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Retrospective analysis on use of external fixation in pediatric extremity trauma and fractures as a damage control device and their outcome in a tertiary care set up

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Abstract
Most of the fractures in children and adolescents are treated conservatively with Plaster of Paris casts, traction. Those requiring operative intervention are managed with K wires, elastic nails and plates. External fixation is used only in open fractures, vascular injuries, polytrauma patients and burns.
Methods: This is a retrospective analysis of the children records who underwent external fixation of their fractures for various reasons to find out those reasons and the bones which were fixed externally, and the results of external fixation with respect union and any complications.
Results: Twenty eight patients including 19 males (68%), age between 6 and 14 yrs average age 9.64 years were treated from 2013 to 2018. A total of thirty five fractured areas were present which included ten femur fractures, nineteen tibial fractures, five patients had vascular repairs. Union rate 100%, average time to union 10.84 weeks. One refracture femur, one varus and valgus malunions of distal tibia, one grade 4 pin tract infection, on shortening and one lengthening both less than 2cms.
Conclusions: External fixation in pediatric trauma is rather a compulsion than a choicest treatment modality, in view of hemodynamic instability, multiple injuries, open fractures and vascular injuries but with acceptable rates of union and complications.

Keywords: Pediatric, fracture, extremity, open, Polytrauma

Introduction
Most of the pediatric fractures are minor and only 20% require reduction. The greenstick and torus fractures often constitute 50% of fractures in children [1, 2]. Open fractures often result from high energy trauma and penetrating wounds. The demographic characteristics and injury mechanisms have varied widely from centre to centre [3, 4, 5]. The Periosteum in children is thick and more active than in adults, often provides good stability and robust healing with greater potential for periosteal bone formation, with lower infection rates [6, 7, 8, 9]. Stabilization of open fractures is essential, although, depending on the fracture site, rigid fixation is not always as important in children as it is in certain settings in adults. As a general principle, the more extensive the soft tissue damage, the greater the need for stable fixation to account for delayed fracture-healing and allow earlier mobility to prevent stiffness. K wires, intramedullary nails and external fixators are used depending on the anatomic site, severity of injury [10]. External fixation provides immediate and rapid stabilization of long bone fractures, allowing an easy approach to damaged soft tissues, the chest, abdomen, and pelvis, and easy manipulation and nursing of the patient in intensive care units. External fixation is a well-known treatment in adult polytrauma patients. In children, the immobilization of femoral and tibial fractures is usually carried out by immediate POP, spica cast, or skeletal traction followed by spica cast, but in children with head trauma or polytrauma, this complicates the nursing services [11]. Traditionally the indications for the use of external fixators are open fractures, and fractures with severe soft tissue injuries, burns, vascular injuries, head injuries and polytrauma patients, fractures with bone loss, comminuted fractures and fracture in leg with fasciotomy [12, 13]. In this retrospective analysis we have tried to find out the various

compulsions for external fixation of various fractures in children, which could have otherwise been managed conservatively or other methods of fixation, their outcome in terms of time taken for union and complications encountered as per the available data.

Results

Twenty eight patients including 19 males (68%), age between 6 and 14 yrs average age 9.64 years were treated from 2013 to 2018. Twelve (43%) patients were less than 10 years of age. Seventeen had history of RTA, four had fall from height, three had crush injury with some heavy object and one patient with type 3c clavicle fracture had fall of sharp heavy object on shoulder. A total of thirty five fractured areas were present which included ten femur fractures, nineteen tibial fractures, two ankle physeal fractures with loss of soft tissue, one crushed foot, one clavicle fracture, one open type 3b shaft of humerus fracture and one closed proximal humerus fracture in a patient with type 3b shaft of femur fracture. Five patients had hemodynamic instability including three floating knees and two abdominal injury patients. One patient had bilateral open tibial fractures and one femur fracture. Two patients had abdominal injuries, two had head injuries, and three patients had floating knees. Two patients had laprotomies, one had craniotomy. Five patients had vascular repairs including two popliteal, two SFA and one subclavian artery repair. Two patients needed ventilator support. One patient needed a free flap to cover the soft tissue defect and ten patients needed split skin grafts. One patient with head injury died and two patients with popliteal artery repair ended up with gangrene and amputation. There were one each of varus and valgus malunions of Distal tibia, the valgus mal union was because of physeal damage and was progressive, one grade four pin tract infections. One severe equinus deformity of ankle occurred due to severe damage to the anterior compartment muscle tendon units near ankle joint and skin loss. There was one lengthening of tibia, and one shortening, and both less than 2 cm. The EF was kept till union and fractures in EF took nine to fourteen weeks (average 10.84 weeks) for union. One refracture occurred in femur due to chronic osteomyelitis, which had to be managed subsequently with rail fixators.

Discussion

The first to use external fixation is traditionally considered to be Malgaigne (1843). However, Lambotte (1902) is considered to be the inventor of real fixators. Parkhill and Lambotte observed that metal pins inserted into the bone were tolerated extremely well by the body [14]. Most of the fractures in children are managed conservatively with close reduction and pop casts. The use of external fixators has traditionally been restricted to open fractures, fractures with burns and polytrauma patients [15-22]. Our patients treated with external fixation is a heterogeneous group, in terms of the age as children (57%) and adolescents (43%), involvement of various bones, which included femur, tibia, with fractures at various anatomic levels, ankle fractures and clavicle, open fractures, closed fractures, fractures with vascular injuries as well as patients with hemodynamic in stability in multiply injured patients. Our sole aim was to see the various reasons for external fixation of pediatric fractures in our institute, which otherwise could be managed with various modalities including flexible nailing, casting, plating with acceptable rate of complications [10, 23-29]. Over all we have found external fixation of much help in pediatric fractures, which required treatment on emergent basis due to reasons such as high grade open fractures, polytrauma, vascular injuries, or multiple fractures in same limb, with the advantages of ease of assembling and application to the patient hence saving time, and not only allowing a damage control but also a definitive method of treatment for most of these fractures We met complications such as pin tract infections, refracture. We had two amputations due to failure of vascular anastomosis in type 3c supracondylar femur fractures. One head injured patients with type 3b fracture died. One (3.84%) grade 4 pin tract infection was managed with pin removal and placement at a more distal level and fourteen (53.8%) minor pin tract infections were managed with oral antibiotics somewhat similar to Schalamon J *et al*. [30] Only one (4%) refracture occurred in our heterogeneous group lower than other studies [31]. One varus and one valgus angulation was due physeal damage unrelated to external fixation use. One equinus deformity of the ankle occurred and was due to trauma associated damage to anterior compartment musculotendinous units.

Conclusion

In conclusion, although external fixation is being used in closed fractures of the extremities in non-emergent conditions, in our institute use of external fixation in pediatric trauma is used rather in emergent conditions as damage control device and in compulsion than a choicest treatment modality, in view of hemodynamic instability, multiple injuries, open fractures and vascular injuries but with acceptable rates of union inherent to young bones with a lot of regenerative potential of Periosteum and acceptable complications.

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