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ORIGINAL STUDY

The role of external fixators in paediatric trauma

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We report a retrospective review of all paediatric trauma patients managed with an external fixator admitted to our institution over a 7-year period. We identified 30 fractures in 28 children. The fractures included 20 tibiae, 5 femurs, 2 humerii, 2 radii and 1 phalanx. The indications were 23 open fractures, 4 comminuted fractures and 3 closed fractures in polytraumatised patients. It was the definitive treatment in 13 fractures. The mean length of total time with an external fixator was 9.6 weeks (range 1-38 weeks.) Difficulties encountered were eight problems, one obstacle and two true complications. There were no cases of re-fracture following removal of the external fixator. This review confirms that there is a role for the use of external fixation in selected paediatric fractures with a low complication rate.

Keywords : paediatric trauma ; external fixators.

INTRODUCTION

External fixators are widely used in children in the elective and trauma settings. In elective cases, external fixators have a role in deformity correction and limb lengthening (*8*). In trauma, external fixation is indicated for skeletal stabilisation in open fractures, fractures associated with severe soft tissue injury including burns, where there is an associated vascular injury and in the polytraumatised child (*5,12*). Once applied, the fixator can be used as the definitive method to stabilise the fracture or subsequently converted to either an alternative fixator or to internal fixation.

The use of external fixators in children is well established but certain factors specific to the paediatric population need to be considered if an external fixator is being utilised (*10*). Smaller diameter bones may limit the size of the half pin, the presence of a physis that can make half pin placement difficult – half pins should be placed at least 2 centimetres from the physis if possible (*12*). In children, the perceived unacceptability of external fixators to the child and / or their carers may limit its use (*2*).

The purpose of this study was to review our experience in use of external fixators in children's trauma including the indications for use of an external fixator, the type of fixator used, the outcomes and difficulties.

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PATIENTS AND METHODS

From our hospital records, we identified 30 paediatric trauma patients admitted to our institution between January 2004 and December 2010 and treated with an external fixator. Of those 30, 2 children were subsequently transferred to other institutions for follow up care, leaving a cohort of 28 children who we have managed until fracture union and are the subject of this review.

There were 16 boys and 12 girls with a mean age of 9.7 and age range from 3 to 15 years. There was no statistical difference ($p = 0.22$) in the mean age of the boys (10.6) and the girls (8.6). The mean Injury Severity Score (ISS) *(1)* on admission was 23.1 (range from 9-48) and there was no statistical difference ($p = 0.18$) in the mean ISS of the boys (20.3) and the girls (27.0).

2 patients had two fractures each, so giving us a total of 30 fractures that were treated with external fixation. All patients were followed up until fracture union and there were no deaths in this group.

Un-paired two tailed t-Tests were used to assess differences in patient demographics and duration of external fixators in the various groups. A p-value of < 0.05 was considered statistically significant.

RESULTS

The fractured bones treated were 20 tibias, 5 femurs, 2 humeri, 2 radii and 1 phalanx (Table I). Indications for application of external fixation were, 23 (77%) open fractures, 3 (10%) fractures in polytraumatised patients (mean ISS 43.3, range 41-48) and 4 (13%) severely comminuted fractures, which were judged not amenable to internal fixation. Of the 23 open fractures, 7 were Gustilo grade II (30%), 4 were Gustilo grade IIIA (17%), 12 were Gustilo grade IIIB (53%) *(9)*.

Table I. — Fractured bones treated with external fixation

Location	Boys	Girls	Total (%)
Femur	2	3	5 (17)
Tibia	13	7	20 (66)
Humerus	1	1	2 (7)
Radius	1	1	2 (7)
Phalynx	1	0	1 (3)

Table II. — Indications for external fixator

Indication	Total weeks with external fixator
Comminuted fracture	8.0 (1-14)
Polytrauma	6.0 (2-10)
Open II	9.0 (1-14)
Open IIIA	8.0 (7-11)
Open IIIB	11.8 (4-38)

The external fixators used were, a Hoffman II (Stryker, Berkshire, UK) in 23 fractures, a Hoffman II Compact (Stryker, Berkshire, UK) in 2 fractures, a Hoffman II Micro (Stryker, Berkshire, UK) in 2 fractures, a Taylor Spatial Frame (Smith & Nephew, Memphis, USA) in 2 fractures and an Ilizarov Frame (Smith & Nephew, Memphis, USA) in 1 fracture.

