**Benha Journal of Applied Sciences (BJAS)** **print: ISSN 2356–9751**
**Vol. (7) Issue (10) (2022), (121-126)** **online: ISSN 2356–976x**
**http://bjas.journals.ekb.eg**

# Definitive Management of Open Fractures in pediatric patients by External Fixators

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**Abstract**

In the last several decades, vehicle accidents have been the leading cause of long-shaft lower-limb fractures in children. These fractures often involve the tibia and fibula and are accompanied by skin and soft-tissue injuries of varying severity. This research aims to assess the efficacy of external fixators in the final treatment of open fractures in children. Methods: Fifteen patients with open long bone fractures were treated with external fixation at Benha University Hospital, with a median follow-up of 12 weeks. The present study validates previous research showing satisfactory functional and radiological outcomes utilising the external fixation approach. Patients' ages varied from 6-16 years old, with a mean of 9.603.07. Almost four out of five (73.3%) were males. Road traffic accidents accounted for 73.3% of all injury mechanisms, followed by the direct fall of a large item (6.6%) and localised trauma (1.3%). Gustilo grades 2 (53.3% of cases), 3a (33.3%), and 3b (6.7%) were the most common. The tibia was the most often broken bone (80%). A total of 87 minutes and 37 seconds were spent in surgery on average. Eighty percent of patients began ROM right away, whereas the remaining 20% did so within 2 weeks, and the other 7% did so within 5 months. Three patients began bearing weight immediately, two patients waited two weeks, and ten patients waited one month. The mean duration of a radiological union was 4.27 1.22 months. It took 4.63 1.14 months on average to get the fixator out. The most common complications were skin infections (60%) and stiffness (26.7%), followed by NV issues (13.3%), a pin fracture (6.7%), and a refracture of bone (6.7%).

**Key words:** external fixation technique, open fractures, long bones.

## 1. Introduction

Most long-shaft fractures in children's lower limbs are open fractures; these are most common in the tibia and fibula; and they are often accompanied by varying degrees of injury to the skin and soft tissues.(1) Despite this, children have a remarkable capacity to heal and reconstruct after fracture. Nonetheless, children have shorter skeletons because their epiphyses have not yet fused. Thus, picking the right internal focus is challenging. When children refuse to cooperate with traditional methods of treating severe skin and soft tissue defects, complications like infection, osteomyelitis, malformation, fracture nonunion, and disability can arise. (2) Associated injuries are common in these children, so a systematic, organised approach is necessary to ensure no other injuries are missed. Low-energy injuries, such as those sustained in sports, are not often connected with widespread organ failure. However, many injuries are common in the aftermath of a high-speed car crash, thus thorough anteroposterior and lateral radiographs of the hip and knee should be acquired to rule out the possibility of such injuries. Finally, when a baby presents with a femur fracture, the possibility of child abuse must always be explored. Researchers have shown that 70% of femur fractures in children less than 3 years old are caused by child maltreatment (4)

## 2.Patients and Methods

### Patients

There were 15 patients (11 males and 4 females) at Benha University Hospital who had open long bone fractures treated with external fixation. Patients were given written explanations of the procedure and consented to it before surgery. All patients were expected to be followed for a minimum of 12 weeks and a maximum of 24 weeks. Children with recent long bone fractures, open long bone fractures, open physes, and patients in otherwise good condition were all considered for inclusion. Patients who were already skeletally mature were disqualified, as were those with old, untreated fractures. Fractures that don't heal quickly or at all.

Evaluation Prior to Operation

Each individual was evaluated thoroughly by taking their medical history and doing a full physical examination. The patient's history was taken, and the cause of injury was identified. The area around the injury was examined for signs of damage, such as bruising, swelling, and ecchymosis, and the patient's nervous system was checked. Long bone, including the joint above and below the fracture, must be seen on plain x-rays (PA and lateral) (fig.1)

### Surgical Procedure

Spinal or general anaesthetic is used to induce sleep.

Patients were operated on a typical radiolucent orthopaedic table while supine.

With the aid of an image intensifier.

Intraoperative fluoroscopy: In all procedures, intraoperative imaging (C-arm) was required.

