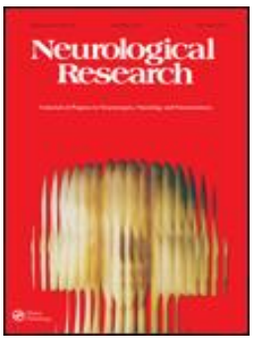

Taylor & Francis
Taylor & Francis Group

Neurological Research

A Journal of Progress in Neurosurgery, Neurology and Neuro Sciences

ISSN: 0161-6412 (Print) 1743-1328 (Online) Journal homepage: http://www.tandfonline.com/loi/yner20

Straight from the horse's mouth: neurological injury in equestrian sports

Vasisht Srinivasan, Clifford Pierre, Benjamin Plog, Kaushik Srinivasan, Anthony L. Petraglia & Jason H. Huang

To cite this article: Vasisht Srinivasan, Clifford Pierre, Benjamin Plog, Kaushik Srinivasan, Anthony L. Petraglia & Jason H. Huang (2014) Straight from the horse's mouth: neurological injury in equestrian sports, Neurological Research, 36:10, 873-877, DOI: 10.1179/1743132814Y.0000000373

To link to this article: http://dx.doi.org/10.1179/1743132814Y.0000000373

Published online: 13 Apr 2014.

Straight from the horse's mouth: neurological injury in equestrian sports

Vasisht Srinivasan[1], Clifford Pierre[1], Benjamin Plog[2], Kaushik Srinivasan[3], Anthony L. Petraglia[1], Jason H. Huang[4]

[1]University of Rochester Medical Center, Department of Neurosurgery, NY, USA, [2]University of Rochester, School of Medicine and Dentistry, NY, USA, [3]Case Western Reserve University, School of Law, Cleveland, OH, USA, [4]Department of Neurosurgery, Baylor Scott & White Health System, Temple TX, USA

Objectives: Equestrian sports can result in a variety of injuries to the nervous system due to many factors. We describe our series of 80 patients with injuries sustained during participation in equestrian sports.
Methods and Results: All patients seen at the regional trauma center with injuries associated with equestrian sports between 2003 and 2011 were reviewed; 80 patients were identified. Fifty-four per cent were female and the average age was 37 years (2.2–79.3). The mean injury severity score (ISS) was 9.9 $\pm$ 0.7. Only two patients had documented helmet use. Glasgow coma score (GCS) was 15 in 93% of patients. The most common neurosurgical injuries were to the cranial vault (28%), including concussions, intracranial hematomas and hemorrhages, and skull, facial, and spine fractures (10%), with the majority (63%) being transverse process fractures. The mechanisms of injury varied: 55% were kicked or stepped on, 28% were thrown or fell off, and 21% were injured by the horse falling on them. The causes ranged from carelessness and lack of attention to animal factors including inadequate training of horses and animal fear. Fourteen per cent required surgery. There were no mortalities and average length of stay was 3.7 $\pm$ 0.35 days. All patients were discharged home with 95% requiring no services.
Discussion: Equestrian sports convey special risks for its participants. With proper protection and precautions, a decrease in the incidence of central nervous system injuries may be achieved. Neurosurgeons can play key roles in advocating for neurologic safety in equestrian sports.

Keywords: Concussion, Closed head injury, Equestrian sports, Neurosurgical trauma, Spine trauma

Introduction

Horseback riding is a sport enjoyed by millions of people nationwide,[1–3] though it is unique in that the athlete participates with a non-human animal instead of a machine or other teammates. This facet of the sport requires not only that the rider masters the fundamentals of the sport, but also care, control, and behavior of the animal itself. Injuries involving equestrian sports occur frequently[1,4–12] with many causes described,[4,7–16] but ultimately, proper training and adequate safety precautions are the only viable solution to injury prevention.

Prior studies[4,7–20] have attempted to fully catalog the epidemiology of horse-related injuries and throughout the last several decades, neurosurgical injuries continue to occur with concussions and fractures as the most common causes of hospitalization.[1,15] Despite national equestrian organizations' attempts to curb injuries, the uncertain nature of dealing with another living organism continues to make equestrian sports more dangerous than automobile racing, motorcycle riding, and rugby.[4,6,20,21] Continued advocacy by neurosurgeons is necessary to adequately impact the incidence of horse-related injuries, but an understanding of the burden of disease is necessary prior to such action. To that end, we present our data detailing the neurosurgical injuries sustained by 80 patients at one regional Level 1 trauma center over an 8-year period.

