Original Clinical Article

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Injuries in the competitive paediatric motocross athlete

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Abstract

Purpose The purpose of this study is to report the spectrum of injuries sustained by competitive paediatric motocross athletes at a level I trauma centre.

Patients and Methods A retrospective study of paediatric competitive motocross injuries treated at a level I trauma centre between 2004 and 2014 was performed. Athletes were included if aged less than 18 years and injured while practising or competing on a competitive motocross track. Medical records were reviewed for age, gender, race, location of accident, use of safety equipment, mechanism of injury, injury type and severity, Glasgow Coma Score at hospital presentation and Injury Severity Score (ISS).

Results In total, 35 athletes were studied. The average age was 14 years. One athlete died. Thirty athletes were injured during competition; five were injured during practice. Twenty-four athletes (69%) suffered an orthopaedic injury with a total of 32 fractures and two dislocations. Two fractures were open (6.3%). Lower extremity fractures were twice as common as upper extremity fractures. Surgery was more common for lower extremity fractures—83% *versus* 30%. The most common fractures were femoral shaft (18.8%), fibula (12.5%), clavicle (12.5%), tibial shaft (9.4%) and forearm (9.4%).

Conclusions Competitive paediatric motocross athletes suffer serious, potentially life-threatening injuries despite the required use of protective safety equipment. Femoral shaft, fibula and clavicle were found to be the most commonly fractured bones. Further prospective research into track regulations, protective equipment and course design may reduce the trauma burden in this athlete population.

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Introduction

Motocross is the most popular form of amateur motorcycle racing in the United States. Athletes compete against other racers on closed courses navigating natural and man-made terrain with hills, jumps and tight turns. The main governing body of organised motocross is the American Motorcycle Association (AMA), which consists of approximately 214 000 members, in which 38% race in AMA-sanctioned competitions.[1] Competitive motocross is a high-intensity and high-speed sport that often results in severe injuries to the central nervous system, truncal region and musculoskeletal system.[2-4] Non-competitive dirt bike injuries have been commonly reported in paediatrics.[5] For example, 38% of all dirt bike injuries encountered in one level I trauma centre were aged less than 20 years with the most commonly sustained injuries being orthopaedic extremity trauma.[6] Larsen et al reported that 95% of injuries that required hospitalisation were orthopaedic in nature.[7] Singh et al reported that 42% of paediatric injuries sustained while dirt bike riding required surgical treatment.[4] Recreational paediatric dirt bike riding is dangerous; however, no studies to our knowledge have specifically investigated the injuries sustained in the competitive paediatric motocross athlete. The purpose of this study is to report the spectrum of injuries sustained by competitive paediatric motocross athletes at a level I trauma centre.

Patients and methods

This study was approved by the College of Medicine Institutional Review Board (IRB). A retrospective review was performed for patients aged less than 18 years between 2004 and 2014. This study was performed at a level I trauma centre where patients who sustain serious injuries from motocross accidents are commonly treated. Nine competitive motocross tracks are within a 100-mile catchment area of the trauma centre. Patients were identified through the paediatric trauma database, which records all paediatric patients treated as a level I or level II trauma activation. Level I trauma activations are more severe than level II and are categorised by our institution with criteria including derangement of vital signs, mechanism

of injury, respiratory compromise and severity of known injuries upon arrival.

Patient medical records were retrospectively reviewed, including initial trauma evaluation, hospitalisations, treatments and all subsequent clinical visits related to the injury. Data collection included age, gender, race, location of accident, mode of hospital transport, use of safety equipment, mechanism of injury, injury type, Glasgow Coma Scale (GCS) at hospital presentation, Injury Severity Score (ISS), treatment and cost of treatment. The ISS is a score that improves the ability to evaluate injury care by comparing mortality experience of varied groups of trauma.[8]

Those included were motocross athletes injured while practising or competing on a two-wheeled motocross bike at a competitive track. Typical motocross athletes practice an estimated six hours per week. Exclusion criteria were athletes aged 18 years or older and injuries sustained on any vehicle other than a two-wheeled motocross bike, including three- or four-wheeled all-terrain vehicles, and recreational, non-competitive riders.

