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A cheaper external fixator for phalynx fractures of hand - functional outcome study

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ABSTRACT

Background: Phalynx fractures account for 2.9% of fractures and are most commonly associated with machinery injuries in middle and young-aged individuals. Many external fixators are used for the fixation of phalanges with complexity which are costly. In this study, we used a cheap, easy fixator to construct and can be used as an emergency or definitive fixation. **Aims and Objectives:** The aim of the study was to evaluate the functional outcome after using a cheaper external fixator for phalynx fractures in place of costly mini external fixators for fixation which is used normally. **Materials and Methods:** We had done this study on 28 patients with phalangeal fractures, mostly due to machinery injuries which are open injuries (22 patients), with male predominance (20). The mean age group in our study was 34.89 years. The most common phalynx involved was the middle phalynx of the ring finger (11 cases). We made a fixator with syringe caps and K-wires as fixators. **Results:** Total active motion score used to assess the functional outcome after 3 months of follow-up and serial X-rays for assessing union. At the end of 3 months, 22 patients (78.5%) had shown excellent results, two patients (7.1%) had fair results, three (10.7%) had good results, and one patient (3.5%) had poor results. **Conclusion:** We suggest this fixator as this is cheap and easy to reconstruct with the instruments commonly available in OT. This fixator gives similar results to complex high-end fixators as compared to previous studies. This needs less expertise and training and is cost-effective for the patient.

Key words: Cheaper; Fixator; Fracture; Hand; Phalynx

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INTRODUCTION

Comminuted and complex fractures of phalanges and metacarpals are the most common machinery injuries seen in trauma and casualty near industrial areas and workplaces needing heavy machinery due to accidental injuries. They have an incidence of 10% among upper limb fractures and constitute 2.9% of all fractures.[1] They are usually associated with intra-articular extension and are mostly open fractures with tendon or vascular injuries.

They pose a great challenge to treat as they are complicated and a malunion in an unacceptable position can cause a decrease in the livelihood income of the patient and also a deformed joint. The principle of our treatment includes restoration of the articular surface and regaining range of motion around these small joints.

Operative intervention is done to restore the articular congruity and length and to correct rotational deformities in phalynx. This construct proposed by our study will help in early mobilization to prevent adhesions and improves the functional outcome. At present, there are many external fixators used to treat these open fractures ranging from uniplanar to biplanar fixators which help in the early mobilization of the fingers and get a proper articular congruity.

Commercial external fixators are expensive but versatile and they need expert skills in their application.[2,3] Many innovative, new, and improvised external fixators have

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previously been described and used to treat these complex hand fractures.[4-6]

In this study, we presented the cheapest and most affordable way to treat these complex fractures with a simple construct fixator that can be used as an emergency and a definitive fixation for phalangeal fractures that may be open or closed.

Review of literature

Fixation of phalangeal fractures with external fixators is not a new concept in the fixation of phalanges. This method dates back to centuries when they used these to treat open fractures of fingers.

The technique of external fixator uses for phalangeal fractures with K-wires and methyl methacrylate (MMA) resin was first described by Crockett in 1974.[7] These fixators were obsolete as they are complicated to apply and look heavy for fractures of hand treatment.

McCulley and Hasting[8] had used a plastic sheath of an intravenous (IV) cannula as a support to hold K-wires to maintain distraction. However, the length of the sheath was inadequate which led to a slippage of smooth K-wires, often losing fracture reduction.

Jafari et al.,[9] utilized cement in place of MMA resin for construct rigidity which made up for additional cost, in our study, we did not use any bone cement even though the loss of reduction and/or loosening of the construct was not reported in our study.

Tank and Patel[10] had done a study with a spinal needle cap as a uniplanar unilateral fixator for phalangeal fractures, measuring range of movements (ROM), and total active motion (TAM) score which showed 19 out of 27 patients in the study an excellent result (range 220–260), five patients had a good result (range 180–219), and three had fair result (range 130–179)".

We had described this new innovative fixator which helps out of these deficiencies. Using K-wire with a needle cap, which has sufficient length and strength, acts as a connecting raft for K-wires and prevents displacement of fragments. It is made up of plastic which can be easily punctured or drilled with K-wire at points required as per fracture reduction. This fixator is simple to construct, needs less experience, and the materials required for this fixator are usually available in our operation theatre room.