Methods of operation:

Through a designated area of the patient's anatomy, at least two pins were put into each major piece (fig.2). As much space as possible was left between the pinnings. The fracture point was located, and pins were placed as near as feasible to it without penetrating the hematoma or the degloved regions. Since no incisions or other surgical procedures are necessary for pin insertion in cases where delayed internal fixing was intended, no recovery time is lost (the zone of surgery). Because of its importance, the connecting tube was positioned as near to the bone as feasible. To provide more stability than a single bar could provide, we utilised two. When compared to a uniplanar frame, the stability given by a biplanar frame is superior. Mixing elastic with stable fixation is only recommended in unusual circumstances because of how fleeting the results might be. Schanz screws range in thickness from 4 mm to 5 mm pins, determined on the severity of the fracture and the patient's weight. It was important to keep in mind the following while installing a Schanz screw:

Avoid sensitive anatomical structures including blood vessels, nerves, and tendons.

No screws or pins were used to secure any of the joints.

• Pre-drilling the cortical bone to prevent thermal injury (ring sequestrum is produced).

• Schanz screws of the proper length, allowing for proper frame assembly.

The anatomy of the various cross-sections of the limb is determined, and the safe zones for pin placement are used to prevent damage to nerves, arteries, tendons, and muscles. Schanz screws may be applied to the tibia in a uniplanar fashion without needing to be positioned at the anterior tibial crest. The thick cortex of the tibial crest provides exceptional stability. However, due of the sufficient thickness of the anteromedial tibial wall and the bicortical anchoring of the Schanz screws, significant purchase in the cortex is often not necessary. Necrosis of the bone may result from producing too much heat when drilling through the thick tibial crest. Schanz screw insertion at the tibial crest might be challenging because the tip of the drill bit can slide medially or laterally, causing damage to the soft tissues. The most distal pin locations also have the greatest infection incidence because to proximity to the tendons of the tibialis anterior and extensor digitorum muscles in the distal tibia. Schanz screws may stay in place for extended periods of time without risk of infection if they are placed in the anteromedial portion of the tibia.


**Fig. (1)** preoperative AP and lateral views showing the fracture.

**Fig. (2)** intraoperative clinical photos

**Fig. (3)** post operative xrays

**Fig. (3)** full union xrays

**Follow up program**

1. Quick and easy follow-up (6 weeks)

Prophylactic parenteral antibiotics (cephalosporin) were given to the patient for the first 24 hours after surgery, and the patient stayed in the hospital for the night after the vascular and neurological examination. All patients were seen at the outpatient clinic at Benha University Hospital every two weeks after surgery. Everyone begins walking and moving their ankles and knees right away.

After surgery, two different types of x-rays were collected (A-P and lateral) (fig.3). These are used to prove that the fracture was reduced and fixed, to note the position of the fixator, and to provide a benchmark for gauging the success of the union. Obtaining postoperative radiographs at 2-week intervals allowed us to monitor the reduction and subsequent union.

B.

Reactions are delayed

Union proven clinically and radiographically triggers fixator removal (fig.4). Following surgery, patients will be surveyed at 3, and 6 months to gauge recovery. The patients' subjective experience of pain was documented using a VAS, with the intensity of their suffering classified as follows: no pain, mild pain, moderate pain, severe pain, and excruciating agony. Pain and skin irritation at the schanz or wire insertion site. Changes in gait pattern and the necessity for walking aids after the sixth week following surgery.

## 3. Results

The mean age of the studied patients was 30 ±10 years. There was a male predominance (80.0%), while females were20% **(Table 1).**

**Table (1)** Demographic characteristics of the studied patients.

| Demographic data | No. | % |
|---|---|---|
| **Sex** | | |
| **Male** | 11 | 73.3 |
| **Female** | 4 | 26.7 |
| **Age (years)** | | |
| **≤10** | 10 | 66.7 |
| **>10** | 5 | 33.3 |
| **Min. – Max.** | 5.0 – 16.0 | |
| **Mean ± SD.** | 9.60 ± 3.07 | |
| **Median (IQR)** | 9.0 (8.0 – 11.50) | |

The most frequent fracture location was the tibia (80%), while femur was (20%) (Table 2).

