Craniofacial Fractures in Equine-Related Injuries : What Should a Maxillofacial Surgeon Expect?

Puolakkainen, Tero

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Abstract

Patients with equine-related injuries (ERI) have high rates of hospitalization and often require surgical treatment. This study aimed to clarify the injury profiles of patients sustaining ERI-related craniofacial fractures and their relationship with other severe head and neck injuries.

This retrospective study included all patients with craniofacial fractures admitted to a tertiary trauma center during 2013-2018. Out of 3256 patients, a total of 39 patients were included in the study (1.2%). Demographic and clinically relevant variables were reported and statistically evaluated.

Males represented only 7.7% of the study population. Isolated facial fractures were over-represented in this study population at 84.6% whereas only 7.7% of patients sustained isolated cranial fractures and 7.7% of patients sustained combined craniofacial fractures, respectively. Surgical intervention for craniofacial fractures was required in 48.7% of patients. In total, 17.9% of patients sustained severe head and neck injuries. Periods of unconsciousness and/or post-traumatic amnesia were seen in 41% of patients. Helmet use could only be confirmed in 17.9% of patients.

As trauma mechanisms behind ERI are often multifactorial and patients are at a high risk of sustaining associated injuries, attentive examination and exclusion of serious life-threatening injuries through a multi-disciplinary approach is imperative for this specific patient population.

Keywords: Fracture, Facial, Sports, Equine, Associated injury

Introduction

Equestrian-related recreational activities are an increasingly popular form of sport. Participants can be found in all age and skill groups ranging from inexperienced children to professional riders. Horseback riding is practiced annually by over 35 million people in the United States and United Kingdom alone and its popularity is expected to rise in the future (1, 2). Horses possess robust physical characteristics as they can reach velocities of up to 65 km/h, weigh over 500kg, and are capable of producing up to 10,000 N of force in a single kick. (3, 4) Furthermore, the unpredictability of these powerful animals, and compliance issues related to wearing protective equipment increase the risks of handlers and horseback riders of being injured. All of these factors corroborate the assertion that equine-related injuries (ERI) can be classified as high-energy trauma. (5)

The injury profile for ERIs is diverse, as trauma mechanisms include falling off the horse, being kicked or crushed by the horse, and various combinations of these. Even though the incidence rates of injuries related to horseback riding might be lower compared to other sports, these injury patterns are often severe by nature and reportedly have higher rates of hospitalization. (6, 7) It seems that whether the equestrian is mounted or not has a salient effect on the injury profile. Mounted riders often sustain injuries related to falling off the horse whereas unmounted patients are often subject to kicks. (8) Additionally, patients can be predisposed to multiple different trauma mechanisms simultaneously.

Despite advances in protective equipment, ERI are often located in the head and neck region. (5, 9, 10) The facial skeleton, in particular, is highly vulnerable, as headgear is typically designed to protect only the cranial portion of the head. This has led to a high rate of surgical intervention in patients sustaining equine-related facial fractures. (6, 9, 11) This concern has previously been recognized and brought up by maxillofacial surgeons. (12, 13) However, the number of craniofacial fractures in previous studies has remained low.

The purpose of this study is to provide demographic data of ERIs in the craniofacial fracture population and present concomitant injuries including severe head and neck injuries in this patient group. We also describe patterns of craniofacial fractures induced by ERI, as well as reporting the

incidence rates for surgical treatment in this patient population. We hypothesized that a significant proportion of the patients who were treated for ERIs affecting the craniofacial skeleton required multi-disciplinary evaluation.

Materials and methods

Study design: This retrospective study included all patients admitted to a tertiary trauma center (Trauma Unit of Helsinki University Hospital, Helsinki, Finland) with any type of craniofacial fracture during the 2013-2018.

Inclusion and exclusion criteria: All patients with comprehensive patient data and any equine-related craniofacial fracture confirmed by radiological imaging were included in this study.

Demographic data, injury mechanism, presence and type of craniofacial fractures, and the need for surgical intervention as well as other relevant clinical parameters are presented in a descriptive manner.