Correspondence to: Anthony L. Petraglia, University of Rochester, Rochester, NY, USA. Email: anthony_petraglia@urmc.rochester.edu

Materials and Methods

This study involved performing a retrospective review of patients who sustained injuries from equestrian sports. A review of the University of Rochester Medical Center trauma registry and medical records was undertaken to identify patients who presented for evaluation at this Level 1 trauma center in Rochester, NY with horse-related injuries between 1 October 2003 and 30 November 2011. This broad time frame was used to ensure trends could be identified and numerous riding seasons were accounted for. Approval was obtained from the hospital's Research Subjects Review Board.

DOI 10.1179/1743132814Y.0000000373

All patients whose reason for seeking medical care was due to directly or indirectly participating in an equestrian-related sporting event were included in this study. Data obtained included demographic data, mechanisms of injury, spectrum of neurologic and non-neurologic injury, length of stay, and disposition. Neurologic injuries were further classified into cranial, spinal, peripheral nerve, and vascular injuries, where applicable. Non-neurologic injuries were further subdivided into non-spinal orthopedic, thoracic, and abdominal injuries. Each injury was counted individually and patients with multiple injuries had each injury counted as a separate one. Mechanisms of injury were obtained from review of the ambulance records, emergency department progress notes, and the admitting services' admission history and physical note. Injury severity scores (ISS) were documented when present, and calculated using medical record data when not available. Operative notes were examined and all surgical procedures were documented. Length of stay and discharge disposition were obtained for all patients. Means and standard deviation were calculated for all data.

Results

Demographic data

A total of 80 patients were identified and their demographic data were gathered (Table 1). The population of patients in this study consisted of slightly more women (54%) and ages of the participants ranged from 2.2 to 79.3 years (average age 37 years). Only two patients had documented helmet use; three additional patients were riding as horse jockeys at the time of injury but no helmet use was documented for them. Alcohol intake was described in two patients. Mean ISS was 9.9 $\pm$ 0.7 (range 1–29). Arrival Glasgow coma score (GCS) was 15 in 93% of patients and only three patients presented with a GCS of 3.

Mechanisms of injury

The mechanisms of injuries varied (Table 2) but the most common reasons for injury were being kicked or stepped on by the animal (55%) and thrown from or falling off the horse (28%). Upon further review of these patients' charts, only eight patients (10%) stated the horse was startled or otherwise fearful, implicating the animal as the inciting factor for the injury. One patient sustained injuries from being pushed by a horse onto a toolbox at a sporting event; upon further inspection, this patient was not a participant but a spectator at an event.

Table 1 Demographics and categorization of injuries from equestrian sports in 80 patients

Average age (years)	37 (2–79)
Male gender (%)	46
Injury severity score	9.9 $\pm$ 0.7
Average length of stay (days)	3.7 $\pm$ 0.35
Patients requiring surgery (%)	14

Neurosurgical injuries

The breadth of neurosurgical injuries sustained, both cranial and spinal, is listed in Table 3. The most common injury identified was a cranial vault injury (28%), and most were concussions without concomitant skull fractures or intracranial hemorrhage. Seven patients did present with hemorrhagic intracranial mass lesions, but none required evacuation. These lesions included two epidural hematomas, two subdural hematomas, and three intraparenchymal hematomas. One craniotomy was performed for a depressed skull fracture. Only two patients required intracranial pressure monitors for low presenting GCS – a 5-year-old boy and a 42-year-old woman. The boy required the craniotomy for washout and elevation of an open depressed skull fracture from being kicked by the horse. Both recovered from their injuries and were discharged home without services in 8 and 11 days respectively. Eight patients had spinal fractures, most commonly transverse process fractures, and only two patients required instrumentation and fusion for burst fractures. All these patients were graded American Spinal Injury Association (ASIA) E by the initial spine service evaluation and remained that way throughout the admission.

