and the joint involved. There are however, specific considerations in acute trauma. Depending on the amount of bone loss, varying degrees of shortening may be required before fusion. The greater the shortening, the more acute the angle of fusion has to be—resulting in a less flexed fusion angle—this allows the digit to grasp objects of bigger diameter and allows easier opposition.

In this series, all the patients were able to return to their preinjury occupations, including the manual laborers, who made up the majority of the patient population. While manual laborers returned to work, on average, later than nonlaborers, this is confounded by the fact that their injuries were often more extensive and affected other digits. In addition, the nature of their work is also a confounding factor.

Disadvantages of performing acute arthrodesis in traumatic situations include potentially increased shortening of digit prior to fusion and a lost opportunity for delayed arthroplasty. If fusion is performed as a delayed procedure after achieving bony healing of fractures, the final length of the digit can be potentially greater as more bone stock is available at point of fusion. Though this lengthens rehabilitation period and delays return to work, one key consideration when we perform acute arthrodesis is to be confident that acute arthrodesis will not result in significantly shorter digit than if delayed arthrodesis was to be done. We also ensure that arthroplasty is a relative contraindication—mainly for the purpose of needing power grip—before proceeding with acute arthrodesis. In patients who require significant interphalangeal joint flexion for their occupations, such as musicians, arthrodesis may also not be an ideal choice. Though ROM requirements greatly differ between types of instruments, arthroplasty is more advantageous than arthrodesis in preserving some ROM for musicians.¹⁴

Limitations of this study included its retrospective study design with a small sample size, and no direct comparison

of the various fusion techniques. However, almost all our patients achieved a good clinical outcome. As such, we have found that acute finger arthrodesis after trauma is a simple and reliable method of surgical management.

In conclusion, acute arthrodesis of the finger joints is a possible treatment modality when dealing with complex finger fractures. It is particularly effective in patients in whom early return to work is important and arthroplasty is not ideal. Surgeons who do not routinely perform complex surgical fixations of the finger may find arthrodesis a technically less challenging surgery.

Note

The ethical review committee statement was obtained for this study.

Conflict of Interest

None.

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