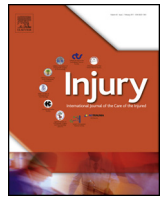




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On and off the horse: Mechanisms and patterns of injury in mounted and unmounted equestrians

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ABSTRACT

Introduction: The purpose of this study is to determine whether discrepant patterns of horse-related trauma exist in mounted vs. unmounted equestrians from a single Level I trauma center to guide awareness of injury prevention.

Methods: Retrospective data were collected from the University of Kentucky Trauma Registry for patients admitted with horse-related injuries between January 2003 and December 2007 ($n = 284$). Injuries incurred while mounted were compared with those incurred while unmounted.

Results: Of 284 patients, 145 (51%) subjects were male with an average age of 37.2 years (S.D. 17.2). Most injuries occurred due to falling off while riding (54%) or kick (22%), resulting in extremity fracture (33%) and head injury (27%). Mounted equestrians more commonly incurred injury to the chest and lower extremity while unmounted equestrians incurred injury to the face and abdomen. Head trauma frequency was equal between mounted and unmounted equestrians. There were 3 deaths, 2 of which were due to severe head injury from a kick. Helmet use was confirmed in only 12 cases (6%).

Conclusion: This evaluation of trauma in mounted vs. unmounted equestrians indicates different patterns of injury, contributing to the growing body of literature in this field. We find interaction with horses to be dangerous to both mounted and unmounted equestrians. Intervention with increased safety equipment practice should include helmet usage while on and off the horse.

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Introduction

Approximately 1 in 63 Americans is involved in some capacity with the horse industry and an estimated 30 million people ride horses each year in the United States, resulting in 78,279 visits to the Emergency Department in 2007 [1–3]. Several studies estimate the rate of injury to range from 1 per 350–1000 h of horseback riding or 18.7 injuries per 100,000 horse-related interactions [4–6]. By comparison to other sports, such as wrestling (10.7/1000 h) or football (6.1/1000 h), equestrian injury is less frequent, though the injury type and severity may differ. Hospital admission is common among equestrians by comparison to motorcyclists and snow skiers [4,7]. Between 20% and 30% of adult equestrians and up to

50% of children (3–18 years) presenting to the Emergency Department are admitted to the hospital, and one in 10,000 riders dies in a given year [5,7–9].

Kentucky represents a US national focal point of equitation with 1 in 22 residents actively involved in the horse industry and 50% of horses being utilized for recreation [3]. This environment facilitates a broad spectrum of participation from recreational riding to professional racing, training, diverse competition and the equine veterinary sciences. In comparison to a prior 5-year study at the same center, horse-related injuries have significantly increased at the University of Kentucky, a Level I trauma center in central Kentucky (0.75% vs. 2.2%, $p < 0.01$) [10]. This suggests an increase in equestrian interaction throughout the state. To identify opportunities for injury prevention, we re-evaluated equestrian injuries at our center by examining differences in patterns of injury among mounted and unmounted equestrians via our own trauma database. It is hypothesized that mounted and unmounted equestrians have distinctly different patterns of injury and that specific targets for injury prevention can be identified.

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Table 1.1
Demographic indices of patients identified in the University of Kentucky Trauma Registry between January 2003 and December 2007 (n=284), separated as mounted (n=208) vs. unmounted (n=76). Statistical significance (*p<0.05) comparison between mounted and unmounted.

