

The Epidemiology, Injury Patterns and Outcomes of Horse-Related Injuries in Israeli Children

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ABSTRACT: **Background:** Horse riding has become increasingly popular in recent years and is a common activity among children. As a result, pediatric horse-related injuries are frequently encountered in emergency departments.

Objectives: To examine the characteristics of horse-related injuries in the pediatric population.

Methods: We collected and analyzed the data on all pediatric horse-related injuries presented to a tertiary hospital, level one trauma center, during the years 2006–2016.

Results: A total of 53 children with horse-related injuries were documented. Forty-two patients were male (79%) and their mean age was 11.13 ± 4.72 years. The most common mechanism of injury was falling off a horse (31 patients, 58%) and the most common type of injury was skeletal (32 patients, 60%). Head injuries occurred in 16 patients (30%) and facial injuries in 12 (23%). The mean Injury Severity Score (ISS) was 10.5 ± 6.32 , and 15 patients (28%) had severe trauma ($ISS > 15$). Twenty-nine patients (55%) required trauma team intervention, 12 (23%) were admitted to the intensive care unit, and 24 (45%) required surgery. The mean length of hospitalization was 4.3 ± 3.14 days.

Conclusions: Our study suggests that horse-related trauma may involve serious injuries and it exhibits typical injury patterns. Young boys are at highest risk. The potential severity of these injuries merits a thorough evaluation. We suggest that these injuries be triaged appropriately, preferably to a medical facility with proper trauma capabilities.

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KEY WORDS: horse riding, trauma, Injury Severity Score (ISS), pediatric emergency department

In recent years horse riding among children has become more and more popular, as both a recreational activity and a therapeutic modality [1]. As a result, injuries related to horses are increasing in prevalence [1–4]. The horse's size and the kin-

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ematics of the injuries may cause substantial damage, such as internal organ damage [5,6], and head [7] and spine injuries [4]. These injuries result in significant morbidity and even mortality [1,2]. It was previously shown that the leading risk factors, such as lack of supervision, lack of experience, and non-usage of protective gear (e.g., helmets, kneepads, and hand protectors) lead to increased severity of these injuries [1,3]. It was also shown that types and mechanisms of injuries differ among age groups [8]. While several studies have outlined the mechanisms and patterns of horse-related injuries in the pediatric population, to the best of our knowledge only one study examining horse-related injuries has been performed in Israel and this study did not focus on children [9]. The aim of the present study, therefore, was to identify the incidence, mechanisms, and patterns of horse-related injuries in the pediatric population.

PATIENTS AND METHODS

The study was performed in a single tertiary level one trauma medical center in Jerusalem, Israel. The records of all patients up to 18 years old who presented as a result of horse-related injury during the period 24 June 2006 to 1 December 2016 were analyzed.

Data regarding demographics, details of injury (mechanism, anatomical region, and type of injury), Injury Severity Score (ISS), respiratory status on arrival, intensive care unit (ICU) admissions, surgical interventions, hospital length of stay, and various outcomes were extracted from patients' files. The study was approved by the institutional review board (approval # 0695-16-HMO) and the need for informed consent was waived.

STATISTICAL ANALYSIS

Data were presented as mean and standard deviation (SD), or number of patients and percentage. Fisher's exact test was used to test the association between two categorical variables. The non-parametric Mann–Whitney and Kruskal–Wallis tests were used to compare continuous variables between two or three independent groups, respectively. Pearson's correlation coefficient and the non-parametric Spearman's correlation coefficient were calculated to estimate the correlation between two

continuous variables. In order to examine simultaneously the effect of two factors on a dependent continuous variable, we used a two-way analysis of variance model. All tests applied were two-tailed, and a P value ≤ 0.05 was considered statistically significant.

RESULTS

During the aforementioned period, 53 children (up to 18 years old) presented to our trauma center and the pediatric emergency department following horse-related injuries. The mean age at presentation was 11.13 ± 4.72 years. Most of the patients were male ($n=42$, 79%) [Table 1]. There was no change in the admission rate over the years.

The most common mechanisms of injury were falling off the horse (31 children, 58%) and getting hit by a horse (13, 25%) [Table 2]. Eleven children (21%) were kicked by a horse and 2 (4%) collided with an object (e.g., vehicle, tree) while riding a horse. Head trauma ($n=16$, 30%) was the most common injury, followed by injuries of the extremities (upper and lower combined) in 15 patients (28%). Other injuries included the face ($n=12$, 23%), chest ($n=7$, 13%), abdomen ($n=4$, 8%), and spine ($n=2$, 4%). The most common patterns of injury were skeletal fractures, occurring in 32 children (60%), and intracranial hemorrhage in 12 (23%). Five patients (9%) had internal chest injuries, 4 (8%) had abdominal injuries of whom 3 had spleen laceration and one had perforation of the small bowel. Minor

injuries and lacerations occurred in 4 patients (8%). Four children (8%) sustained multiple significant injuries [Table 2].