Aims and objectives

To use the regular instruments available in OT complex to make a cheap external fixator for phalynx fractures in hand and assess their functional result with costly external fixators in use.

MATERIALS AND METHODS

This study was conducted at Maheshwara Medical College and Hospital and NRI institute of medical sciences from April 2019 to December 2021 after getting an ethics review by the Institutional Ethical Committee for the study, with patients who presented to outpatient department with fracture of phalanges. They were advised for pre-operative investigations and after tests, the patient is planned for surgery.

All the patients selected for this study were treated with K-wires and a plastic protective cap of syringes of 10cc syringe or 5cc based on the phalangeal length as a static external fixator device with uniplanar fixation. This fixator requires 1.5 mm or 1.2 mm Kirschner wires (K-wires), 2 plastic caps of syringe needle mostly of 10cc syringe. After regional anesthesia (ring block) sometimes along with wrist block for patients with multiple phalanges involvement. Fractures were assessed and reduction was brought by closed methods using an image intensifier (C-arm). Thorough wound wash and debridement was done in open fractures before using this fixator along with any tendon repairs.

Two parallel 1.5 mm K-wires are passed into the proximal and distal phalanges in relation to the fractured phalynx. Gentle traction is applied after passing K-wires to achieve an optimum length of the fractured phalanx. K-wires are passed in the zone of phalanges where tendon or ligament or neurovascular injury is avoided. Reduction is checked under C arm guidance after fixator application.

The measured amount of plastic tube is cut with a surgical blade if it is found to be excess. The plastic syringe tubes are then placed along the finger on both sides after reduction of the fractured phalynx and K-wire fixation. Locations of pins are marked on the plastic tube, which is predrilled with 1.5 mm k wire and is widened to accommodate changes in angles at which K-wires lie in the sagittal plane. The K-wires are then passed through the holes in the tube and a distance is maintained between tube and skin for allowing postoperative dressing and also to prevent pressure wounds over the sides of the finger.

In an alternate method, the plastic tube is kept parallel to the finger on both sides and K-wires are drilled through the tube into the bone and further. The K-wires are drilled

directly through the tube into the underlying bone in some cases where there is an expected change in rotation or in cases that can cause angulation of fracture fragments. Bactisafe gauge dressings are applied over wounds and also pin sites. The protruding end of the K-wires is cut and adhesive plaster is applied to cover protruding K-wires to prevent damage from sharp points of K-wires in the fixator construct (Figure 1).

Active finger and wrist range of motion exercises are started after surgery with minimal dressing. A single IV antibiotic was given in closed fractures, in compound fractures, 3 days of IV antibiotics were given. The patients were reviewed after 2 weeks for suture removal then after 1 month, and then monthly for the next 3 months.

X-rays were taken 4 weeks after surgery to see fracture healing, after confirming callus presence, the fixator was removed. These patients were encouraged to do active finger movements during the post-operative period and also after fixator removal. ROM of interphalangeal joints was noted along with TAM score in every visit to assess the functional improvement (Figure 2).

RESULTS

We had done this study on phalangeal fractures in 28 patients among which 20 were male and eight were female. The mean age in our study was 34.8 years with a range from 19 years to 59 years with a Standard Deviation (S.D) of 9.7.

Among these patient's major cause of the trauma is Machinery injury, that is, among 28 patients 22 were from machinery injury among which open injuries were found in 17 cases with Grade III A injury for 14 patients and Grade II injury for three patients.

Among the patient fracture of middle phalynx (20 cases) was predominant followed by proximal phalynx (4) and distal phalynx (4). Most of the patients usually had involvement of the ring finger (14 cases) index finger (6), middle finger (4), little finger (3), and thumb (1).

After fixator application, we were about to get an approximation of skin in most of the cases and in three cases we had used collagen dressing with skin grafting for the injury. TAM score was used to assess functional outcome which was measured at the end of 3 months based on Duncan et al., (Table 1).[11]

This had shown a mean of 232.3 and S.D of 32.3. According to this scale, the outcome in our study was

Figure 1: Instruments used during surgery and steps in using this fixator showing tendon repair over the fixator

Figure 2: Post-operative functional outcome and X-ray for above case

Table 1: Duncan et al., functional outcome according to TAM score

Finger	Thumb	Result
220–260	119–140	Excellent
180–219	98–118	Good
130–179	70–97	Fair
<130	<70	Poor

TAM: Total active motion

excellent in 22 patients (78.5%) and fair in two patients (7.1%), good in three patients (10.7%), and poor in one patient (3.5%) (Figures 3 and 4). The tabulation of results is given in the Table 2.