Category	Mounted Mean (sd)	Unmounted Mean (sd)	p Value
Age (years)	38.1 (16.7)	34.8 (18.6)	0.16
Length of hospital stay (days)	3.7 (3.5)	2.9 (2.3)	0.08
Length of ICU stay (days)	0.5 (3.5)	0.25 (0.9)	0.58
Glasgow coma scale	14.6 (1.7)	14.3 (2.6)	0.41
Injury severity score	11.5 (7.8)	10.2 (9.6)	0.25
Category	Mounted n (%)	Unmounted n (%)	p Value
Male patients	99 (48%)	46 (60%)	0.07
Female patients	109 (52%)	30 (40%)	
Recreational	191 (92%)*	52 (68%)	<0.01
Occupational	17 (8%)	24 (32%)*	
Helmet usage	12 (6%)*	0	0.04
Mortality	0	3 (4%)*	0.04

Methods

Equestrian injury data were sampled from the University of Kentucky Trauma Registry between January 2003 and December 2007. Data points included age, gender, injury severity score (ISS), abbreviated injury score (AIS) by body region, Glasgow coma scale score (GCS), safety equipment usage, blood alcohol level, surgical procedures, length of hospital stay, length of stay in the ICU, discharge disposition, and whether the injury was occupational or recreational in nature. Age, gender, length of hospital stay, length of ICU stay, GCS, and injury severity score were compared via unpaired t-test and reported as mean and standard deviation. Occupational vs. recreational injuries, helmet usage, mortality, AIS scoring and surgical procedures were compared by doubling the one-tailed probability from Fisher’s exact test and reported as significant when p < 0.05. Severe head injuries were defined by an AIS score of 5; moderate, 3–4; and mild, 2.

Results

Between 2003 and 2007, 12,668 injuries were entered into the University of Kentucky Trauma Registry due to blunt force trauma. Of total blunt trauma, 284 (2.2%) cases were due to interaction with horses. Demographic data are summarized in Table 1.1. Mean age upon admission was 37.2 years (S.D. 17.2, 2–79). 51% were male. Three deaths occurred (3/284, 1%), all in the unmounted cohort, due to kick to the chest, kick to the head, or head injury after fall from a trailer while loading a horse. The mean ISS scores of mounted vs. unmounted groups are 11.5 (S.D. 7.8) and 10.2 (S.D. 9.6), respectively. The mounted group had more injuries during recreation while the unmounted group had more during occupation (92% vs. 68%, and 32% vs. 8%, p < 0.01). Females within the mounted group were younger than males (34.7 vs. 41.8, p < 0.01)

Table 1.2
Demographic indices comparing males and females within either mounted (n=208) or unmounted (n=76) cohorts. Statistical significance (*p < 0.05).

Category	Mounted		p Value	Unmounted		p Value
	Males (n=99) Mean (sd)	Females (n=109) Mean (sd)		Males (n=46) Mean (sd)	Females (n=30) Mean (sd)	
Age (years)	41.8 (16.1)*	34.7 (16.5)	<0.01	37.0 (19.1)	31.5 (17.5)	0.2
Length of hospital stay (days)	4.0 (4.0)	3.4 (3.0)	0.23	3.0 (2.0)	2.8 (2.7)	0.7
Length of ICU stay (days)	0.3 (1.7)	0.6 (4.5)	0.6	0.3 (0.9)	0.2 (0.9)	0.5
Glasgow coma scale	14.8 (1.3)*	14.3 (2.0)	0.05	14.4 (2.5)	14.2 (2.8)	0.8
Injury severity score	11.1 (6.3)	11.9 (9.1)	0.5	9.5 (6.2)	11.3 (13.3)	0.4

Table 2
Mechanisms of injury in mounted and unmounted equestrians (n=290).

Mechanism	Mounted n (%)	Unmounted n (%)
Thrown/fall	157 (73)	1 (1)
Thrown and dragged	5 (2)	0 (0)
Thrown and crushed	39 (18)	0 (0)
Kicked	5 (2)	59 (78)
Crushed	0 (0)	15 (20)
Carriage related	5 (2)	1 (1)
Hit by vehicle while riding	3 (1)	

and had a lower mean GCS score (14.3 vs. 14.8, p = 0.05) upon admission, as summarized in Table 1.2.