Non-neurologic injuries

Non-neurosurgical injuries were also documented (Table 4) and varied based on the mechanism of injury. Injuries were divided based on organ system and/or area affected. The most common were extremity (22%), rib fractures (20%), and solid organ (liver, kidney, and spleen) injury (27%). Eleven patients (14%) required an operation for their

Table 2 Causes of equestrian injury

Reported reason	Number (%) of patients (*N* = 80)
Kicked by horse	39 (49)
Thrown from/fell off horse	22 (28)
Stepped on by horse	4 (5)
Horse fell on patient	13 (16)
Not involving horse	1 (1)
Other	1 (1)
Total	80 (100)

Table 3 Craniospinal injuries resulting from equestrian incidents

System injured	Number (%) of patients
Spinal column	8 (10)
Cervical spine	8 (3)
Thoracic spine	3 (4)
Lumbosacral spine	3 (4)
Cranial vault/brain	22 (28)
Concussion	18 (23)
Trauma	11 (14)

injuries, which varied based on the injury from laparotomies to reduction and fixation of fractures.

Disposition and outcome

Finally, data were calculated on various hospital parameters. The average length of stay for each patient was 3.7 ± 0.35 days (range 1–17 days). All patients were discharged home from the hospital and only four patients (5%) required home care services. No mortalities occurred in this series.

Discussion

Horses have been used by humans for millennia for many tasks, including transportation and as forms of entertainment. The ancient Greeks participated in a variety of equestrian sports and stories of horse riding and chariot racing appear throughout Homer's *Iliad*. In modern times, while horses no longer serve as a primary method of transportation, they are still widely used in a variety recreational activities enjoyed by millions worldwide each year.[1,2,21–23] Participants must not only learn the skills needed to perform tasks for the purposes of the sport but also master the techniques necessary to control the animal safely, and a certain degree of risk must be accepted due to the unpredictable nature of the animal. This key facet of the sport creates additional challenges and unique considerations that are not found in other sporting events or athletic contests.

Participants of equestrian sports expose themselves to an increased risk of injury, and numerous studies[1,2,4–19,21,24,25] over the last 30 years have continued to demonstrate this. Despite decades of increased education, awareness, and training, injuries continue to occur without abatement. Our data corroborates those found in prior studies in that the majority of patients are young women who were thrown from, fell off, or directly injured by the horse, and sustained concussions and orthopedic injuries.[1,4,6–15,17,20,22] While the prevalence of equestrian injuries is dwarfed by other reasons for emergency room visits,[1,26] the rate of injuries is thought to be higher than that of other activities, including motorcycle riding and automobile racing.[1,4,6,20,21] This is despite the lower velocity and lower impact nature of the sport, and advocates the need for more outreach and education on proper safety; higher velocity activities often have state or federal regulations to establish minimum safety guidelines for the participants (e.g. FAA regulations, state driving laws, national sport organizations, etc.). In our series, we were limited by the lack of adequate documentation to fully investigate the role helmets and other protective gear played in injury prevention.

Additionally, a close inspection of our data reveals that 10% of the injuries ($n = 8$) resulted from a primary animal cause; i.e., the horse was afraid or startled and reacted in a manner that caused injury to the participant. Riders must, at all times, remain cognizant of the unpredictable nature of the animal and be proactive to address problem scenarios before they develop. Riding clubs and schools can prepare rigorous safety programs to ensure that novice riders learn proper animal handling and safety procedures akin to pilots or drivers understanding the mechanics of their vehicles.

While the neurologic injuries presented in our study appear fairly benign compared to more severe thoraco-abdominal or penetrating injuries, it is important to note that riders who sustain multiple falls or injuries with repeated concussions or subconcussive hits are at risk for more serious future neurologic decline, as seen in other areas of athletics. There is ample evidence from other sports that increasing helmet use can prevent or reduce a large number of head injuries.[18,20,21,25,27] Fractures are the second most common reason for hospital admission, and most likely occur at the point of impact (either with the horse or the ground). While other sports do expose their participants to falls (e.g. skiing, snowboarding, hockey, skating, etc.), there is ample protective gear available in each of those sports to reduce the risk of injuries. Furthermore, conventional wisdom in these sports encourages use of protective equipment. This is contrasted in equestrian sports, where one survey by Condie *et al.* revealed only a 20% compliance rate by riders for protective gear, including helmets.[25] This was suggested in our series by the dearth of information on the use of protective gear by patients. More work is needed to study the biomechanics of fractures generated by equestrian sports and the role of safety gear in reducing these injuries.[1,3,23,27] The data obtained from this work should then be translated into safety lessons in riding schools, stressing, however, that helmets are keys to injury prevention.