DISCUSSION

The fixator we had described in this study prevents soft-tissue contracture while giving time for the wounds to heal, and to plan for definitive fixation if needed. However, in most situations, this fixator can be used as definitive management of fractures. This effective, easy-to-construct fixator is recommended in the management of fractures involving phalanges of the fingers when commercial external fixators are not available or when

Table 2: Tabulation of results of our study

S. No.	Age/ sex	Deformity	Pain	Active ROM MP	Active ROM PIP	Active ROM DIP	Extensor Lag	TAM score	Functional outcome	Phalynx involved	Finger involved	Open (o)/ Closed (c)
1	29/M	No	Nil	90	80	80	0	250	Excellent	Middle	Ring	O
2	35/M	No	Nil	85	85	75	0	245	Excellent	Middle	Ring	O
3	32/M	No	Nil	90	70	65	10	215	Good	Middle	Index	C
4	48/M	Mild	Nil	90	85	70	0	245	Excellent	Middle	Ring	C
5	54/M	No	Nil	90	80	75	0	245	Excellent	Middle	Ring	O
6	22/M	Mild	Nil	85	90	70	0	245	Excellent	Distal	Index	C
7	28/M	No	Nil	90	80	80	10	240	Excellent	Middle	Middle	O
8	19/F	No	Nil	80	85	80	0	245	Excellent	Proximal	Little	C
9	22/M	No	Nil	65	65	60	20	170	Fair	Middle	Index	O
10	27/M	No	Present	90	90	70	20	230	Excellent	Distal	Ring	O
11	25/F	No	Nil	75	60	60	20	175	Fair	Middle	Middle	C
12	32/M	No	Nil	90	75	85	0	250	Excellent	Middle	Index	O
13	35/M	No	Nil	90	80	80	0	250	Excellent	Middle	Thumb	O
14	42/M	No	Nil	90	90	80	0	260	Excellent	Distal	Ring	O
15	49/M	No	Nil	85	85	85	0	255	Excellent	Middle	Little	C
16	42/F	No	Nil	80	80	75	0	235	Excellent	Middle	Ring	C
17	44/F	No	Nil	85	90	75	0	250	Excellent	Middle	Index	O
18	29/M	No	Nil	60	45	30	15	120	Poor	Distal	Ring	O
19	32/M	No	Nil	90	85	80	10	245	Excellent	Middle	Ring	C
20	30/F	Mild	Present	85	75	75	0	235	Excellent	Middle	Index	C
21	32/M	Mild	Nil	80	80	75	0	235	Excellent	Middle	Ring	O
22	59/M	No	Nil	80	85	90	10	245	Excellent	Proximal	Little	O
23	45/M	No	Nil	90	80	90	0	260	Excellent	Middle	Ring	C
24	28/F	No	Nil	70	75	60	15	190	Good	Proximal	Middle	O
25	36/M	No	Nil	90	85	90	0	265	Excellent	Middle	Ring	O
26	34/F	No	Nil	85	80	90	0	255	Excellent	Middle	Ring	C
27	35/M	Mild	Present	75	65	75	0	215	Good	Proximal	Middle	O
28	32/F	No	Nil	85	80	85	15	235	Excellent	Middle	Ring	O

ROM: Range of movements, PIP: proximal interphalangeal, DIP: Distal interphalangeal joint, TAM: Total active motion