Twenty-four patients (45%) required surgical interventions. Most of the surgeries were orthopedic (11, 46%), followed by maxillofacial (9, 38%), general (2, 8%), and neurosurgery (2, 8%). Twenty-nine patients (55%) required trauma team intervention and 12 (23%) were admitted to the ICU. Mean length of hospitalization was 4.3 ± 3.14 days (range 1–15 days). The mean ISS was 10.5 ± 6.32 (range 4–34), with severe trauma (ISS > 15) occurring in 15 children (28%) [Tables 1 and 3].

The time of arrival at the pediatric emergency department did not predict any change in the outcome. There was no difference in the prevalence of intubations ($P = 0.61$), trauma team intervention ($P = 0.28$), length of hospitalization ($P = 0.85$), or hospitalization outcome (discharge to a rehabilitation center

Table 1. Demographic characteristics and treatment outcomes in pediatric horse-related trauma

	N (53)	%
Gender		
Male	42	79%
Female	11	21%
Age (mean \pm SD)	11.13 ± 4.72	
Breathing		
Spontaneous breathing	46	86%
Oxygen mask	4	8%
Intubation in PED	3	6%
Trauma unit intervention	29	55%
Operation room	24	45%
ISS (mean \pm SD)	10.5 ± 6.32	
Severe trauma (ISS > 15)	15	28%
Hospitalization (> 1 day)	48	
Duration, days (mean \pm SD)	4.3 ± 3.14	91%
ICU hospitalization	12	
Duration, days (mean \pm SD)	3.25 ± 2.19	23%
Discharge destination		
Home	49	92%
Rehabilitation facility	2	4%
Transfer to other hospital	1	2%
Died	1	2%

ISS = Injury severity score, ICU = Intensive care unit, PED = pediatric emergency department

Table 2. Comparison of mechanism, region and type of injury in horse-related trauma on presentation to the trauma unit/pediatric emergency department

	N (53)	%
Mechanism of injury		
Fell off a horse	31	58%
Hit by a horse	13	25%
Kicked by a horse	11	21%
Moving object collision	2	4%
Region of injury		
Head	16	30%
Extremities	15	28%
Face	12	23%
Thorax	7	13%
Abdomen	4	8%
Spine	2	4%
Type of injury		
Fracture	32	60%
Intracranial hemorrhage	12	23%
Chest injury	5	9%
Abdominal injury	4	8%
Skin laceration	4	8%

Table 3. Demographic and clinical characteristics in severe horse-related trauma (ISS > 15)

	N (15)	%
Gender		
Male	13	87%
Female	2	13%
Age (mean \pm SD)	10.73 ± 4.34	
Mechanism of injury		
Fell off a horse	8	53%
Hit by a horse	4	27%
Kicked by a horse	2	13%
Collision with moving object	1	7%
Type of injury		
Intracranial hemorrhage	9	60%
Abdominal injury	5	33%
Head laceration	1	7%

or mortality, $P = 1.0$) between children who presented in the evening and night hours and children who presented during the morning working hours. There was no significant correlation between age ($P = 0.79$), gender ($P = 0.62$), or mechanism of injury ($P = 0.51$), and the ISS score. ISS was found to correlate with an increase in airway protection procedures (intubations) ($P = 0.004$), higher trauma team intervention ($P = 0.008$), and dismal hospitalization outcome (discharge to a rehabilitation center or death, $P = 0.023$). However, there was no significant increase in duration of hospitalization among patients with a high ISS score ($P = 0.42$). One patient (2%) died from collision with a vehicle while riding the horse.

DISCUSSION

Horse-related injuries are common among children and usually occur in the setting of recreational activity [1]. Several studies have assessed these injuries in terms of demographics, mechanism of injury, and pattern and severity of injury in different regions of the world [10,11]. To the best of our knowledge, only one study has assessed horse-related injuries in the general population of Israel [9], while no such study has addressed the pediatric population of Israel. Since the severity of horse-related injuries might be also culturally and regionally dependent, our aim was to characterize horse-related injuries in the pediatric population of Israel.

Unlike other studies [1,10,12,13], in our cohort, horse-related injuries were more common among males, similar to findings in the general Israeli population [9]. This finding could be explained by the use of horses for agriculture in rural areas rather than for recreational use. In our study, an increased incidence of injuries was found among adolescents, as shown elsewhere [2,10], which may be related to the longer duration of grooming a horse among adolescents compared to younger children. Like other types of trauma, in our study the population with the highest risk of horse-related injuries was the age group 11–16 years old (average 11.13), similar to previous findings of an average age of 10.4 [13] and 12.0 [10] years. Another study on horse-related injuries in Israel found an increased incidence during the years 1985–1997 and a plateau during the years 1998–2008 [9]. We also found no increase in incidence during the years 2006–2016.

