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Simple low cost static external fixators for phalangeal fractures of hand

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Abstract

Introduction: Fractures of phalanges are the most common fractures with Incidence of 2.9% every year. They are more common in the young to middle-aged males. The phalangeal fractures are usually considered as simple injuries. Such kind of injuries may results into deformity, if not addressed properly at beginning. Phalangeal fractures with unacceptable angulation and rotations in any plane require operative fixation. There are numbers of external fixators which are versatile in the designs but needs thorough expertise to use. We describe a simple, low cost, 'easy to construct and easy to use' external fixator which can be used for a variety of hand fractures, particularly in an emergency setting as well as definitive fixation.

Method: There were 27 patients with different types of fracture of phalanges of hand in our study. Among them 19 male and 8 female patients [mean age -31.85 yrs]. There were 7 open fractures and 20 closed fractures. Out of 27 patients, 15 had fractures of proximal phalanx & 12 patients had fracture of middle phalanx. Our technique is to treat with k wire and plastic cap of spinal needle cap as a static external fixator device. One patient with tendon injury and one with skin loss which was treated by plastic surgical intervention.

Result: At the end of 3 months of follow up, range of movements and TAM score out of 27 patients 19 had an excellent result (range 220-260), 5 patients had a good result (range 180-219) and 3 with fair result (range 130-179).

Conclusion: This technique is simple, low cost, reproducible, easy applicability in the management of fractures involving the small bones of the fingers where complex fixators are not available or costly or needed expertise. Complex Unstable fractures can be converted into stable fractures by this robust and reproducible method. We recommend this simple, low cost, 'easy to construct and easy to use' fixator in the management of fractures involving the small bones of the fingers.

Keywords: Phalanges fractures, low cost external fixator

Introduction

Fractures of phalanges are the most common fractures of the upper extremity and account for 10% of total such cases [1]. Incidence of phalangeal fractures is almost 2.9% every year [2]. They are more common in the young to middle-aged males [3]. The phalangeal fractures are usually considered as simple injuries. Such kind of injuries may results into deformity, if not addressed properly at beginning.

Phalangeal fractures with unacceptable angulation and rotations in any plane require operative fixation [4].

The aim of operative intervention involves restoration of articular congruity, length and correction of rotations. This stable bony construct will expedite early mobilization to prevent adhesions and improves functional outcome.

There are numbers of external fixators which are versatile in the designs but needs thorough expertise to use [5].

But limitations to use these kind of fixators is high expense and unavailability [6].

We describe a simple, low cost, 'easy to construct and easy to use' external fixator which can be used for a variety of hand fractures, particularly in an emergency setting as well as definitive fixation.

Material and methodology

In our study 27 patients with different type of fracture of phalanx of hand were included. There were 19 male and 8 female patients [Mean age -31.85 yrs]. There were 7 open fractures and 20 closed fractures. out of which 15 involved proximal phalanges and 12 involved middle phalnges.

There were involvement of thumb in 2 patients, index finger in 10 patients, middlefinger in 5 patients, ring finger in 6 patients, little finger in 4 patients.

According to our study the mode of injury were road traffic accident in 15 patients, domestic/trivial fall in 8 patients and industrial trauma in 4 patients. One patient with tendon injury and one patient with skin loss which were treated by plastic surgical intervention.

All patients were treated with k wire and plastic cap of used spinal needle (sterilized with ETO) as a static external fixator device.

This fixator construct requires 1.6 mm Kirschner wires (K-wires), a plastic cap of spinal needle. After regional anesthesia mostly ring block sometimes augmented with wrist block if multiple phalanges in single patient, fracture of respective phalanx is assessed and reduction achieved by closed methods with aid of image intensifier. In case of any open wounds we used to give thorough wound wash and initial debridement prior to fixation.



Two parallel bicortical 1.6 mm K-wires are introduced into the either fragment of the fractured phalanx. With the help of gentle traction over these k wires; optimum length of fractured phalanx is achieved. Then bicortical K-wires inserted into the either fragment parallel to previous k-wires are inserted from plastic tube which usually aid to correct rotational malalignment and angulation. K wires used to passed in safe zone region of phalanges to avoid any tendon or ligament entrapment or neurovascular injury. Image intensifier guidance helps to achieve a decent position within fragment.

