

Original Research Article

Syringe needle-cap use as novel, static, uni-planar or bi-planar, mini-external fixator for treatment of intra-condylar phalangeal fractures

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ABSTRACT

Background: Comminuted intra-articular phalanx fractures are complicated injuries often treated with external fixation. Syringe needle- cap can be an excellent mini-external fixators because they are radiolucent, readily available, inexpensive, simple, safe and easy to use. Our cases received a novel treatment in the form a syringe needle-cap/mini external fixator that was originally placed in static mode for 3 weeks and then later removed in OPD visit to a dynamic-mode of ROM to allow rehabilitation of the PIPJ/DIPJ. Our cases illustrates the power and utility of this 'static' uniplanar or biplanar stable technique to treat intra-condylar phalanx fractures and achieved good functional recovery of finger.

Methods: This was a prospective case study covering period from January 2021 to May 2022 at department of plastic surgery, Command Hospital, Chandimandir, Panchkula, Haryana, India. 10 young male patients were presented with intra-articular fractures of phalanx. All patients had undergone pre-operative and post procedure X-rays for evaluation. A static external fixator consisting of a uniplanar or biplanar 2 ml syringe needle-cap and 0.8mm small size (3-4 cm) Kirschner wires as an optimal fixator across the fractured joint. K-wires were removed in OPD visit after 3 weeks to dynamize the ROM of affected joint of finger post-operatively.

Results: 10 male patients were studied with average age of 28 years. 06 of them are intra-condylar fractures at PIP joints and rest are intra-articular fractures. After 3 weeks, we removed this fixator device and started controlled physiotherapy. End results notified in our study were achievement of good functional recovery of finger ROM at 3 months follow up.

Conclusions: Syringe needle-cap use as mini-external fixation should be considered as a novel tool in the treatment of comminuted intra-articular phalangeal fracture.

Keywords: Syringe needle-cap, Intra-condylar comminuted unstable fractures, Kirschner's wire

INTRODUCTION

Intra-articular phalangeal fracture are often treated operatively to optimize articular alignment and provide skeletal stability. Comminuted intra-articular phalanx fractures are complicated injuries often treated with external fixation. External fixation facilitates fracture stabilization and its use has resulted in acceptable clinical outcomes.¹ The use of traditional external fixation devices

has been hindered by cost, size, availability, and technical complexity.²⁻⁵ This led to the development of mini external fixators and those made of less expensive materials.^{6,7}

Application of these mini fixators is effective in treating comminuted intra-articular fractures of the hand.^{6,8} These constructs evolved from static biplanar to static uniplanar devices made of cement tubes, needle sheaths, IV cannulas, and syringes. The ideal external fixation system

should be affordable, readily available, adaptable, and easy to use. The use of dynamic external fixation has advanced the care of these injuries but can be difficult to implement.^{9,10}

To date, using external fixators for comminuted intrarticular phalangeal fractures has facilitated treatment with either a static construct or a dynamic construct.¹¹ Though static and dynamic constructs each confer specific benefits, dynamic fixators allow for early range of motion (ROM) while minimizing the forces across the joints, this has been shown to improve functional outcomes and prevent digit stiffness. Although dynamic constructs do have inherent benefits when treating periarticular and articular fractures, they also carry certain risks including pin tract infection and hardware breakage.^{12,13} In addition, not all fractures are adequately stable for initial treatment with a dynamic construct. Most available commercial dynamic fixation devices are costly bulky, and not readily available. Metal-on-metal constructs like the 'Suzuki frame' or pins-and-rubber constructs like the 'Agee force coupler' can be difficult to apply and balance.^{14,15} These issues underscore the need for a simple, safe, and more effective external fixation construct.

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A low-cost, stable uni-planar/biplanar external fixator that is easy to apply, readily available, radiolucent, modifiable, and can be converted from a static construct to a dynamic one would be available tool when treating these complex injuries. We presented case series of individuals who sustained a comminuted intra-articular phalangeal fracture of their fingers.

They were treated using a uniplanar/biplanar external fixation device that comprised Kirschner wires passed through a 2 ml syringe cap. The device was removed after 3 weeks to allow static construct to a dynamic/ROM for finger functional recovery to normal state during the course of treatment.

Objectives

The primary objective of this study was to utilize syringe needle-cap use as mini-external fixation device as a useful tool in the treatment of comminuted intra-articular phalangeal fractures.