Table 4 Non-neurological injuries resulting from equestrian incidents

Injury	Number (%) of patients ($N = 80$)
Orthopedic	
Upper extremity	6 (8)
Lower extremity	11 (14)
Hip/pelvis	7 (9)
Abdominal	
Liver	13 (16)
Kidney	4 (5)
Spleen	5 (6)
Other	7 (9)
Thoracic	
Pulmonary contusion	5 (6)
Pneumothorax/hemothorax	9 (11)
Rib fractures	16 (20)
Clavicle fracture	4 (5)
Other	1 (1)

Despite the preponderance of data already published in the literature, injuries continue to occur. This suggests that for all the advances made thus far in safety technology (e.g. helmets, pads, etc.), efforts in prevention must improve to adequately treat the prevalence of injuries. Several studies have shown more experienced riders are safer and sustain fewer injuries,[1,3,22] arguing for more rigorous educational and safety programs to better train participants and athletes. With data demonstrating poor compliance with protective equipment, these programs should also stress the use of helmets and other safety gear at all times when riding, no matter how experienced the rider or animal.

One subset of equestrian sports which predisposes its participants to higher risks of injury is steeplechase racing, also known as National Hunt racing in the United Kingdom and Ireland. Steeplechase jockeys ride at faster speeds, jumping fences and other obstacles as a normal part of their event. As a result, these riders put themselves at increased risk compared to their peers who do not participate in these racing events, especially ones that involve jumping at high speeds.[26] This sport has been studied previously and found to have higher risks of injury, particularly repetitive concussive and sub-concussive brain trauma.[26] Also, amateur jockeys fall more than their professional counterparts, increasing their risk of injury.[26] The National Steeplechase Association, which represents these athletes, requires jockeys to submit to baseline concussion testing and repeat testing following a head injury before they are cleared to ride again.[28] Programs and requirements such as this can be helpful to stem the tide of injuries that could result from repetitive head trauma.

One significant limitation of this study is that it only captured those patients seen or referred to our institution. Those who visited other facilities, including outpatient clinics, were not included, nor were those who did not seek medical care. More problematic is the number of patients who do not appear for medical attention following what may, on the surface, appear to be a minor injury. This number is impossible to calculate and without this, the true prevalence of the spectrum of neurologic injury cannot truly be estimated. This likely underestimates the true prevalence of injuries and based on the data published in other series,[2,5,7–10,14,17,29] we estimate the true rates of injury from equestrian sports to be much higher in the Rochester, NY area than what is presented in our series.

Conclusion

Equestrian sports convey their own unique risks for participants and spectators, and the central nervous system often bears the brunt of injuries. Younger female riders tend to have more injuries, though all participants are at risk. Most injuries tend to be orthopedic, involving both the spine and appendicular skeleton, though a large number of concussions and mild traumatic brain injures also occur. Furthermore, the true prevalence of injuries is likely under-reported with many patients not seeking care due to no 'obvious' injury. With proper protection and precautions, as well as increased safety education for riders, a decrease in the incidence of these injuries may be achieved. By advocating for increased safety requirements and promoting more education on injury prevention, especially the use of helmets and protective equipment while riding, neurosurgeons can play a key role in improving outcomes in these patients and reduce the number of equestrian injuries in the United States.

Disclaimer Statements

Contributors Vasisht Srinivasan, Principal author, contributed to manuscript preparation and data analysis. Clifford Pierre and Benjamin Plog were involved in data mining and chart review. Kaushik Srinivasan was involved in manuscript preparation and data analysis. Anthony Petraglia, corresponding author, contributed to study conceptualization, data analysis, and manuscript preparation. Jason Huang was involved in the supervision of study and manuscript preparation/editing.

Funding The authors received no funding for this study.

Conflicts of interest The authors have no financial support to declare and no conflicts of interest to disclose.

Ethics approval For this study, all ethical standards adhered to both institutional and national guidelines and in accordance with the Helsinki Declaration of 1975, as revised in 2000.

