



# PAEDIATRIC ORTHOPAEDIC TRAUMA EMERGENCIES: CURRENT STATUS-WHAT'S NEW-FUTURE DIRECTIONS

Nikolaos Trygonis<sup>1</sup>, Emmanuela-Dionysia Laskaratou<sup>1</sup>, Ioannis Sperelakis<sup>1</sup>, Ioannis Anifantakis<sup>1</sup>, Rozalia Dimitriou<sup>1,2</sup>

1: Department of Trauma and Orthopaedics, University Hospital of Heraklion, University of Crete, Greece; 2. Medical School, University of Crete, Greece

## ABSTRACT

Paediatric trauma represents the leading cause of mortality and disability. The orthopaedic surgeon plays a pivotal role in diagnosing and properly treating paediatric trauma with recent advances being systematically interfered in specific guidelines. In this narrative review we summarize paediatric trauma injuries, their current management focusing on existing controversies or concepts not properly supported by current data. We analyse open fractures, pelvic and spinal injuries, injuries with neurovascular compromise or ones requiring urgent reduction and the paediatric acute compartment syndrome. We conclude that although current data suggest a systemic approach to paediatric polytrauma is now implemented, there are still questions unanswered that require high-quality studies and proper follow-up.

## CONTACT

Nikolaos Trygonis M.D.  
Department of Trauma and Orthopaedics  
University Hospital of Heraklion  
University of Crete, Greece  
Email: [nikolaos.trygonis@gmail.com](mailto:nikolaos.trygonis@gmail.com)

## INTRODUCTION

The importance of trauma in children is apparent in that injury is the leading cause of death and disability in the paediatric population. Each year more than 9,000 children die of serious injury, and approximately 8.7 million children require emergency department care for treatment of their injuries. Specifically, motor vehicle accidents (MVs) are 1 of the top 2 causes of death in children of all age groups. The paediatric trauma population represents a unique challenge due to differences in anatomy, physiology and age-specific considerations. Although the principles of care for the paediatric polytrauma patient are noted as being close to the ones implemented through the Advanced Trauma Life Support (ATLS), there are subtle differences mainly because the ossified paediatric skeleton does not provide protection to the viscera, leading to other types of injuries. The aim of this review was to summarize paediatric trauma injuries, their current management focusing on existing controversies or concepts not properly supported by current data.

## Materials and Methods

This is a narrative review analyzing paediatric orthopaedic emergencies, including injuries with neurovascular compromise, pelvic and spinal injuries, open fractures, the paediatric compartment syndrome and injuries requiring urgent reduction. In each section we focused on the incidence and current guidelines of managing each injury. We illustrated the updates on management with existing controversies and discussed future directions in dealing with paediatric orthopaedic emergencies.

## Injuries with neurovascular compromise

The most common paediatric injury associated with a neural injury is the supracondylar fracture of the distal humerus. Fractures with vascular compromise should undergo reduction and fixation as soon as possible within 6 hours from the time of injury. There is no clear indications whether to perform a surgical exploration in a pink pulseless hand (no palpable radial pulse, normal capillary refill) after reduction and CRPP. Another type of injury also associated with neurological compromise is elbow dislocation with incarcerated medial epicondyle fractures and other rare injuries such as displaced femur fractures, proximal tibial fractures and tibio-femoral dislocations.

## Injuries requiring urgent reduction

Traumatic hip dislocation are an uncommon injury of the paediatric population, but a delay of more than 6 hours in reducing the hip carries a potential 20-fold increase in risk for AVN. Paediatric femoral neck fractures are also rare injuries, and currently there are no definite guidelines as to the timing of surgery and type of fixation. When fixation was delayed for more than 24 hours after injury, there was a high incidence of complications including AVN and physeal arrest. Regarding unstable SCFE it is disputed whether early stabilization may reduce the AVN risk. Timely reduction of the SCFE may restore the blood flow to the femoral head thereby decreasing the risk of AVN, however timing to surgery remains debatable.