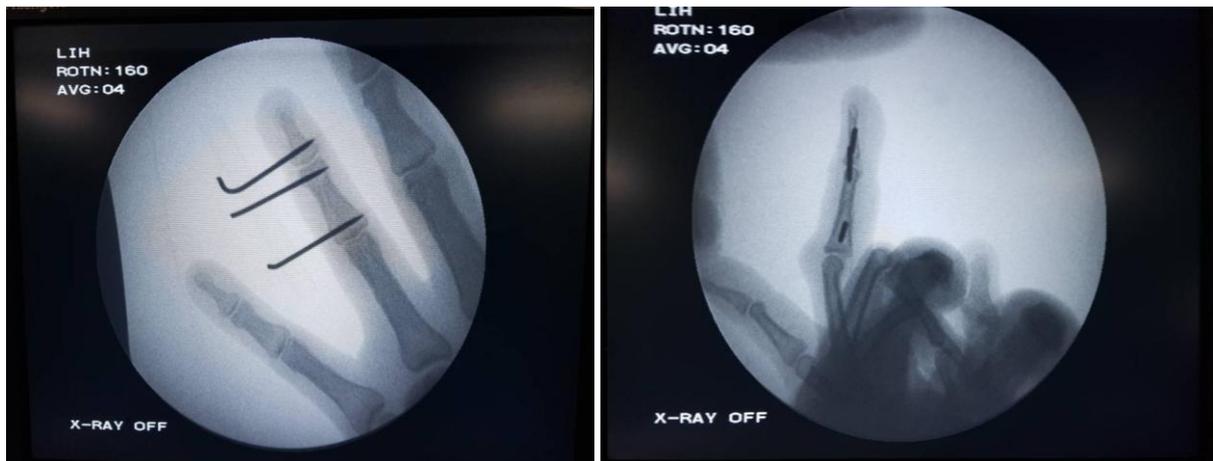


Fig 2: image intensifier image shows final reduction with spinal needle cap external fixator in both plane; ap and lateral respectively.

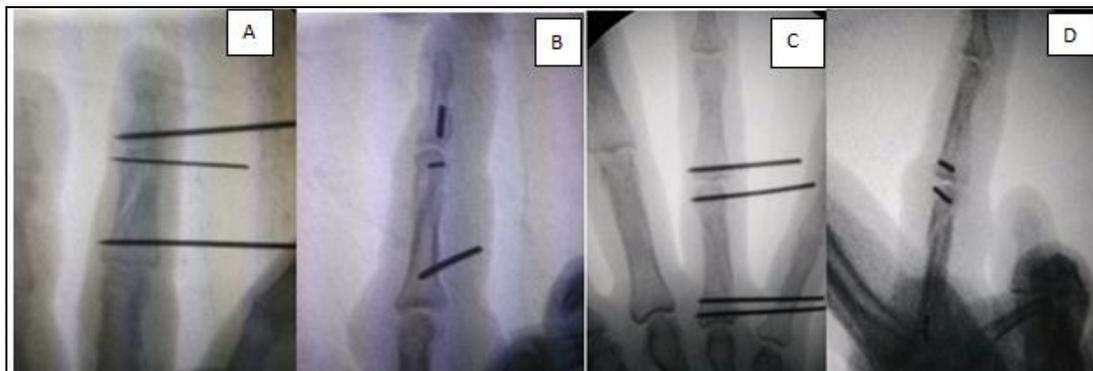


Fig 3 a to d: (a, b) fixation construct showing placement of wires in middle and distal phalanx portion anteroposterior and lateral image respectively. (c, d)fixation construct showing placement of k wires through proximal fragment and distal fragment with joint spanning to confer stability to construct.

Ideally it is advisable to put all the K-wires in the same sagittal plane after correcting finger rotation. When the K-wires are used to fix a single fractured bone (phalanx), it allows for early mobilization of adjacent joints. According to fracture anatomy and maintenance of reduction decision made

to span adjacent joints over fixator construct. In some phalangeal fractures with butterfly fragment, k wire is used to transfix that fragment from plastic tube along with primary construct.

The required length of tube is cut with scissors. The plastic tube is then placed beside the finger after final reduction of the fractured phalanx. The locations of inserted pins are marked over plastic tube. These points on the plastic tube are later predrilled with 1 mm k wire.

These openings can be widened easily to accommodate the minor variations in angles at which the four K-wires lie in the sagittal plane. The K-wires are passed through these holes in the tube and the tube is lowered giving adequate clearance from the skin.



Fig 4: clinical picture showing fixator placed for proximal phalanx fracture.