Patients were most commonly injured while engaged in recreation (85%), most frequently following a fall from mount (54%) (Table 2). Other injuries were less common, attributable most commonly to a kick (22%). Extremity fracture (33%) and head injuries (27%) were most common overall. Whereas facial and abdominal injuries were more common among unmounted equestrians (p < 0.01, p < 0.01, respectively), chest and leg injuries were more common in the mounted group (p = 0.03, p < 0.01, respectively). However, the rate of head injury was not different between mounted and unmounted equestrians. AIS data are summarized in Tables 3.1 and 3.2 and comparison of head injury severity in unmounted vs. mounted equestrians is in Table 4.

Surgery was required in 118 cases (42%) with lower extremity fracture fixation the most common surgical procedure in both mounted and unmounted equestrians (51% and 39%, Table 5). Significantly more pelvic fracture repairs were performed among mounted equestrians (20% vs. 0%, p < 0.01).

Discussion

The purpose of the present study is to determine whether discrepant patterns of horse-related trauma exist in mounted and unmounted equestrians at a single Level I trauma center in an area of dense equine-human interaction. Prior studies have indicated that both riders and handlers are at risk of significant injury and that safety equipment should be employed when in close proximity to the animal [11,12]. In order to guide further injury prevention efforts, we describe the mechanisms and patterns of injury in mounted and unmounted equestrians.

Internationally, the most commonly injured equestrian is a young (<=30 years) female falling from mount during recreation, a pattern similarly demonstrated in the present study [13,14]. Indices of age, length of hospital/ICU stay, GCS, and ISS were not different overall between mounted and unmounted equestrians. Females were significantly younger within the mounted group and had lower GCS scores upon admission, owing to a GCS <8 in 5 female riders vs. 1 male. Only one female patient was wearing a helmet at the time of injury. This pattern is well described in

Table 3.1

Counts of injuries by region and AIS score in mounted equestrians (n=208). Statistical significance (*p < 0.05) compared to unmounted group in Table 3.2.

AIS score	Head	Face	Neck	Chest	CS	TS	LS	Abdomen	Arm	Leg	External	Total
1–5 (Total)	75	27*	1	82*	11	19	27	37*	43	144*	42	508
1	5	13	1	9	1	0	0	2	6	7	42	86
2	37	12	0	7	4	10	18	16	27	44	0	175
3	19	2	0	42	0	2	8	12	10	92	0	187
4	11	0	0	24	4	7	1	7	0	1	0	55
5	3	0	0	0	0	0	0	0	0	0	0	3
6	0	0	0	0	2	0	0	0	0	0	0	2

AIS = abbreviated injury score, CS = cervical spine, TS = thoracic spine, LS = lumbar spine.

Table 3.2

Counts of injuries by region and AIS score in unmounted equestrians (n=76). Statistical significance (*p < 0.05) compared to mounted group in Table 3.1.

AIS score	Head	Face	Neck	Chest	CS	TS	LS	Abdomen	Arm	Leg	External	Total
1–5 (Total)	26	38*	0	16*	3	2	5	30*	9	21*	20	170
1	1	19	0	4	0	0	0	4	2	1	20	51
2	8	17	0	4	1	2	3	8	3	9	0	55
3	6	2	0	6	2	0	2	13	4	11	0	46
4	7	0	0	0	0	0	0	5	0	0	0	12
5	4	0	0	0	0	0	0	0	0	0	0	4
6	0	0	0	2	0	0	0	0	0	0	0	2

AIS = abbreviated injury score, CS = cervical spine, TS = thoracic spine, LS = lumbar spine.

the literature, leading several authors to advocate targeted training in this high-risk group [13,15].

Multiple studies have described head and extremity injury as most common in riders secondary to fall from mount [10,15–18]. Soft tissue trauma and fracture predominate in this group with concussion noted as the most common cause of hospitalization [13,18,19]. The mean ISS score for riders is 11.5 in the present study, which is not different from handlers and approximates the most common maximum mean ISS of 12 reported in the literature [10,20]. Ball et al. observe that severely injured equestrians with ISS ≥ 12 represented only 2% (151 of 7941) of horse-related injuries treated at their center [20]. Among more severely injured riders (ISS ≥ 12), such as professional jockeys and jumping competitors, trauma to the trunk is more commonly seen, likely owing to increased forces contributing to the injury [5,20,21]. In one series, rib and clavicle fracture as well as hemo/pneumothorax was observed in over half of patients [20]. While spinal trauma is relatively less common among riders, lumbar and thoracic injuries predominate over cervical [5].