Adequate soft tissue cover was achieved in the 11 Grade IIIB fractures, by 6 split skin grafts, 3 free flaps (2 lattisimus dorsi and 1 gracilis), 2 acute shortenings with primary closure and 1 local fasciocutaneous flap.

Overall total treatment time with an external fixator was 9.6 weeks (range of 1-38 weeks) (Table II). The 12 grade IIIB open fractures (11.8 weeks) did not have a statistically significantly longer frame time as compared to the 11 grade II and IIIA fractures (8.6 weeks) ($p = 0.36$).

Following removal of the initial external fixator, one of four treatment protocols were followed ; no further protection, protection in a plaster cast, internal fixation or conversion to circular frame (Table III). There were no cases of re-fracture following removal of the external fixator.

Treatment with an external fixator in these 28 children did result in some difficulties. We have classified difficulties as problems, obstacles and true complications *(13)*. There were 7 problems, 1 obstacle and 2 true complications. These have been detailed in Table IV. The 2 pin site infections were successfully treated with oral antibiotics. 2 patients had residual joint stiffness, 1 distal radial fracture with reduced wrist movements, which fully resolved with physiotherapy and 1 femoral fracture, which lacked 5° of full knee extension.

Table III. — Management after initial external fixator removal

Management	Number	Weeks with fixator
None	13 (43.3%)	8.8 (3-14)
POP cast	12 (40%)	11.0 (4-38)
Internal fixation	4 (13.3%)	2.5 (1-6)
Circular frame (TSF)	1 (3.3%)	6.0

DISCUSSION

External fixators have an important role in paediatric trauma and should be part of the routine armamentarium of orthopaedic surgeons who treat children's fractures. Whilst many children's fractures can be successfully managed without the need for surgical stabilisation, some cases may require additional stability in the form of either internal or external fixation. Internal fixation may not be appropriate in open fractures or polytraumatised children.

A variety of external fixators are available for use in paediatric patients. External fixators may be either unilateral or circular and both types have their advantages and disadvantages (*3*). Circular frames tend to be more complex to apply, especially in the trauma situation and may restrict access for soft tissue interventions. As a result, unilateral fixators are usually favoured in acute trauma (*7*). In our series, we used a unilateral fixator to initially stabilise 90% of fractures and a circular fixator in the remaining 3 fractures. The decision to choose a circular fixator was dictated by the experience of the operating surgeon and the nature of the injury – one severely comminuted tibial fracture and two Grade IIIB open fractures of the tibia. An open fracture is the most common indication for the application of external fixators and in this series, 77% of the fractures we treated were open and the majority were Grade IIIB (53%.) A variety of soft tissue techniques are available to obtain cover and in the 13 IIIB open fractures we treated, soft tissue cover was obtained with 6 split skin grafts, 3 free flaps, 2 acute limb shortenings with primary closure and 1 local flap ; this is similiar to other reported series (*16*).

In our series, superficial pin site infections occurred in 2 children (7%) and this compares favourably with reported pin site infection rates of 4% (*4*), 52% (*17*) and 73% (*11*). We believe that our low rate of pin site infection is the result of carefully following an established protocol (*18*).

Re-fracture following removal of the external fixator is an uncommon but well recognised complication. The reported rate in the literature varies from 5% (*12*) to 21% (*11*). In our series, none of the children we treated re-fractured after removal of the external fixator. We would advocate that if there is any concern about bone union, the fixator should either be maintained for a further period of time or if it is removed, the limb is protected in a plaster cast. In our series, we protected 40% (12 limbs) with a cast after fixator removal and the cast remained on for a mean time of 5.9 weeks.

2 patients with open IIIB tibial fractures had significant bone loss and subsequent delayed union. 1 case with bone loss and 3cm shortening was managed with an Ilizarov frame for bone transport ; total time in circular frame was 38 weeks. Another case with bone loss due to a large butterfly fragment but with no shortening, was initially treated with a linear external fixator for 6 weeks ; secondarily converted to a TSF for a further 22 weeks until union and a planned bone graft was not required (Fig. 1).