As an alternative method, the plastic tube can be kept parallel to the finger along the desired plane of insertion of K- wires. The K-wires can then be drilled directly through the tube into

the underlying bone.

Gauze dressings are placed over the finger and around the pin sites. The protruding end of the K-wires can be cut flush with the tube with pointed pincers which usually covered with cut adhesive plaster. This prevents damage from sharp points on the fixator construct.

Active finger and wrist movements were encouraged following surgery immediately. In closed fracture a single shot parenteral antibiotics, while in compound fracture 3 days intravenous antibiotics.

The patients were reviewed every 2 weeks for the first 1 months, and then monthly for next 6 months. Repeat radiographs were taken at 4 weeks post-surgery to look for fracture healing and after confirmation of the same, external hardware was removed. The patients were encouraged for active finger movements. Range of movements (ROM) were noted on every visit.

Results

Details are given in the table. 27 patients with mode of injury, site of fracture, fracture anatomy, open or close, need of any additional treatment, range of movement, TAM score and functional outcome according to Duncan *et al.*

Table 1: Total Active Movement (TAM) according to Duncan *et al.* [15]

Finger	Thumb	Result
220to260	119to140	Excellent
180to219	98to118	Good
130to179	70to97	Fair
< 130	< 70	Poor

Table 2: Patients Data and Outcome

Age sex and serial no:	Pain	Deformity	Active rom at mp	Active rom at pip	Active rom at dip	Extension lag at pip	Tam score	Functional outcome
1)32/M	No	No	90	90	80	0	260	Excellent
2)39/M	No	No	85	90	80	0	255	Excellent
3)26/F	No	No	90	85	75	5	250	Excellent
4)50/M	No	No	80	90	75	0	245	Excellent
5)44/M	No	No	85	85	80	0	250	Excellent
6)50/M	Present	Minimal	70	60	75	20	205	Good
7)27/M	No	No	90	90	75	0	255	Excellent
8)35/F	No	No	90	95	75	0	260	Excellent
9)28/M	Present	Minimal	90	85	80	20	255	Good
10)43/M	No	No	85	80	80	0	245	Excellent
11)28/M	No	No	90	80	80	0	250	Excellent
12)29/M	No	Minimal	80	60	60	30	170	Fair
13)13/F	No	No	90	80	40	10	180	Good
14)42/F	No	No	90	95	80	0	265	Excellent
15)9/M	No	No	90	95	80	0	265	Excellent
16)37/M	Present	No	85	90	75	0	250	Excellent
17)25/M	No	No	90	85	80	0	255	Excellent
18)48/M	No	No	75	60	60	10	205	Good
19)12/M	Present	Minimal	75	60	60	20	175	Fair
20)19/F	No	No	90	80	80	0	250	Excellent
21)50/M	No	No	95	75	75	0	245	Excellent
22)23/M	No	No	90	90	80	0	260	Excellent
23)25/M	Present	Minimal	90	85	80	0	255	Excellent
24)36/F	No	No	75	70	55	30	170	Fair
25)31/F	No	No	70	65	70	10	205	Good
26)37/F	No	Minimal	80	70	75	0	225	Excellent
27)22/M	No	No	90	80	80	0	250	Excellent

At the end of 3 month of follow up of the range of movement and TAM score out of 27 patients 19 had an excellent result. All the patients are able to continue their routine work daily

without any difficulty. 5 patients had a good result and 3 with fair result.