Results

We identified 35 patients that fit the inclusion criteria for this study. On average, three to four patients were injured per year. All 35 patients were injured at one of nine competitive motocross tracks. Two of the nine tracks accounted for 13 (37%) injured athletes. More races are held at these two tracks. All athletes were wearing a full face protective helmet, shatter-proof goggles, gloves, protective pants, long-sleeve jersey and at least 8-inch boots as required by AMA rules of competition.[1] A total of 16 (46%) patients were transported by ambulance, 15 (43%) by life flight and four (11%) were not reported. The average distance from the motocross tracks to the trauma centre was 47 miles. The average distance from the patient's home to the trauma centre was 96 miles. Mean patient age was 14 years (8 to 17) and a standard deviation of 3.9 years (Fig. 1). More than 90% of injuries were sustained in patients aged 11 to 17 years. All patients were white males.

The mechanism of injury varied. Jumps were reported as a mechanism of injury in 20 (57%) athletes. Collision with a second vehicle was reported in three (9%) of the accidents. One athlete (3%) struck an observation tower at the finish line, resulting in a fatality. Injuries occurred during the racing season from February to November with no injuries in December or January. Of the 35 athletes, 30 (86%) were injured during the weekend when most races are held.

Five (14%) athletes were activated as a level I trauma, 26 (74%) were activated as a level II trauma and four (12%) were not specifically listed as a level I or a level II trauma. The average GCS on evaluation was 13.9 and the standard deviation was 2.9. After evaluation in the trauma bay, 20 (57%) of the patients were admitted as floor status, nine (26%) were admitted to the intermediate care unit, five (14%) required treatment in the Intensive Care Unit and one (3%) was pronounced dead in the Emergency Department. In total, 24 (69%) athletes suffered an orthopaedic

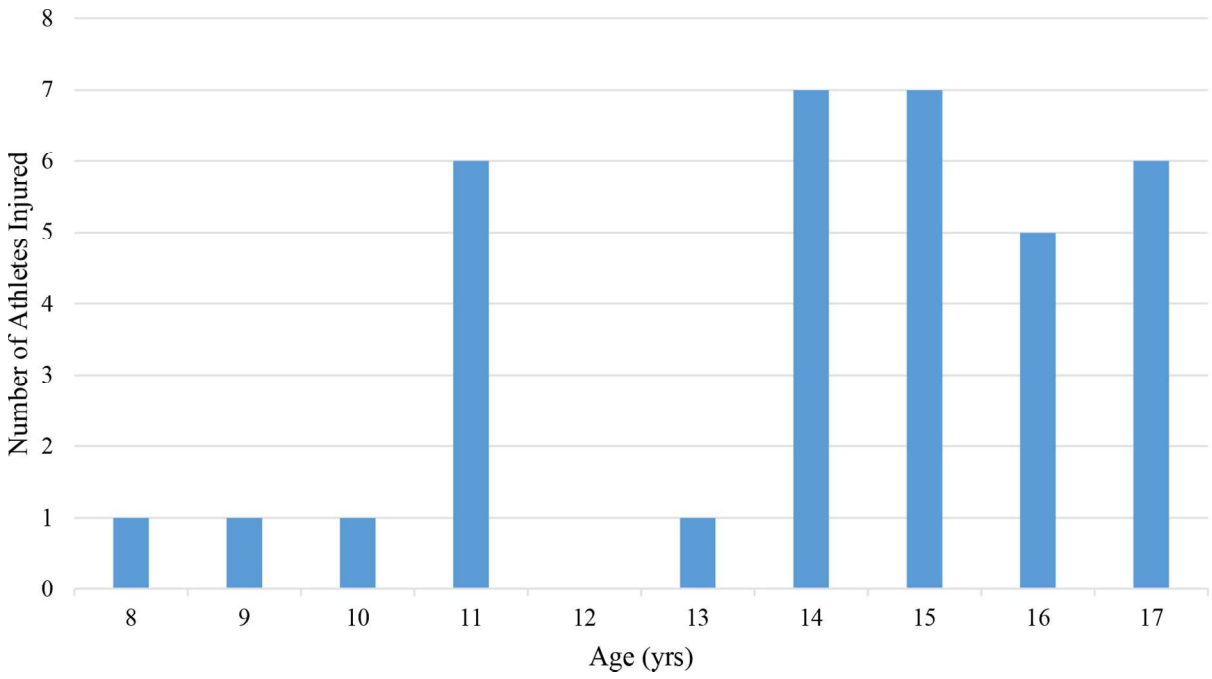

Fig. 1 Age distribution of paediatric motocross athletes injured.