Cranial fractures were classified as fracture of the skull base, fractures of other than skull base, and combined cranial fractures, including both of the aforementioned fracture types. Facial fractures were classified as mandibular, nasal, combined midfacial, combination of facial thirds, upper facial third and unilateral zygomatic-maxillary-orbital (ZMO-) fractures. ZMO-fractures included unilateral zygomatic, maxillary and orbital fractures as well as combinations thereof. Dental and dentoalveolar injuries were classified as injuries to the dentition and adjacent structures, including alveolar bone. Cervical spine injuries, blunt cerebrovascular injuries, and intracranial injuries were classified as severe head and neck injuries.

Occurrence of concomitant injuries, unconsciousness and/or posttraumatic amnesia and Glasgow Coma Scale (GCS) values at primary contact were reported. Cervical spine injuries, blunt cerebrovascular injuries, and intracranial injuries were classified as severe head and neck injuries.

Statistical analysis:

Data were analyzed using GraphPad Prism version 5.00 (GraphPad Inc. San Diego, California, USA). The two-tailed Mann Whitney U-test was used to assess the significance of differences in continuous variables. Fisher's exact test was used to examine the association between variables with nominal scales. P-values of less than 0.05 were considered statistically significant.

The study was approved by the Internal Review Board of the Head and Neck Center, Helsinki University Hospital, Helsinki, Finland (HUS/54/2019).

Results

During 2013-2018, a total of 3256 patients with craniofacial fractures were admitted, and 39 (1.2%) of them were ERI (Supplemental table 1). Females were over-represented in this study population, as only 7.9% of the patients were male. The mean age of the patients was 33.8 years and 20.5% of the patients were under 18 years of age. The distribution ratio of facial fractures in mounted and unmounted patients was roughly 1:1. In mounted patients, falling off the horse was related to 95% of cases. Unmounted patients were mainly subjected to horse kicks. Around one quarter of the total patients included in the study sustained their injuries from multiple trauma mechanisms. Helmet use during the trauma incident was confirmed in only seven patients (17.9%).

Over 90% (36 of 39) of the patients sustained a facial fracture. Three patients sustained isolated cranial fractures and three patients had combined craniofacial fractures, thus cranial fractures represented 15.4% (6 of 39) of the patient population (Supplemental table 2). Regarding facial fracture types, the majority were unilateral ZMO-fractures (44.4%) followed by mandibular fractures (22.2%). Dentoalveolar injuries were found in nine (23.1%) patients and craniofacial lacerations in three (7.7%) patients.

As seen in Supplemental table 3, almost half of the patients (48.7%) required surgical intervention for craniofacial injuries. One patient required multiple surgical operations.

Two patients (5.1%) required primary intubation (Supplemental table 4). Seven patients (17.9%) sustained severe head and neck injuries, which mainly consisted of intracranial injuries. In addition to radiologically detected intracranial injuries, over 40% of the patients suffered from a state of unconsciousness and/or post-traumatic amnesia. A total of six patients (15.4%) suffered from other concomitant injuries, of which three had injuries to multiple parts of the body. Of these six patients, four (66.7%) required further surgical treatment. None of the included patients expired.

Patients with cranial fractures had severe head and neck injuries and intracranial injuries more frequently than patients without cranial fractures ($p=0.006$ and $p=0.003$, respectively). In addition, patients with GCS<12 were more likely to have cranial fractures ($p=0.002$). Other statistically significant differences between patients' demographic variables, fracture types or injury mechanism, and concomitant injuries were not found.

Discussion

The purpose of this study was to describe characteristics of ERIs in craniofacial fracture population and present concomitant injuries including severe head and neck injuries in this patient group. Our hypothesis, that the present patient group required multi-disciplinary evaluation, was confirmed. Patients had high occurrence rates for facial fractures and a considerable proportion of patients (17.9%) sustained concomitant severe head and neck injuries and other concomitant injuries (15.4%). A significant occurrence rate for unconsciousness and/or post-traumatic amnesia (41%) was also noted. Additionally, patients with ERI-related craniofacial fractures often required surgical intervention. As trauma mechanisms behind ERI are often multifactorial and a significant proportion of patients require surgical treatment, attentive examination and exclusion of serious life-threatening injuries is imperative when treating subjects of this specific patient group.

