Research Article

Management of Phalangeal Fractures by Syringe External Fixators

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Abstract
Highly comminuted phalangeal fractures with intra-articular extensions are common in developing countries. Traditional external fixation devices for such fractures are not readily available, are expensive and need considerable amount of expertise in its application. **Patients and methods:** A total of 20 patients with phalangeal fractures were managed by closed reduction and external fixation using simple syringe fixator and follow up was done at the orthopaedic department, Al-Azhar University hospitals over the period from February 2019 to December 2019. K wires and an empty syringe barrels were used. K wire was first passed through the barrel. Then the K wire with the barrel was inserted into the site proximal to the fracture just lateral to the central extensor slip. A second K wire was passed into the site distal to the fracture site while holding the finger in traction and reduction. The patients were recalled after 3 weeks. **Results:** The mean radiological union time was 5.28 weeks. Mean period of treatment of phalangeal fracture is 10.02 weeks. The mean TAM was 214.25 degrees. TAM was excellent in 12digits (60%), good in 4 digit (20%), fair in 2 digits (10%) and poor in one digit (5%). The functional results after fractures of the middle phalanx (mean TAM is 214.4) had better recovery than those of the proximal phalanx (mean TAM is 213.6). **Conclusion:** External fixation technique by simple syringe fixator is proved to be an efficient, simple and cheap alternative for hand fractures fixation showing superiority to other techniques.
Keywords: Phalangeal Fractures, External Fixators

Introduction
Highly comminuted phalangeal fractures with intra-articular extensions are common in developing countries. Road side accidents and on job accidents are common causes of such types of injuries which may present as open fractures with tendon injury, neurovascular damage, and sometimes with a fracture dislocation of the adjacent joint. [(1)]

The management of such type of fractures is difficult, and treatment remains controversial. The consensus regarding the management of such type of fractures is that articular congruity must be restored, and the fracture should be stabilized in near anatomical position by internal or external fixation device. [(2), (3)]

Internal fixation device is usually not preferred in such scenarios as the fracture site is mostly a bag of bones, and also there is a potential risk of infection in open fractures. Mini internal fixation devices of hand are expensive & not usually available. External fixation remains an important treatment modality in such case. [(4)]
Commercially available external fixation devices are not always available, are expensive, and need considerable amount of expertise in its application.[(5)]
On this thesis, we'll describe some innovative and cheap external fixator.

Patients and Methods
In this study, 20 patients with phalangeal fractures were managed by closed reduction and external fixation using simple syringe fixator and follow up was done at the orthopaedic department, Al-Azhar Univrsity hospitals, over the period from February 2019 to December 2019. Informed consents were obtained.

With Inclusion criteria: 20 patients with fracture phalanges, open, unstable or comminuted with or without intra-articular extension. With Exclusion criteria: Closed and stable phalangeal fractures.

All patients with Preprocedural preparation; history, examination and imaging.

Surgical tricks

Generally, the fixator construct require a plastic tube (one 3 cm or one 5cm or one 10 cm, or two insulin syringes) and wires proximal and distal to fracture. Operative steps include:

Initial debridement of any wounds, The fracture is reduced with traction and manipulation and checked with the image intensifier, 1st K-wire is introduced in the fractured bone proximal to the fracture after passing through syringe barrel and then its tip is flushed by saline to clear plastic debris, then the wire is advanced through two bone cortices, 2nd K-wire is introduced in bone distal to the fracture after passing at first through syringe and its tip is flushed by saline. Then, fracture is checked with the image intensifier & once acceptable reduction has been achieved, introduce another wires (one proximal and one distal).

Grades on plastic tube are used to determine level of introduction of that wire in fractured bone proximal to the fracture.

In phalangeal fracture, 0.8 or 1 mm wires were used. Stability of construct was targeted by having at least 4 cortices purchase on each side of the fracture.

All patients have the same postprocedural management, Bulky dressing was done (no splint) postoperatively on the same finger only, Broad spectrum oral antibiotic was given once and analgesics. 1 gm of cefoprazone once post-operatively except in open fractures, continued every 12 hours for three days postoperatively F/U x-rays were done for all patients and before discharge, all patients were educated well about the steps and importance of the rehabilitation program and were informed about the dates of follow up visits, Follow up every 3 weeks for check x-rays, evaluation of bony union and functional outcome, Patients with restricted joint motion are advised aggressive physiotherapy.

Results

In this study, 20 phalangeal fractures were treated with external fixation technique using simple external fixator (syringe barrel and k-wires) over a period of 10 months.

The mean radiological union time was 5.28 weeks. Clinical union preceded or was achieved by the time of radiological union.