The authors present here case study of 10 patients with a comminuted intra-articular phalangeal fracture of the finger treated using a syringe needle-cap as a novel, readily

available, simple, in the form of static uni/biplanar stable mini-fixator that was removed after 3 weeks and achieved good recovery in ROM of finger after 3 months follow up.

METHODS

Study period and design

This was a prospective case-study covering period from January 2021 to May 2022 (16 months) with a sample size of 10 patients treated at department of plastic surgery, Command Hospital, Chandimandir, Panchkula, Haryana, India. The study had been undertaken at plastic surgery dept after getting well informed written consent from the patients participating in the study.

Ethical approval

The present study entitled-'syringe needle-cap use as mini-external fixation should be considered as a novel tool in the treatment of comminute intra-articular phalangeal fractures' was well within ethical norms and ethically justified.

Inclusion and exclusion criteria

Clinical assessment should include a detailed patient history documenting occupation, hand dominance, and mechanism of injury. Physical examination of the PIPJ/DIPJ begins with observing for signs of an open injury, swelling, skin discoloration, and joint alignment. The digital arc of motion (resting posture, active flexion, and extension) should be recorded as should the presence of gross deformity and/joint stability. Radiographic assessment of the finger is mandatory and will help guide the treatment plan. Early controlled ROM is encouraged on the basis of clinical judgment and reduction in fracture tenderness, usually by post injury 3 weeks if not earlier.

Inclusion criteria

Patients with following criteria were included (a) close wound with intra-articular fracture; no swelling; (b) no vascular compromise; and (c) no tendon injury.

Exclusion criteria

Patients with following criteria were excluded (a) open wound; (b) associated tendon injury patient with chronic lymphedema; (c) active infection; (d) those who may have difficulty protecting external hardware (e. g., active substance abuse, psychiatric issues, and seizure disorders) or those who cannot participate in a therapy rehabilitation program.

Methodology

External fixation can, with little to no soft tissue disruption, provide adequate stabilization of fracture fragments, traction across the PIPJ (if needed),

neutralization of forces across the PIPJ, and, with this reported technique, active ROM at a time of the surgeon's choosing. A static external fixator consisting of a single 2 ml syringe needle-cap and Kirschner wires is an optimal fixator because of its availability, radiolucency, modifiability, and low cost. K wires along with needle-cap can be removed in the OPD setting after 3 weeks to dynamize the ROM of affected joint of finger postoperatively. This affords the surgeon the opportunity to treat these fractures in a static to dynamic manner in the manner and timing he or she sees fit.

Statistical analysis

At the end of follow up all data were collected and statistical analysis was carried out. Data was coded and entered into excel sheet and double checking was done to ensure data quality. To analyse the data, SPSS 16.0 version was used.

Operative technique

After anatomic reduction of the fracture and PIPJ/DIPJ (as confirmed fluoroscopically), the fracture is stabilized using an mini-external fixator device consisting of a plastic 2 ml syringe needle- cap and multiple 0.5-0.8 inch smooth Kirschner wires. To allow for the dynamization of the construct, the first wire is placed through the head of the proximal phalanx, as close to the axis of rotation of the PIPJ as possible. The joint is then placed on traction and a second wire is placed through the diaphysis of the middle phalanx. This maneuver effectively neutralizes the forces across the PIPJ. To eliminate rotation of the middle phalanx, 1 or two other pins can be placed near the head of the middle phalanx, on the basis of the fracture pattern and requirements to obtain stability. With this construct (1 pin proximal/1or 2 pins distal), the middle phalanx has been stabilized, forces across the PIPJ have been neutralized, the PIPJ has been placed on traction. Under live fluoroscopy, the arc of motion, fracture stability, and PIPJ congruity can be assessed. This finally creates a static construct .After the first dressing change, the patient is instructed on appropriate pin care. Our protocol includes daily hand hygiene with gentle soap and water washes and twice-daily isopropyl alcohol swabs applied to the K-wire insertion sites. Post-operatively in the clinic setting, the needle cap along with K-wires removed to dynamize a static construct. Removal of this device allows ROM across the PIPJ/DIPJ of affected digit. Once the device is removed after 3 weeks it allows patient to start dynamic ROM rehabilitation therapy to digit.

Observations

Study sample size

10 patients were studied with average age of 28 years (range 20-32 years). The pre-operative radiographic images showed fractures and post-procedure radiographs shows good fracture reduction and adequate joint space.

All patients had excellent ROM/functional recovery of affected phalangeal joint of finger at end of 3 months with use of this syringe needle-cap device- low cost, readily available, safe, simple and easy to use. The patient, in these cases, achieved fracture union and gained acceptable ROM of the PIPJ/DIPJ.