## Open fractures

The incidence of open fractures in paediatric trauma patients is approximately 3%, with open tibial fractures being the commonest, followed by open forearm fractures. The Gustilo and Anderson classification is used. In children it is argued that tissue of questionable viability can be preserved because children have better healing potential than adults. Also the timing of debridement in fractures of type I-III is still unclear, but should not be postponed more than 24 hours. The fixation method of type III open fractures remains high controversial and there is a lack of level I data with open tibia fractures being the most challenging.

## Spine trauma

Spine injuries in children are rare (5%), with involvement mostly of the thoracolumbar spine. MRI is advised if available especially for children under 8 years of age with a cervical injury as the osteoligamentous structure of the paediatric spine and not yet ossified components mean that many injuries are not depicted in bone imaging and also plays a pivotal role in diagnosing SCIWORA injuries (5-6% of paediatric patients with spinal injuries). Children have a higher risk of developing a spinal deforming following a spinal injury, so the operative indications are still in some cases undetermined.

## Pelvic ring injuries

Paediatric pelvic ring injuries are quite rare (0.2%) fracture, they are usually the result of high-energy trauma and are often associated with a high injury severity score and a higher risk of injury to the pelvic viscera. Pelvic fracture patterns in children differ based on age and whether the triradiate cartilage is open. Routine imaging includes AP and Inlet-Outlet and Judet radiographs, however CT plays a very important role in the polytrauma paediatric patient as it enables full-body imaging and identification of injuries. The management in emergency situations follows the damage-control principle and emergency fixation is required in about 17% of cases.

## Acute compartment syndrome

The diagnosis of paediatric acute compartment syndrome (PACS) in children can be particularly challenging and requires a high level of suspicion. The classical adult manifestation is often present in the child, however the clinical findings are difficult to elicit in an agitated preverbal child. The golden standard remains prevention of PACS by recognising potential causes. In paediatric patients, good outcomes can be achieved even with delayed fasciotomies over 24 hours. Generally, children show a robust rate of nerve and muscle recovery compared to adults and a discrete linear relationship between time to diagnosis and outcomes has yet to be proved.

Table 1

Injury	Management	Points of dispute	Future research
Neurovascular compromise	Reduction and fixation	Pink pulseless hand after fixation of supracondylar fractures	Indications for exploration in supracondylar fractures-
SCFE	Early fixation and reduction dependent on stability	Time of fixation for unstable SCFE, type of fixation	Capsulotomy, biomechanical stability
Femoral neck fractures	Definite fixation	Time of fixation	Type of reduction, when to ORIF, capsulotomy
Hip dislocation	Emergent reduction	Separation of femoral epiphysis, occult dislocations	Rehabilitation
Open fracture	Use of antibiotics, wound management	Extension of debridement, when to fix Gustilo I-II open fractures	Extension of debridement, duration antibiotic course regimen
Spine fractures	Non-surgical or surgical based on condition	Prophylactic bracing, type of fixation and decompression	Sciwora injury, reducing impact of neurological deficit
Pelvic ring fractures	CT, stabilisation based on patient condition	Accepted non operative management	Type of fixation on the paediatric population varies, more aggressive fixation, operative indications
Acute compartment syndrome	Fasciotomy, immobilization of fracture	Clinical assessment in children	PACS after flexible nails Amount of debridement

## Conclusion

There have been made rigorous advances in analysing and treating the paediatric trauma. Evidence suggests that an understanding of the physiology of the child and the key differences with adults is essential. The orthopaedic surgeon needs to be properly educated in diagnosing the trauma emergency in the child and judge the proper reaction, with regard to timing of surgery, manner of fixation and further rehabilitation. However, there is lack of level I data supporting some of these guidelines and a lack of follow-up studies specifically adjusted to the paediatric population. Future directions in research should emphasize the validation of paediatric guidelines shedding light in the obscure ones.

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