JOURNAL OF CHILDREN'S ORTHOPAEDICS

injury. A total of 32 orthopaedic fractures were identified and 19 (59%) of those fractures required operative treatment. Lower extremity fractures were nearly twice as common as upper extremity fractures. Operative treatment was more common for lower extremity fractures (n = 15, 83%) than the upper extremity (n = 3, 30%). The most common fractures were femoral shaft (18.8%), fibula (12.5%), clavicle (12.5%), tibial shaft (9.4%) and forearm (9.4%), while 17 (48%) athletes sustained a concussion with the majority occurring in the 14- to 17-year-old age group (Fig. 2). Other significant non-orthopaedic injuries included facial fractures, pulmonary, cardiac and brain contusions, subarachnoid and subdural haemorrhages, splenic, kidney and pancreatic lacerations, haemothorax, pneumothorax, commotio cordis, laryngeal fracture, lacerations and cardiac arrest. The detailed list of injuries with number of injuries and operative treatment can be found in Table 1. The average cost of treatment per patient, including all post-operative care and follow-up, totalled US$28 771 (US$9156 to US$106 054).

Discussion

Competitive motocross is a growing and nationally organised sport popular among the paediatric population. Safety regulations are governed by the American Motorcycle Association (AMA). Events held at competitive motocross tracks require riders to wear a full face protective helmet, shatterproof goggles, protective pants, long-sleeve jersey and at least 8-inch riding boots.[1] Despite the required safety equipment, motocross continues to be a sport with a high rate and severity of injuries among its athletes. The purpose of this study is to report the spectrum of injuries sustained by competitive paediatric motocross athletes at a level I trauma centre.

Over a ten-year period, 35 paediatric motocross athletes required a level I or level II trauma activation at our hospital for injuries sustained during competition or practice on a closed motocross course. All participants were white males with an average age of 14 years (8 to 17). Of the nine motocross tracks, two accounted for 37% of the injuries. Additionally, over half of the injuries were related to course obstacles, such as jumps, and one fatality was due to a collision with a finish line observation tower. Course design has a significant impact on athlete safety. Every track is unique and some obstacles may be too difficult and may not be appropriate for adolescents. Current regulations exist on course design, difficulty and positioning of stationary structures; however, further research into obstacle design may improve athlete safety.[1]

Despite the use of extensively documented protective equipment, paediatric athletes suffered a large number of injuries, most commonly abrasions (n = 22), contusions (n = 19), lower extremity fractures (n = 18), concussions (n = 17) and upper extremity fractures (n = 10). Extremity fractures accounted for the highest overall number of injuries with a total of 28. Of the lower extremity fractures, 83% required surgical intervention compared with 30% in the upper extremities. Concussions were common, affecting nearly 50% of athletes. The majority of injuries and concussions occurred in the 14- to 17-year-old age