Other series report that time to union is delayed in open fractures and in particular the more severe grade IIIB fractures (*6*). In our series though,

Table IV. — Problems, obstacles and complications (*13*)

Problem	Obstacle	True Complication
2 Pin site infections	1 Adjustment of external fixator under general anaesthetic following loss of position post-operatively	1 malunion requiring corrective osteotomy and a circular frame
2 Hypertrophic scars		
2 Stiff joints		1 patient with 1.5 cm tibial overgrowth
2 Delayed unions		

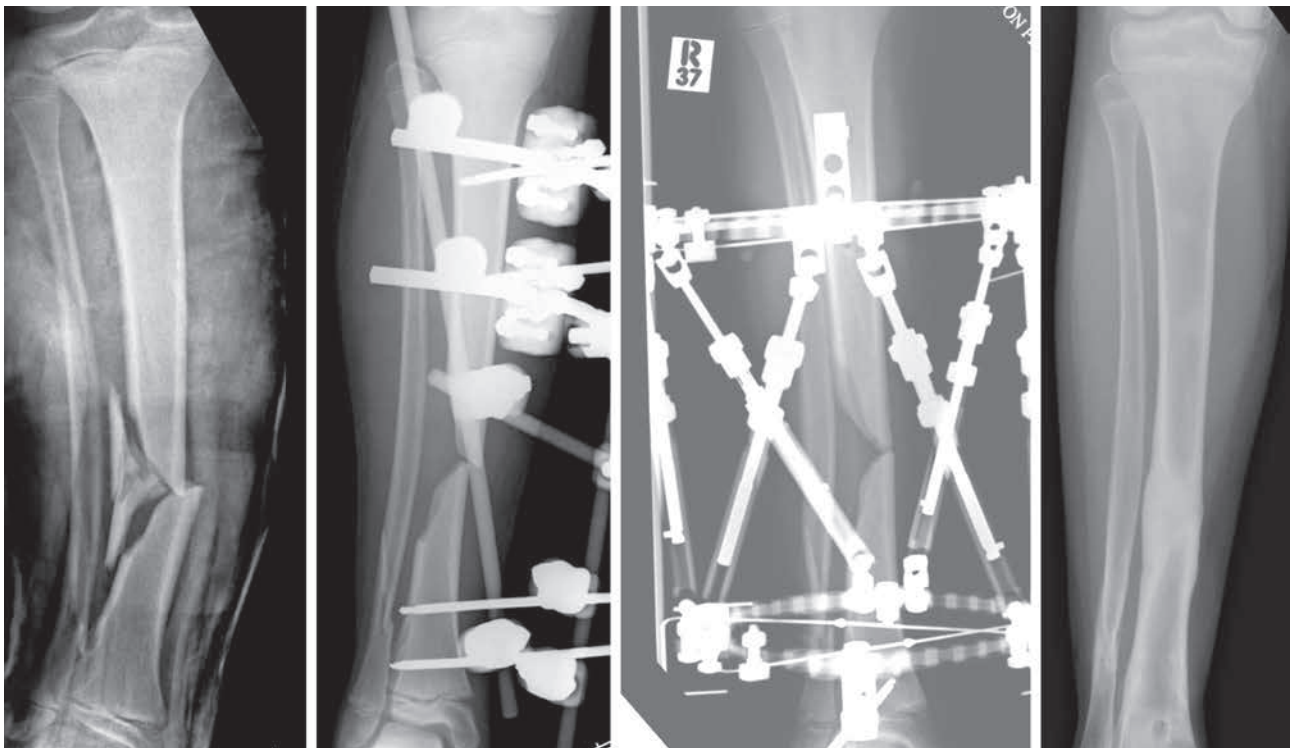

Fig. 1. — Plain AP radiograph of an 11 year old boy with an isolated grade IIIB open right tibial fracture, following pedestrian versus car trauma. Initially managed with a mono-linear external fixator and definitive soft tissue coverage with a local flap. Converted to a circular Taylor Spatial Frame at 6 weeks. Plain radiograph at 1 year follow-up with full union.

external fixator time in the grade II and IIIA fractures was 8.6 weeks, which was not statistically significantly shorter ($p = 0.36$) than the IIIB fractures in which union time was 11.8 weeks.

Some authors have suggested that use of external fixators in this population might be perceived to be unacceptable to the child or carers (*2*). Anecdotally, that was not our impression. The psychological impact of an external fixator used in a traumatised child is not well characterised and most reports in the literature (*15*) are related to elective procedures such as limb lengthening (*14*).

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