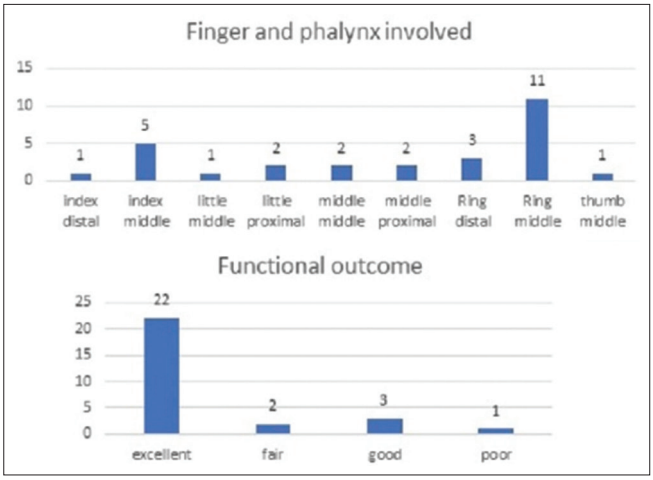

Figure 3: Functional outcome result and finger involvement bar diagram

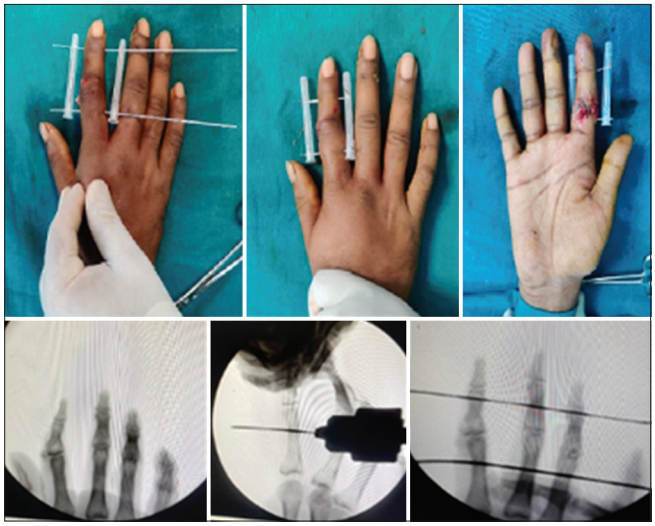

Figure 4: Case 2 showing fixator use in middle phalynx fracture of index finger

patients are not affordable for higher-end external fixator costs.

This fixator has advantages mainly due to its ability to achieve and maintain fracture reduction by the principle of ligamentotaxis. In the case of centrally impacted articular fragments, they may need open reduction or early mobilization of the distracted joint (dynamic traction) to benefit from articular remodeling.

This fixator was compared to a similar fixator used by Thomas et al.,[12] who used a plastic tube as a unilateral uniplanar fixator and we had changed to uniplanar both

Table 3: Comparison of our study with similar studies for fractures of hand using fixators

Results	Parson et al., 1992.[14] (Micro external fixator)	Drenth et al., 1998.[15] (Mini Hoffmann device)	Belsky et al,. 1984.[4] (Mini external fixator)	Jafari and Ajvadi 2016.[9] (K wires with cement)	Tank and Patel 2018.[10] (Spinal needle cap with k wires)	Our study
Excellent	78	10	78	45	70	78.5
Good	16	10	16	7	19	7.1
Fair	4	3	0	4	11	10.7
Poor	2	6	0	0	0	3.5

sides fixator of phalynx so that rotational malalignment can be prevented.

Tank and Patel[10] had done a similar study with spinal needle cap as a uniplanar unilateral fixator for phalangeal fractures, they had stated that "at 3 months follow-up of range of motion and TAM score ion 27 patients 19 had an excellent result, five cases had good range, and three had a fair result. In our study, as we had used a uniplanar bilateral fixator, which showed better result with no rotational deformity.

Dailiana et al.,[13] had done a study with a mini external fixator for phalangeal fractures in 57 patients "Forty-nine patients with 57 fractures were included in the study. In all cases, patients' satisfaction was high; the DASH score was <7.9 and the VAS score was <0.5." In this study, they had used an external fixator which was costly and needs the expertise to apply. A comparison of our study with similar studies with fixators is tabulated down (Table 3).

Limitations of the study

The patient selection criteria for the above study is arbitary.

CONCLUSION

Our fixator can be used to fix complex fractures of phalanges using simple basic instruments with minimal expertise in a cost-effective way. We recommend these fixators for those surgeons who are working in a setup where costly external fixators cannot be used for fractures

This fixator has advantages over other fixators

1. Uniplanar bilateral fixator – prevents rotational displacement
2. Radiolucent – better to get a lateral view and also to see the articular surface
3. Cost effective
4. Needs less expertise and can be performed in emergency OT and removal is easy as well
5. The patient can start their activities immediately after fixator application so movement is regained almost to pre-injury level.

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Authors Contribution:
PS - Idea for the fixator and made manuscript ready and primary surgeon to perform surgeries; **SPM -** Primary surgeon and collected review of literature; **SKD -** results evaluation; **RB -** Assistant in surgeries and for ethics and consent of patients.

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