In contrast to injuries suffered by riders, kick and crushing mechanisms are commonest among unmounted handlers, resulting most frequently in trauma to the chest and abdomen [11,22]. In one series, abdominal trauma resulted in serious visceral injuries with hand, foot and rib fracture accounting for over half of the total fractures [22]. Meredith and Antoun suggest that, though fall from mount may be a more frequent cause of facial trauma, unmounted kick is the most common mechanism for facial fracture [23].

Findings from the present study reiterate these distinct patterns described in the literature. Significantly more injuries to the chest and lower extremity were noted among riders. The majority was attributed to rib fractures and pneumothoraces with approximately equal numbers of fractures to the tibia, fibula and femur. Handlers more frequently injured the face and abdomen, owing to facial fracture and liver and splenic laceration secondary to kick mechanism. Extremity fracture followed by head and abdominal trauma were the most common injury patterns overall. Head trauma occurred at a rate that was not different between riders and handlers, a finding not previously reported. In concert with the current literature, this reiterates the risk of head injury to both riders and handlers and the need for encouraged helmet utilization at all times during equestrian activity [12,23].

The United States Equestrian Federation (USEF) began requiring helmets for sanctioned jumping events in 1964 [19]. Since that time, the United States and Europe have instituted standardization criteria for helmets and protective vests utilized during a variety of equestrian competitions [2,19,21]. Improvements in headwear have resulted in as much as a 40% absolute risk reduction in head injuries observed in one series from the United Kingdom [15]. Nevertheless, head injury remains one of the commonest and most devastating equestrian traumas, promoting the notion that head injury prevention is synonymous with prevention of death from

Table 4

Closed head injuries (CHI) in mounted (n = 61) vs. unmounted (n = 16) equestrians.

	n (%)
<i>Severe CHI</i>	
Mounted	2 (3)
Unmounted	2 (13)
<i>Moderate CHI</i>	
Mounted	24 (39)
Unmounted	6 (38)
<i>Mild CHI</i>	
Mounted	35 (57)
Unmounted	8 (50)

Table 5

Mounted (n = 87) and unmounted (n = 31) equestrians undergoing surgical repair of horse related injuries. Statistical significance (*p < 0.05) between groups.

Type	Mounted n (%)	Unmounted n (%)
Lower extremity repair	45 (51)	12 (39)
Pelvic fracture repair	17 (20)*	0 (0)
Upper extremity repair	11 (13)	3 (10)
Spinal fracture repair	7 (8)	2 (6)
Exploratory laparotomy	6 (7)	5 (16)
Irrigation and debridement	6 (7)	1 (3)
Facial fracture repair	5 (6)	5 (16)
Craniotomy	2 (2)	3 (10)
Laceration repair	1 (1)	1 (3)
Skin graft	1 (1)	0 (0)
Fasciotomy	0 (0)	1 (3)

horse-related injury [10,20]. Though no protective equipment absolutely prevents injury, helmet usage indeed reduces the number and severity of head trauma in falls from mount [21,23].

Head injuries were significantly reduced (27% vs. 44%, $p < 0.01$) between the present and prior studies (January 1994–December 1998) from this center in association with a reduction in overall mortality (1% vs. 6.7%, $p = 0.01$) [10]. However, reported helmet usage did not increase between these time periods, suggesting the possibility of incomplete reporting, low utilization or improved medical/surgical care for those suffering head trauma, as survival following head injury significantly improved vs. historical comparison (94% vs. 85%, $p = 0.02$) [10]. Though helmet usage is more regularly reinforced in riders vs. handlers, rates of head injury in the present study were similar between mounted and unmounted equestrians, supporting the need for helmets at all times around horses [12,23]. Given that two of the three mortalities were due to fatal blow to the head while unmounted, this is a potential area of focus for future injury prevention.