**Table (2)** fracture location in the studied patients.

| Fractured bone | No. | % |
|---|---|---|
| **Femur** | 3 | 20.0 |
| **Both bone leg** | 12 | 80.0 |

The most common mechanism of injury was RTA (73.3%), followed by direct fall of heavy object (13.3%). Falling from height was the least frequent mechanism (6.7%) (Table 3).

**Table (3)** mechanism of injury in the studied patients.

| Mechanism of injury | No. | % |
|---|---|---|
| **RTA** | 11 | 73.3 |
| **Direct fall of heavy object** | 2 | 13.3 |
| **Localized trauma** | 1 | 6.7 |
| **Falling from height** | 1 | 6.7 |

Time of surgery ranged from 45 to 180 minutes. The mean time to radiological union was 4.27 ± 1.22 months. The patients started ROM immediate postoperatively (80%), after 2 weeks (13.3%) and after 5 months (6.7%) . Weight bearing started immediately in 3 cases , after 2 weeks in 2 cases and after 1 months in 10 cases. The average time of Radiological union was 4.27 ± 1.22 months. The average time of fixator removal 4.63 ± 1.14 months. Complications included skin infection (60%), Stiffness (26.7%) , NV problems (13.3%),pin fracture (6.7%) and refracture of bone (6.7%). (Table 4).

**Table (4)** surgical outcome in the studied patients.

| | | Surgical outcomes |
|---|---|---|
| **Time of surgery (min)** | **Median (range)** | 87.0 ± 37.26 |
| **Time to union (wks)** | **Mean ±SD** | 4.27 ± 1.22 |
| **Time to fixator removal (wks)** | **Mean ±SD** | 4.63 ± 1.14 |
| **Skin complications** | **n (%)** | 9 (60%) |
| **Stiffness** | **n (%)** | 4 (26.7) |
| **NV problems** | **n (%)** | 2 (13.3) |
| **Refracture of bone** | **n (%)** | 1 (6.7) |
| **Fracture of pins** | **n (%)** | 1 (6.7) |

## 4. Discussion

In both planned medical procedures and emergency situations, paediatric patients often benefit from the use of external fixators. Deformity repair and limb lengthening are two procedures that may benefit from the use of external fixators in elective patients [5]. Open fractures, fractures with extensive soft tissue damage (such as burns), fractures with an accompanying vascular injury, and polytraumatized children are all situations in which external fixation for skeletal stability is necessary in trauma [6]. After the fixator has been placed, the fracture may be stabilised using it as the permanent way or by switching to another fixator or internal fixation. While it is generally documented that external fixators may be helpful, there are a few things to keep in mind while treating a juvenile patient [7]. Half pins should be positioned at least 2 cm from the physeal, although in cases when the bone is too small or there is a physis, the pin may be put closer [8]. Some youngsters don't utilise external fixators since they're unpopular, according to a study [9].