The common mechanism of injury was falling off a horse (58%), followed by a kick by a horse (21%). The findings regarding falling off a horse are compatible with some studies [9,11,13], while other studies report higher rates of falling off a horse but lower rates of injuries from a kick [2,10,12]. Four patients had two different mechanisms of injury, but no significant difference regarding severity of injury was found when comparing them to children with one mechanism of injury ($P = 0.37$). It is possible that lack of supervision and guidance in the Israeli population results in a higher incidence

of injuries from horse kicks. The two most common regions of injury were the head (30%) and the extremities (28%), with upper extremities more common than lower. Some studies reported head injuries as the more common [8,10], while in others extremity injuries were the most common [1,12]. The high prevalence of head injuries in the pediatric population can be attributed to a large head-body ratio [14], or to lack of awareness and enforcement of protective gear usage.

The most common pattern of injury was fractures (60%), compared to other studies, namely 27.7% [1] and 37% [10]. These results can be related to lack of proficiency and non-usage of protective equipment [10,11].

In our study 24 patients (45%) required surgery, a high percentage compared to other studies from Israel (16.85%) [9] and worldwide (8.2%) [2]. A relatively high rate of patients was admitted to the ICU or required trauma team intervention compared to elsewhere [2]. Only one death was recorded, concurring with the mortality rate in other studies [2,9,15]. Mean ISS was 10.5 ± 6.32 , which was twice as high as previously described in children [8,10,11] but compatible with findings in the adult population in Israel [9]. When comparing the children who underwent surgery with those who did not, we found no significant difference in age ($P = 0.69$), mechanism of injury ($P = 0.14$), or gender ($P = 0.49$).

Unlike other studies that showed increased injury severity among younger children or among children who were not mounted [10], in our study there was no correlation between age or mechanism of injury and ISS. Our findings suggest that horse-related injuries might have distinct characteristics that are culturally dependent. This could be explained by adherence to the use of protective equipment (e.g., helmets), the presence of a parent or caregiver, or even the instructor especially in unmounted injuries, and the setting of the horse-riding activity (supervised versus unsupervised horse riding).

Our study has some limitations. Being retrospective, data regarding helmet use or other protective gear were missing in many of the charts. Also, given that our medical center is the main trauma facility in the region, there might have been a selection bias since an increased number of severely injured children were referred to our hospital.

CONCLUSIONS

Horse-related trauma may involve serious injuries and it exhibits typical injury patterns. Our findings suggest that horse-related injuries should be assessed in tertiary level one trauma centers whenever possible. An interventional program for safe riding practice might be advisable to decrease the severity of horse-related injuries.

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Capsule

Teaching baby B cells

Antibodies are central to immune defense. B cells can generate several antibody isotypes that fulfill different functional roles, and repeated antigen exposure induces antibody somatic hypermutation. **Nielsen** et al. studied a longitudinal birth cohort to determine how antigen exposure early in life affects human antibody production. Somatic hypermutation increased as the children got older, and certain VH genes

were associated with different isotypes. Increased pathogen exposure was associated with immunoglobulin D (IgD) and IgM mutations. Interestingly, children with eczema or allergies had higher rates of IgE mutation. These valuable data shed light on how human B cells grow up.

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Capsule

Comparing tumor growth to development

The tumor microenvironment – the milieu in which tumor cells reside – is often dysregulated compared with normal tissues. This action can help support tumor growth as well as counteract therapeutic strategies. In a perspective, **Li and Stanger** revisited the idea that tumor cells remodel their environment, similar to the role of organizers in embryonic development. The authors discussed the evidence

that genetic alterations, which drive tumor cell initiation and progression, can also drive tumor microenvironment dysregulation to support growth and metastasis. Targeting the tumor microenvironment could thus lead to improved therapeutic strategies.

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Capsule

Dendritic cell dynamics

Conventional dendritic cells (cDCs) are critical to innate immunity and orchestrating adaptive T cell responses. cDCs originate from a common precursor and can be delineated into different subtypes. **Cabeza-Cabrero** and colleagues used multicolor fate mapping in mice to show that precursor cDCs enter tissue, differentiate into a single subtype, and proliferate as clones of sister cDCs under steady-state conditions. Viral

infection caused a rapid influx of cDCs into infected tissue, where they differentiated into tissue-resident cDCs, diluting preexisting cDC clones. Thus, infection can cause rapid changes in cDC populations.

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