Fig 5: Pre Op X-Ray



Fig 6: Post Op- Xray

Fig 7: 3 Month Follow Up



Fig 8: 3 Month post operative clinical movements

Case 1: Spiral fracture of proximal phalanx of index finger



Fig 9: Pre op x-ray



Fig 10: Post Op- Xray



Fig 11: 3 Month Follow Up

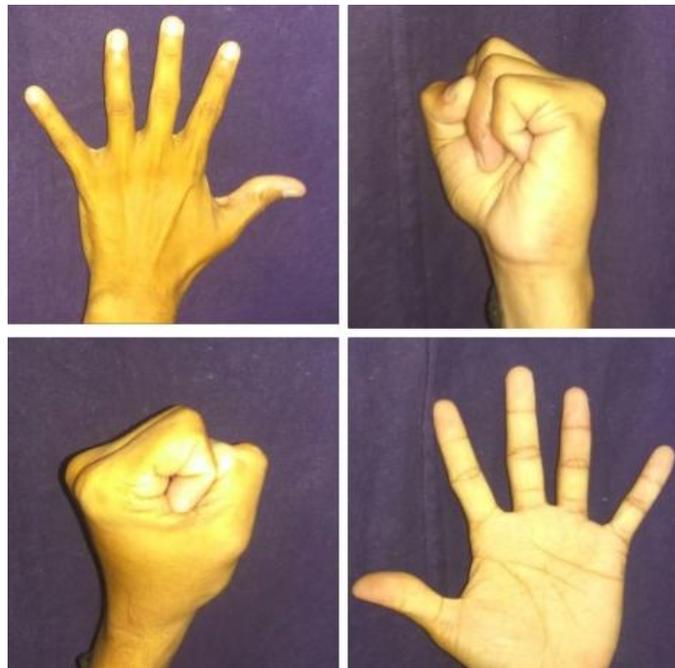


Fig 12: 3 month post operative clinical movements

Case 2: Spiral fracture of middle phalanx

Discussion

Fractures of phalanges are usually common and minor injuries, are often fail to attend [7]. Most phalangeal fractures are treated conservatively, but some form of fixation is often indicated in unstable pattern of fractures, intra-articular fractures and open fractures [3, 4, 8, 9]. Therefore these Patients require operative intervention to achieve the optimal position for bone healing and to allow early mobilisation.

Displaced fractures in spite of proper reduction show a marked tendency to instability and angulation. The natural support provided by the muscles to the shaft of long bones is lacking in the short bones of the hand [10]. The fractured fragments are greatly influenced by the pull of tendons [5]. Ligamentotaxis principle is basis of distractor fixators to obtain alignment and length [11].

Application of routinely used external fixator available commercially is practically demanding and their radio-opacity causes hindrance to plain x-rays [11].

To counteract these inadequacy, the surgeons readily modified handmade external fixators [12].

The technique of external fixation using K-wires bonded with methyl methacrylate resin was first described by Crockett in 1974 [13]. These early fixators lost popularity as they were cumbersome and not ideal for hand fracture treatment.

McCulley and Hasting [14] described the use of the plastic sheath of an intravenous cannula as a crossbar to hold K-wires in place. However, the length of the sheath was inadequate and often the sheath slipped over the smooth K-wires to about the skin, often losing fracture reduction [14].

We have described fixators which oversee these deficiencies. The K-wire with spinal needle cap has sufficient length and resilience to act as a connecting shaft for multiple K-wires.

It is made up of soft plastic and therefore can be easily perforated at designated points to accommodate the K-wires. It is simple to construct with basic orthopaedic experience and all the materials required for this fixator are readily available in most operative room.

Advantages of our fixator

1. Radioloucent: gives good lateral view, unlike many

commercially available fixators.

2. This fixator can be easily removed in the out patient department, often without the need for a digital block anesthesia.
3. Less bulky and light weight with Preservation of biology
4. Cost effective
5. Patient can be advised ROM exercise and routine activity with care after fixation.
6. Although this fixator can be used in various other fractures like metacarpal and metatarsal with phalangeal fractures of foot, nonetheless its application should be based on the accepted principles in the management of hand fractures.

Thomas RK *et al.* [11] and Jafari D *et al.* [12] utilized cement for construct rigidity which may incur additional cost, in our study we did not use any kind of bone cements though we did not face later loss of reduction and loosening of construct.

In our studies we did not encountered with any kind of sufficient pin loosening or fracture displacement, pin tract infection and sequestration. There were no case of re-fixation surgery. one patient with tendon injury and other one with skin loss which was treated by plastic surgical intervention. one patients with fair outcome did not follow physiotherapy regime.

Table 3: Functional outcome of different studies compared with our study

Outcome	Drenth <i>et al</i> 1998 [16]	Parsons <i>et al</i> 1992 [17]	Jafari D and Ajvadi A 2016 [12]	Our study
Excellent	35%	14%	78.6%	70%
Good	35%	71%	12.5%	19%
Fair	10%	-	7.1%	11%
Poor	10%	15%	-	-

In many complex articular fracture of fingers which require mini-open reduction, this distractor fixator can be used as definitive fixation.

Conclusions

Early mobilization with stable fixation is the key to good clinical outcome. Complex Unstable fractures can be converted into stable fractures by this robust and reproducible method. Most phalangeal fractures can be treated successfully with various available current modalities. We recommend this simple, low cost, 'easy to construct and easy to use' fixator in the management of fractures involving the small bones of the fingers where complex fixators are not available readily and are technically demanding.

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