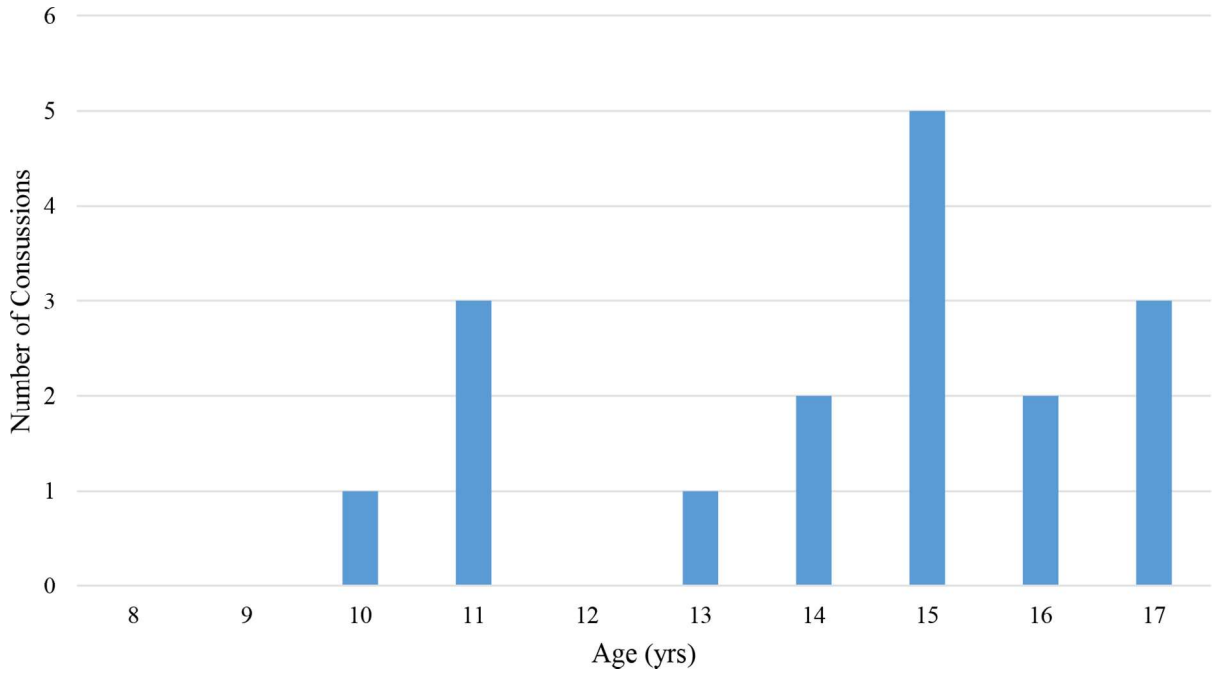

Fig. 2 Occurrence of concussions during a competitive motocross race based on the age of the patient.

Table 1. Paediatric motocross injury summary

Injury location	Injuries (n)	Operative treatment
Upper extremity fractures	**10**	**3**
Distal radius	2	1
Forearm	3	2
Humerus	1	0
Clavicle	4	0
Lower extremity Fractures	**18**	**15**
Forefoot / mid-foot	1	1
Calcaneus	1	0
Pilon	1	1
Tibial shaft	3	3
Fibula	4	2
Femur shaft	6	6
Distal femur	1	1
Hip / femoral head	1	1
Axial skeleton fractures	**4**	**1**
Spine	3	0
Pelvis / acetabulum	1	1
Joint dislocations	**2**	**1**
Femoral head	2	1
Miscellaneous	**80**	**5**
Facial fractures	3	1
Dental injury	2	1
Contusions	19	0
Pulmonary contusion	7	0
Cardiac contusion	1	0
Brain contusion/SAH/SDH	4	0
Splenic laceration	1	0
Liver laceration	2	0
Kidney laceration	3	0
Pancreatic laceration	1	1
Haemothorax / pneumothorax	2	1
Rib fractures	4	0
Commotio cordis	1	0
Laryngeal fracture	1	1
Lacerations	4	0
Sprains	1	0
Abrasions	22	0
Cardiac arrest	2	0

SAH, subarachnoid haemorrhage; SDH, subdural haematoma

group. Although previous studies have investigated the importance of properly fitting helmet use as a risk factor for concussions, other risk factors may contribute to these findings, such as physiologic developmental changes or risk-taking behaviour in adolescent males.[5] We suspect that the risk-taking behaviour plays a significant role in the high number of injuries in the 14- to 17-year-old age group. Future protective equipment design must address the rate of extremity trauma in paediatric motocross. Current AMA rules do not require shin, knee, thigh or arm guards and it is our recommendation that all paediatric motocross athletes use these additional forms of protective equipment when in competition or practice.

Our findings suggest that paediatric motocross events have the potential to tax local healthcare systems during peak event times. In total, 86% of injuries occurred on the weekend, with the highest rate of injuries during the peak season between March and October. Most athletes did not reside locally to our medical centre and lived an average distance of 96 miles away. An ambulance and Emergency Medical Technician (EMT) are required at every official practice and race,[8] while 57% of the injured athletes were transported by ambulance and 43% were transported by helicopter life flight with costs upwards of US$18 223. The total average cost of treatment was approximately US$28 000.

One limitation of the study is its retrospective nature. Additionally, our focus of study was the most severely injured paediatric motocross athletes triaged as trauma activations. We suspect more athletes were injured during competition with a lower injury severity not qualifying them for trauma activation. Further research on less severe motocross injuries treated in emergency departments and clinics is warranted.

In conclusion, our study reported the spectrum of injuries sustained by competitive paediatric motocross athletes. Many hospitals and physicians rarely encounter a patient who is involved in a motocross injury, but hospitals should be prepared to treat injuries related to motocross. We found that paediatric motocross injuries have significant economic costs, morbidity and mortality. Further prospective research into track regulations, protective equipment and course design may reduce the trauma burden in this athlete population. We recommend that hospital facilities within a motocross track catchment area stay up-to-date on local race schedules and mobilise resources accordingly.

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COMPLIANCE WITH ETHICAL STANDARDS

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OA LICENCE TEXT

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ETHICAL STATEMENT

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