Our case examples illustrates the power and utility of this static uni-planar/biplanar, stable, low cost, readily available technique to treat intra-condylar finger fractures to achieve good functional recovery of ROM of finger.

RESULTS

Results of treatment have been recorded and analyzed statistically at end of 3 months post procedure follow up period in this prospective case study using IBM SPSSversion 16.0 programme, and significant effectiveness in recovery was accepted. As shown in Figure 1, 09 patients are male and 01 patient was female. In Figure 2, we had evaluated mechanism of injury, most common cause is accidental fall then, RTA, Crushed due to some heavy objects and 01 case is iatrogenic. Figure 3 shows in right handed patients PIP joints is most commonly involved and left handed patients DIP joints are most commonly involved. Figure 4 shows post procedure good alignment in all cases using our external fixatator. Figure 5 shows 40% improvement in range of motion in 03 weeks and 90% in 03 months as shown in Table 1 comparison between pre-op and post op flexion- extension range of motion and grip strength improved after 03 month of physiotherapy. Syringe needle-cap can be an excellent novel, static, uni-planar or bi-planar, mini- external fixator for treatment of intra-condylar phalangeal fractures. Our cases illustrates the power and utility of this 'static' uniplanar or biplanar stable technique to treat intra-condylar phalanx fractures and achieved good functional recovery of finger. All patients had excellent ROM/ functional recovery of affected phalangeal joint of finger at end of 3 months with use of this syringe needle-cap device- low cost, readily available, safe, simple and easy to use. The patient, in these cases, achieved fracture union and gained acceptable ROM of the PIPJ/DIP joint.



Figure 1: Pre-operative X-ray hand with intra-articular phalangeal fracture-dislocation picture.



Figure 2: Post-operative X-ray hand with device in-situ picture.



Figure 4: Post-operative X-ray after removal of device and point digit ROM hand picture.



Figure 3: Post-operative patient hand picture with device in situ (static, bi-planar syringe needle-cap device along with K-wires as stable mini-external fixator).

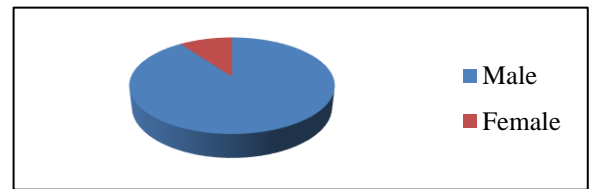


Figure 5: Gender distribution in study.

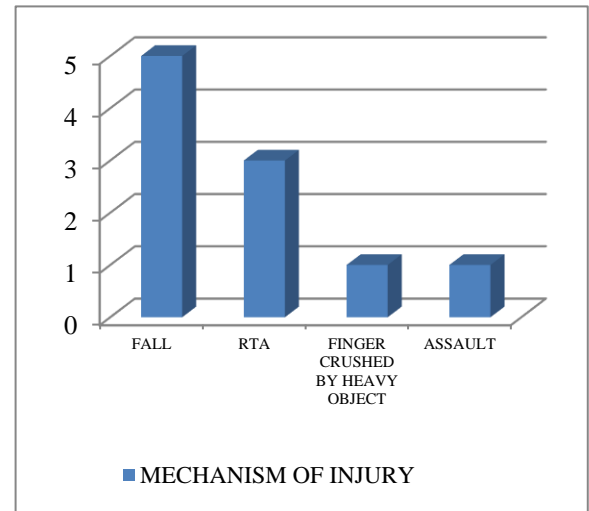


Figure 6: Etiology/mechanism of injury distribution in study cases.

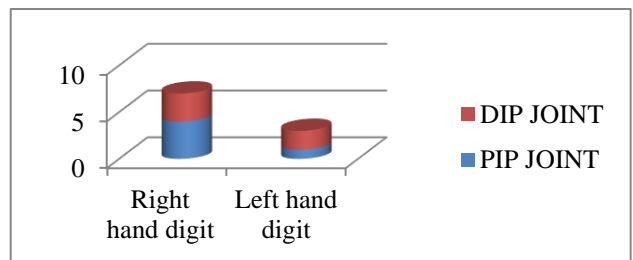


Figure 7: Hand digit joint affected side with confirmation of diagnosis by digital X-ray imaging preoperative in study cases.