References

1 Loder RT. The demographics of equestrian-related injuries in the United States: injury patterns, orthopedic specific injuries, and avenues for injury prevention. J Trauma. 2008;65:447–60.
2 Jagodzinski T, DeMuri GP. Horse-related injuries in children: a review. WMJ. 2005;104:50–4.
3 Mayberry JC, Pearson TE, Wiger KJ, Diggs BS, Mullins RJ. Equestrian injury prevention efforts need more attention to novice riders. J Trauma. 2007;62:735–9.
4 Ball CG, Ball JE, Kirkpatrick AW, Mulloy RH. Equestrian injuries: incidence, injury patterns, and risk factors for 10 years of major traumatic injuries. Am J Surg. 2007;193:636–40.
5 Ball JE, Ball CG, Mulloy RH, Datta I, Kirkpatrick AW. Ten years of major equestrian injury: are we addressing functional outcomes? J Trauma Manag Outcomes. 2009;3:2.
6 Norwood S, McAuley C, Vallina VL, Fernandez LG, McLarty JW, Goodfried G. Mechanisms and patterns of injuries related to large animals. J Trauma. 2000;48:740–4.
7 Sorli JM. Equestrian injuries: a five year review of hospital admissions in British Columbia, Canada. Inj Prev. 2000;6:59–61.
8 Hobbs GD, Yealy DM, Rivas J. Equestrian injuries: a five-year review. J Emerg Med. 1994;12:143–5.

9 Barone GW, Rodgers BM. Pediatric equestrian injuries: a 14-year review. J Trauma. 1989;29:245.
10 Eckert V, Lockemann U, Püschel K, Meenen NM, Hessler C. Equestrian injuries caused by horse kicks: first results of a prospective multicenter study. Clin J Sport Med. 2011;21:353–5.
11 Havlik HS. Equestrian sport-related injuries: a review of current literature. Curr Sports Med Rep. 2010;9:299–302.
12 Lloyd RG. Riding and other equestrian injuries: considerable severity. Br J Sports Med. 1987;21:22–4.
13 Grossman JAI. Equestrian injuries: results of a prospective study. JAMA. 1978;240:1881.
14 Petridou E, Kedikoglou S, Belechri M, Ntouvelis E, Dessypris N, Trichopoulos D. The mosaic of equestrian-related injuries in Greece. J Trauma. 2004;56:643–7.
15 Bixby-Hammett D, Brooks WH. Common injuries in horseback riding. A review. Sports Med. 1990;9:36–47.
16 Hamilton MG, Tranmer BI. Nervous system injuries in horseback-riding accidents. J Trauma. 1993;34:227–32.
17 Cuenca AG, Wiggins A, Chen MK, Kays DW, Islam S, Beierle EA. Equestrian injuries in children. J Pediatr Surg. 2009;44:148–50.
18 Dekker R, Van Der Sluis CK, Kootstra J, Groothoff JW, Eisma WH, Duis HJ. Long-term outcome of equestrian injuries in children. Disabil Rehabil. 2004;26:91–6.
19 Macnab AJ, Cadman R. Demographics of alpine skiing and snowboarding injury: lessons for prevention programs. Inj Prev. 1996;2:286–9.
20 Buckley SM, Chalmers DJ, Langley JD. Injuries due to falls from horses. Aust J Public Health. 1993;17:269–71.
21 Smartt P, Chalmers D. A new look at horse-related sport and recreational injury in New Zealand. J Sci Med Sport. 2009;12:376–82.
22 Guyton K, Houchen-Wise E, Peck E, Mayberry J. Equestrian injury is costly, disabling, and frequently preventable: the imperative for improved safety awareness. Am Surg. 2013;79:76–83.
23 Bixby-Hammett DM. Accidents in equestrian sports. Am Fam Physician. 1987;36:209–14.
24 Newton AM, Nielsen AM. A review of horse-related injuries in a rural Colorado hospital: implications for outreach education. J Emerg Nurs. 2005;31:442–6.
25 Condie C, Rivara FP, Bergman AB. Strategies of a successful campaign to promote the use of equestrian helmets. Public Health Rep. 1993;108:121–6.
26 Rueda MAF, Halley WL, Gilchrist MD. Fall and injury incidence rates of jockeys while racing in Ireland, France and Britain. Injury. 2010;41(5):533–9.
27 Watt GM, Finch CF. Preventing equestrian injuries. Sports Med. 1996;22:187–97.
28 Clancy J. Jump jocks get new concussion test. This is horse racing. ST Publishing, Inc; 2013. [Web log post]. [web 2014 Jan 31]. Available from: http://thisishorseracing.com/news/index.php/this-is-horse-racing/1933-jump-jocks-get-new-concussion-test
29 McCroy P, Turner M. Equestrian injuries. Caine DJ, Maffulli N (eds). Epidemiology of pediatric sports injuries. Individual sports. Med Sport Sci. Basel, Karger. 2005;48:8–17