The goal of this research was to reflect on our past experiences with external fixators in paediatric trauma cases, specifically looking at the types of fixators utilised, the results, and the challenges we encountered. Treatment of tibial open fractures in children with external fixation was compared to intramedullary nailing in a biomechanical research by Hossein Aslani et al., 2013. Age was a mean of 10.5 3.2 years [10]. Seventeen consecutive paediatric patients (14 boys, 3 girls) with long bone fractures of the lower extremities were treated during a 12-month period by Josef K. Eichinger et al. (2012). An average of 7.4 years of age [11] Twenty-one kids, ages 2.3 to 16.4 (mean 13.1), participated in a research by Tony El Hayek et al. in 2004. [12. The ages of the patients in our research varied from 6 to 16 years old, with a mean age of 9.60 3.07. Grade 2 instances made up 53.3% of the total, while 3a cases accounted for 33.3%, and 3b cases made up 6.7%, of the total cases analysed. Twenty tibias, five femurs, two humeri, two radius, and one phalanx were examined by Joel A. Humphrey et al., in 2015 (13). (Table I). There were a total of 23 open fractures (77%), 3 fractures in patients who had had multiple injuries (mean ISS 43.3, range 41-48), and 4 severely comminuted fractures (13%) that required external fixation because they could not be treated successfully with internal fixation. Seven of the 23 open fractures (30%) were Gustilo grade II, four were Gustilo grade IIIA (17%), and twelve were Gustilo grade IIIB (53%). [13]. Our findings on the average length of a marriage coincide with those of Hossein Aslani et al. (2013) and contrast with those of Josef K. Eichinger et al. (2012), who found a mean of 73.5 days. (9.6 weeks; 1–38 weeks) according to studies by Joel A. HumpHrey et al. [11] and others (2015). [13]. Comparatively, Hossein Aslani et al. (2013) discovered infection surrounding pins in only 22.2% of patients, hence this study's figure of 60% for skin infection is rather high [10]. The majority (76.9%) of fractures in our series were originally stabilised with a unilateral fixator, whereas the remaining 3.2% of fractures were stabilised using a circular fixator. One highly comminuted tibial fracture and two Grade IIIB open fractures of the tibia necessitated the use of a circular fixator, and the choice to use one was based on the surgeon's expertise and the severity of the injuries. All of the fractures in this series were open, and most of them were Grade II (53.2%). This is the most prevalent reason for using an external fixator. The risk of re-fracture after an external fixator has been removed is small but well-known. The literature reports a range of prevalence from 5% (108) to 21%. [13]. One of the kids in our series (6.7%) had a refracture after the external fixator was taken off. If there is any doubt that the bones will fuse together, we recommend keeping the fixator in place for a little longer, or if it must be withdrawn, covering the limb in a plaster cast. After the removal of fixators, we cast 86.7% of the limbs in our series for a mean of 3.6 weeks to ensure proper healing. After fixator removal, a cast was used to preserve 40% (12 limbs) for a mean of 5.9 weeks (Joel Humphery et al., 2015). [13]. For an average of 3.2 weeks following the removal of the fixator, a cast was used by Tony El Hayek et al., 2004. (12). One instance showed varus angulation (33.3%), one case showed valgus angulation (33.3%), and one case showed procurvatum (33.3%). One patient (5.5%) had varus angulation, and one patient (5.5%) had procurvatum, in accordance with Hossein Aslani et al [10] In addition, Josef K. Eichinger discovered angulation in 2 of the patients he examined in 2012. (109). Consistent with previous research showing a 6.8% (10 instances) and 8.2% (12 cases) prevalence of limb length disparity due to bone loss, we discovered two cases (13.3%) in our investigation. Knee and ankle stiffness were seen in 75% and 25% of patients, respectively, after surgery. Similar results were obtained by Joel Humphery et al. in 2015 (3.5% of patients) and Josef K. Eichinger et al. in 2012 (17.7% of patients), but our research included only patients who were stiff at baseline. In our research the mean commencement of weight bearing was $4.63 \pm 1.14$ weeks, whereas in earlier studies the mean of weight bearing in lower limb fractures were 3.6 weeks [13] and 4.2 weeks [10]. Some writers have argued that children and parents in this community would object to the use of external fixators [14]. Anecdotally, it was not our impression. Most findings in the literature [15] are connected to elective treatments like limb lengthening, therefore the psychological effect of using an external fixator on a traumatically injured kid is not well characterised [16].

## 5. Conclusion

External In individuals who have sustained several injuries or who have open fractures, fixing is a must. A patient may get less invasive nursing care and avoid painful plaster casts with an external fixation.

During delayed union, it's possible to use dynamization or compression, and the repair of residual abnormalities is permitted. The benefits of external fixation include the ability to see the cutaneous condition, the need for no extra treatment, the potential for dynamization and early physical therapy, and the potential for shortening of the limbs in situations of substantial soft tissues loss. Rare neurovascular iatrogenic lesions from pin insertion, infection at the pin sites, bone weakening from pin insertion, patient complaints about the fixation's bulk and weight (though these are improving) and iatrogenic fractures from weakening bones from pin insertion (though these are becoming less common as dynamization and progressive material removal are used). These difficulties reduce the frequency with which external fixation is used in youngsters, but they do not exclude its use. treatment**.**

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