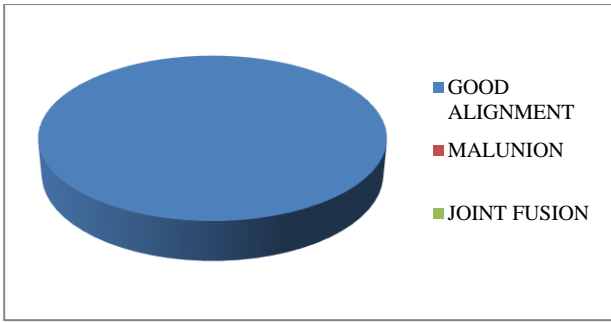


Figure 8: Post-op anatomical alignment- PA and lateral view.

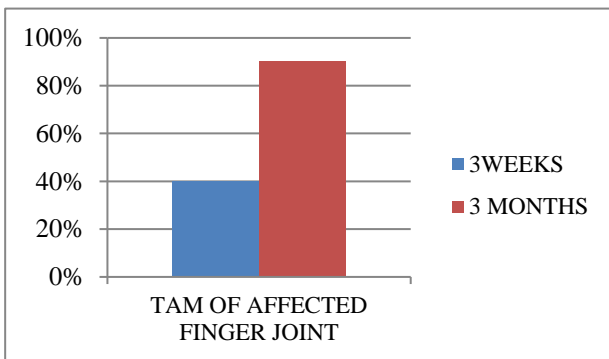


Figure 9: Post-op ROM/TAM digit analysis.

Table 1: Comparison between pre and post operative clinical situation of patient.

Parameters	Pre-OP mean±SD (range)	Post-OP mean±SD (range after 3 months)
Flexion-extension	12±4 (10-25)	60±10 (0-80)
Grip strength % of non-injured hand	63% (51-71)	82% (70-92)

DISCUSSION

Syringes can be excellent fixators because they are radiolucent, readily available, inexpensive and modifiable. In our case example, the patient received a novel treatment with an external fixation device fashioned from a syringe that was originally placed in static mode for 3 weeks and then later converted in the clinic setting to a dynamic-mode to allow rehabilitation of the PIPJ. Kaspanyan et al they also shows dynamic external fixator for upper extremity are useful but there fixator are very cumbersome and costly as compare to our which is cheap and easily available.³ Krakauer et al they presented a hinged device for phalanges fracture.⁴ This technique enabled the surgeon to choose exactly when to begin digital ROM exercises and to customize a treatment plan for each patient. These treatment plans thus can vary on the basis of different fracture patterns and patient-specific needs. Although our study primarily focused on outcomes after

the use of a dynamic external fixator, a further study comparing the utility of this technique with classic static external fixation was needed. Future studies should also compare the mechanical strength and durability of plastic-based syringe external fixators to modern metal external fixators. Our case example illustrates the power and utility of this “static-to-dynamic” technique. Syringe external fixation should be considered as a useful tool in the treatment of comminuted intra-articular phalangeal fractures or as a secondary alternative in settings where modern external fixators are not readily available. As in every fracture case, the surgeon has to follow the general principles of reduction and fixation. Many different techniques.⁵ Suzuki et al have been described in the literature for middle phalanx fractures. For simple, transverse fractures, the open reduction and internal fixation with a plate, as well as intramedullary fixation with k-wires or cannulated screws, can be reliable treatment options. For more complex, comminuted fractures, external fixation methods that achieve reduction based on the principle of ligamentotaxis seem to be more efficient. Intra-articular fractures are challenging cases for hand surgeons and anatomic reduction is necessary for a good outcome with respect to movement and function. In these cases, external fixation systems may give a good outcome with minimal tissue trauma. Severely comminuted fractures of the middle phalanx, with or without the involvement of the articular surface and various types of soft tissue damage, are indicated for external fixation with continuous distraction.

Limitation

This study comprised of a small sample size involving young, otherwise healthy active individual. The sample size could not be large as consider population is small and duration of study is also less just 1 and ½ years. Hence study cannot be said conclusive for general population. Further comparative study at different centre also required.

CONCLUSION

We presented a case series of individuals who sustained a comminuted intra-articular phalangeal fracture of their finger. They were treated using a syringe needle-cap as static, uni-planar external fixation device that comprised Kirschner wires passed through a 2 ml syringe. The device was removed after 3-weeks to allow static construct to a dynamic/ROM for finger functional recovery to normal state during the course of treatment. This affords the surgeon the opportunity to treat these fractures in a novel, simple, inexpensive, safe, readily- available and adaptable static to dynamic manner in the manner and timing he or she sees fit.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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