All fractures achieved union except 1 fracture (5%) where nonunion was observed. Fracture is open comminuted due to crush injury. And revision by ORIF by k-wires and bone graft was done. 13 fractures (65%) united in anatomical reduction, 6 fractures (30%) united in relative reduction and 1 fracture (5%) united with angulation (chart1)

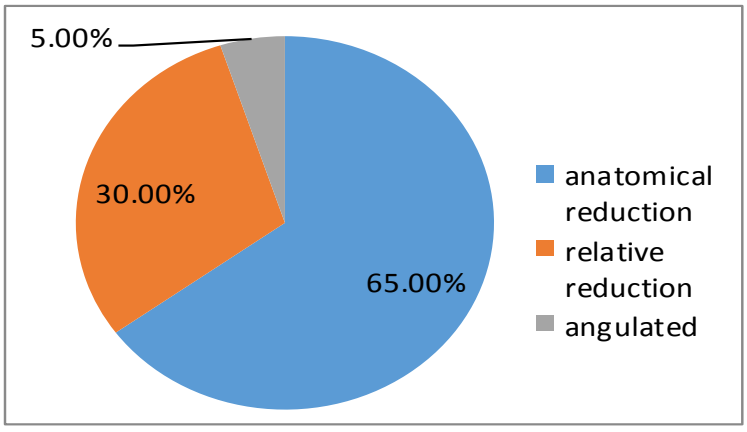

Chart 1: Type of reduction

Regarding time of union, 4 fractures (20%) were united by 4 weeks. 5 fractures (25%) were united by 5 weeks. 6 fractures (30%) were united by 6 weeks. Two fractures (10%) were united by 7 weeks. One fracture (5%) was united by 8 weeks. One fracture (5%) was united by 10 weeks.

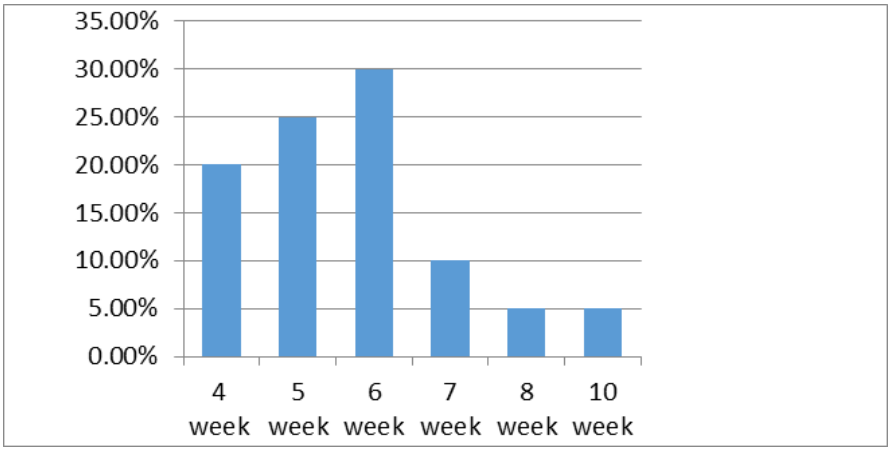

Chart 2: Time to union.

The device had been removed at mean of 5.55 week (4 – 10 weeks). Mean period of treatment of phalangeal fracture is 10.02 weeks.

Regarding gap between time of union and return to normal daily activities, no gap in 3 patients (15%), within two weeks in 8 patients (40%), within 4 weeks in 4 patients (20%), within 6 weeks in 1 patient (5%), within 8 weeks in 2 patients (10%) & one patient take long periods (takes 11 weeks) (chart 3).

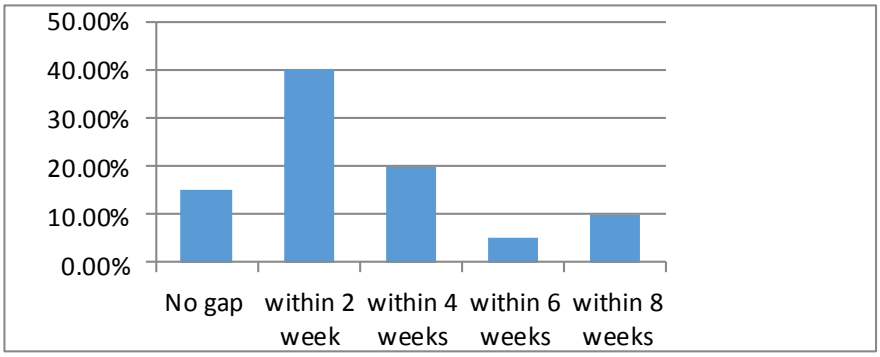

Chart 3: Gap between union and return to daily activities

At the final evaluation and by a goniometer, TAM for all involved digits was calculated. The mean TAM was 214.25 degrees. TAM was excellent in 12digits (60%) and was good in 4 digits (20%) and was fair in 2 digits (10%) and poor in one digit (5%).