Despite evidence in support of universal helmet precautions around horses, overall utilization is inconsistent with a variable range of 10–80% [8,10,19,20]. A survey of experienced riders in Alberta yielded only a 9% rate of helmet usage despite the involvement of nearly half in prior falls from mount [20]. Given that minor injuries are far more common than severe trauma, many equestrians may be afforded a false sense of security regarding injury risk [19]. Such findings have led Meredith and Antoun to conclude that the institution of primary prevention strategies in addition to encouraged helmet utilization will likely improve future outcomes [23].

Regional outreach programmes, such as Saddle up Safely, seeks to address this discrepancy by providing information on effective riding and handling practices, equipment usage, and equine behaviour to amateur riders through a series of videos, publications and quizzes available online [24]. Area lectures and workshops are promoted via social media and the programme blog. Notably, the website instructs equestrians on the purchase and correct fitting of the current industry standard helmet, while dispelling common misconceptions regarding helmet usage (i.e. all helmets are equally effective). Though the university hospital distributes freely available literature from Saddle Up Safely, one potential future direction could be the provision of these materials with brief counselling to the appropriate patients upon discharge in an effort to reduce recidivism among equestrians.

Additional protective equipment has been advocated as a part of standard practice in specific equestrian settings. Given the rate of kick injuries to handlers, some studies have endorsed the use of vests for stabling personnel [22]. Meredith observes that, despite the increased likelihood of facial fractures due to kick in unmounted equestrians, helmet usage is rarely encouraged among this group [23]. She further advocates the development of “anterior guarding” as an accessory to current helmet design for handlers [23]. Back protectors were first recommended in 1994 for certain competitions and protective vests are currently mandatory for the cross-country phase of eventing and professional racing [19,21]. The affect of vests upon injury prevention is incompletely studied though the development of spontaneously inflating air jackets shows potential for future direction among equestrians and motorcyclists [25,26]. Further research endorses prevention of rein entrapment with non-slip gloves, wrist protection with rigid stabilization and properly fitting equipment, boots and safety release stirrups to prevent dragging [14,15,24].

Rates of surgical intervention among children and adults range between 17% and 50% in the literature [9,20,27]. Extremity fracture repair in adults and oromaxillofacial repair in children are most commonly reported [20,28]. In the present study, surgical repair was performed in 118 cases (42%) with lower extremity repair as the

most common in both riders and handlers (51% and 39%, respectively). Significantly more pelvic fracture repairs were performed among the mounted group, likely reflecting the difference in predominant mechanism of injury. Given the relatively small numbers of interventions, further investigation will be important to better characterize surgeries in the injured equestrian.

Association between alcohol usage and horse-related injury is limited in the literature. A CDC study of horse-related deaths in North Carolina found that 33% of decedents tested positive for alcohol intoxication [29]. Other studies suggest approximate usage between 6% and 19% [2,10,20]. The present study reports alcohol toxicology in only 6 (2%) patients, though sampling was incomplete. Further studies are needed to determine the prevalence and relevance of alcohol intoxication in equestrian injury.

Conclusion

In conclusion, this report reiterates and contributes several findings to the body of literature concerning equestrian injury:

1. Reduction in head trauma coincides with reduction in mortality, as both were reduced in the present study by historical comparison (27% vs. 44%, $p < 0.01$; 1% vs. 6.7%, $p = 0.01$, respectively).
2. Horses are dangerous to riders and handlers, as evidenced by equal rates of head injury. This finding reinforces the need for protective equipment usage at all times around horses.
3. Mounted and unmounted equestrians share distinct injury patterns, despite equal rates of head injury.

Conflict of interest statement

The authors have no conflicts of interest to report related to this manuscript.

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