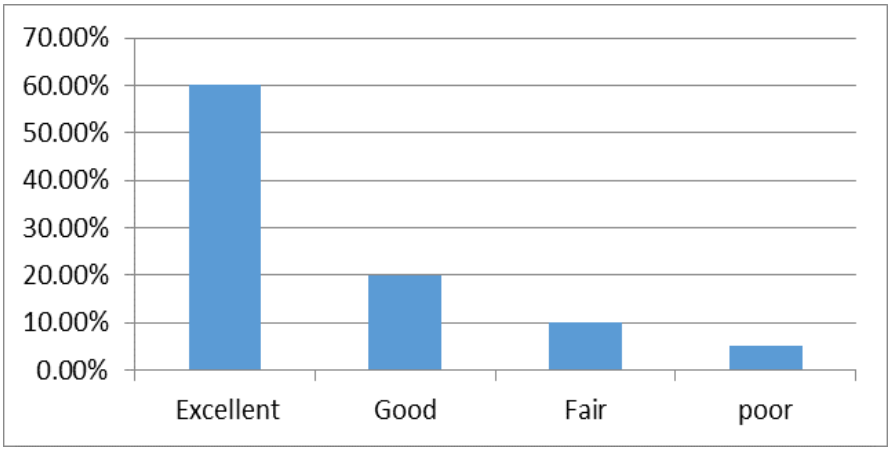

Chart 4: TAM of involved digits.

Secondary procedures were performed for one case. The procedures included revision of fixation by k-wire with bone graft.

The functional results after fractures of the middle phalanx (mean TAM is 214.4) had better recovery than those of the proximal phalanx (mean TAM is 213.6).
Complications were observed in 9 Patients. 4 patients (20%) had post-operative stiffness which was treated by concentrated physiotherapy, 2 patients (10%) recovered and return to work and one patient had fixed deformity but refused to do operation for release as deformity doesn't interfere with daily activities, One fracture (5%) didn't unite & revision by bone graft and ORIF by k-wires was done.

Three patients (15%) complained from numbness and tingling along affected digits. All recovered spontaneously within 3 weeks maximum postoperatively, one patient (5%) complaining of postoperative pin tract infections which was treated by daily dressing and antibiotics.

Other cases had no specific complaints regarding function. All patients returned to their preinjury employments. The average quick dash score was 14.49/55

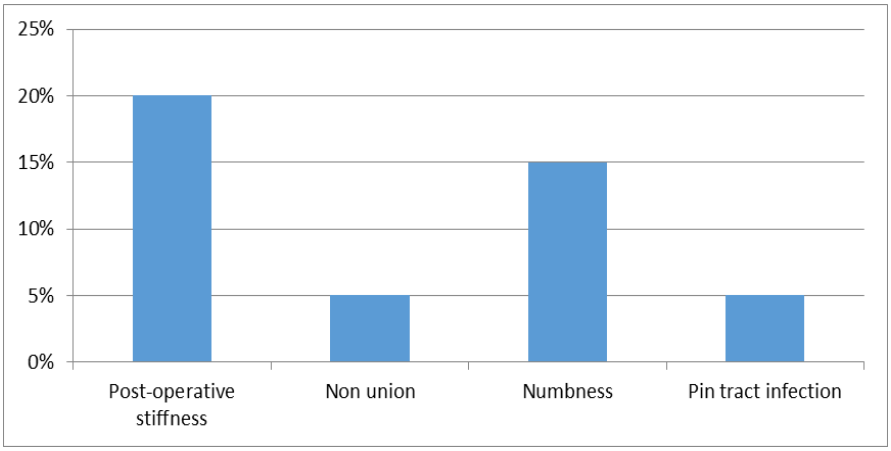

Chart 5: Post-operative complications

Discussion

Patients were followed up within average three months. K-wires (0.8 mm to 1 mm k-wires) and syringe barrel (one 3 cm, one or two insulin syringes) were used. No back slab was used and active ROM was allowed within day one after fixation. The American Society for Surgery of the Hand (ASSH) Total Active Motion (TAM):- Sum of the degrees of active MP, PIP and DIP joint flexion less the degrees from full extension divided by the normal (either contralateral total or 260 degrees) and the result is the percentage of normal[6]. ASSH categories the percentages as the following:

Table 3: TAM evaluation system of the ASSH. [6]

Score	Finger	Thumb
Excellent	85 – 100% (220 – 260)	119 to 140
Good	70 – 84% (181 – 219)	98 to 118
Fair	50 – 69% (130 – 180)	70 to 97
Poor	<50 (0 – 129)	0 to 69

The final mean TAM was 214.25 degrees. TAM was excellent in 13 digits (65%) and was good in 4 digits (20%) and was fair in 2 digits (10%) and was poor in 1 digit (5%). Fixators were removed within 4 weeks in 4 fractures (20%), 5 weeks in 5 fractures (25%), 6 weeks in 6 fractures (30%), 7 weeks in two fractures (10%), 8 weeks in 1 fracture (5%), 10 weeks in one fracture (5%).

Nonunion was observed in 1 fracture (5%). Post-operative stiffness occurred in 2 patients (10%). Numbness and tingling was observed in 3 patients (15%) who improved spontaneously in all patients. One patient had pin tract infection which improved with daily dressing and antibiotics. All patients returned to their pre-injurious jobs and activities. Results are illustrated in the following table. (Table 4)

Table 4: Results.

Case No.	Sex	Age	Phalanx	Shape	intra-articlar	union time	MCP ROM	PIP ROM	DIP ROM	TAM	Post-op stiffness
1	**male**	42	middle	oblique	no	6	80	80	80	240	no
2	**male**	57	proximal	tranverse	no	6	80	80	15	175	no
3	**male**	35	middle	spiral	yes	4	75	80	70	225	no
4	**male**	39	proximal	tranverse	no	5	80	85	80	245	no
5	**male**	44	proximal	oblique	yes	6	70	75	80	225	no
6	**male**	47	proximal	spiral	no	10	90	80	80	250	yes
7	**male**	34	proximal	tranverse	no	4	80	60	30	170	no
8	**male**	29	proximal	spiral	yes	7	90	90	80	260	no
9	**male**	19	middle	Y shape	no	6	80	80	60	220	no
10	**male**	22	distal	oblique	yes	5	75	75	70	220	no
11	**male**	28	proximal	spiral	no	8	85	90	75	250	no
12	**female**	57	proximal	tranverse	no	Prolonged	30	30	20	80	yes
13	**male**	61	middle	spiral	no	5	75	80	60	215	no
14	**female**	51	middle	tranverse	no	4	60	65	65	190	no
15	**male**	50	middle	oblique	no	7	80	75	70	225	no
16	**male**	49	middle	spiral	no	5	75	65	75	185	yes
17	**female**	29	proximal	v shape	yes	4	90	80	80	250	no
18	**female**	36	proximal	spiral	no	6	65	80	60	205	yes
19	**male**	45	middle	tranverse	no	5	75	75	65	215	no
20	**male**	48	proximal	spiral	yes	6	85	85	70	240	no

In Lenehan's series, 25 patients with phalangeal fractures were treated by closed reduction and external fixation by mini-Hoffman external fixator. All fractures united in average 8 weeks. The mean follow-up period was 64 (range36–125) weeks. The mean total active range of movement for the injured digit was 205° (range 120–240°). When expressed as a percentage of the non-injured digit, a mean of 80% was achieved. Mean flexion deficit was 16 (range 0–50, median 8) mm. Mean extension deficit was 5.75 (range 0–20, median 0) mm. Grip strength when expressed as a percentage of the non-injured side was 92% with a mean recorded value of 39 (range 28–53) mmHg. All fractures united and there were no infective complications. Mean time to return to work was 5 (range 2–12) weeks [(7)].

About k-wire fixation, Boussakri in 2014 in a study of 28 patients treated with percutaneous elastic intramedullary nailing using a single wire and a full range was obtained in 97% (60). Thomas fixed 10 open proximal phalanxes transverse fractures with interosseous wire loop supplemented by oblique k-wire. All fractures healed by 6 weeks. The results were 90% excellent and 10% good [(8)].

S.C. Deshmukh fixed 13 patients with a complex fracture-dislocation of the proximal interphalangeal joint of a finger and one patient

with a complex fracture-dislocation of the interphalangeal joint of thumb using a pins and rubbers traction system. The mean AROM of the proximal interphalangeal joint was 85 degrees and that of the distal interphalangeal joint 48 degrees. The mean grip strength was 92% of the uninvolved hand. Twelve patients have returned to their original occupations [9]. Ebinger tried conservative treatment on 48 displaced P1 fractures. Fracture consolidation and recovery of full active motion was achieved simultaneously in 44 from 48 fingers by 6 weeks [10].

Conclusion and Recommendations

External fixation technique by simple syringe fixator (syringe barrel and k-wires) is proved to be an efficient, simple and cheap alternative for hand fractures fixation showing superiority to other techniques and providing comparable results to plating.

This technique can be carried out in the emergency room using simple widely available materials including k-wires and syringe barrel. It requires no special training and has a short learning curve. Additionally, fixators' removal is an outpatient clinic procedure.

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