Horseback riding is one of the most popular recreational activities in Europe. (14) Additionally, it is practiced annually by over 30 million people in the United States. (1) Compared to other Western countries, the popularity of horseback riding in Finland is slightly lower as its practiced by only

approximately 140,000-160,000 persons annually. (15) Another considerable finding is that male patients (7.7%) were under-represented in our study, as others have reported 18.8%-51.1% of ERI-related facial injuries occurred in males. (8, 16, 17) Therefore, our findings might not be directly comparable to the injury rates reported from other countries. In a study by Krüger et al, men were at higher risk of sustaining serious injuries compared to females. (18)

According to our results, facial bones are more vulnerable to fractures than cranial bones in ERI-accidents. However, patients with cranial fractures are more likely to have severe head and neck injuries. Current protective equipment is designed to protect the head from cranial injuries, leaving the facial area exposed. Regarding facial fractures, the ZMO-region was the most commonly affected anatomical site (44.4%), followed by mandibular fractures (21.5%). Almost 14% of the patients suffered fractures in multiple facial thirds. These results are in agreement with previous studies with similar study setups. (6, 7, 19). Overall, the location and distribution of facial fractures in the ERI-patient population seem to be somewhat similar to the facial injuries sustained in other sports. (20) Almost half of the patients in our study required surgical intervention to treat sustained craniofacial injuries. This relatively high value suggests that even though injury profiles of ERI patients might be similar to those witnessed in other sports, the high energy transmission seems to predispose fractures to unfavorable positions and require operative treatment more frequently.

A recent study by Meredith and colleagues showed that up to 20% of ERI may present in the head region regardless of the rider or handler being mounted or unmounted at time of trauma. (21) However, facial injuries were not adequately differentiated from cranial injuries and the further elucidation of injury severity was not presented. In our study, 15.4% of patients sustained a cranial fracture whereas 17.9% of patients had severe head and neck injuries. Blunt cerebrovascular injuries require particular attention, as they seem to be more prevalent in the facial fracture population than previously conceived. (22, 23) This finding raises further concern about the lack of safety gear protecting the neck region.

The risk of traumatic brain injuries (TBI) in ERI is well recognized but there is a paucity of studies related to the disruption of neurological function in this patient population. In our study over 40% of

the patients suffered from unconsciousness or post-traumatic amnesia due to the injury. Even though this finding is somewhat facile and we were not able to reliably report the duration of unconsciousness or the severity of amnesia due to the retrospective study design, this does bring up the issue that patients have sustained considerable force transmission to the central nervous system. Moreover, even short periods of unconsciousness may have long-term consequences on neurological functions. (24) This finding is particularly interesting as the majority of the patients in our study sustained only facial fractures and not cranial injuries. These assertions support the need to upgrade personal protective equipment to shield the facial area as well.

Carmichael et al. found that, in addition to craniofacial injuries, patients with ERI also commonly present injuries in the lower extremities as well as the thoracic region (16). In our study, six (15.6%) patients with ERI-induced craniofacial fractures had concomitant injuries as well, of which three had injuries located in different anatomic regions. Indeed, the proper evaluation of these patients upon initial evaluation is especially important as facial injuries are often intimidating by appearance and may draw the attention from other, possibly life-threatening injuries (please see Supplemental Digital Content for patient case). Moreover, ocular injuries are of particular importance when assessing facial fractures affecting the orbital region (12). We also report a considerably high occurrence rate of dental injuries, as almost 25% of our patients suffered from injuries to the teeth and surrounding structures.

The significance of using proper safety equipment has been recognized in many recreational activities including horseback riding (20, 25). A previous study by Davidson et al., reported that 6.7% of all ERI were fatal and it was confirmed that none of the expired patients had worn helmets. (8) Furthermore, none of the patients wearing helmets during the trauma event sustained severe head injuries. This finding is in concordance with the notion that safety helmets have a compelling, protective effect against cranial injuries (26, 27). Unfortunately, we were not able to reliably confirm the use of protective head gear of our patients during the event of trauma, and thus no definitive conclusions can be drawn with regard to the use of safety equipment and craniofacial injuries based on our results. Spreading awareness of the use of proper safety gear and appropriate behavior in close

proximity of horses is imperative to reduce the incidence rates for severe, potentially life-threatening ERI.

The occurrence of injury-related lacerations affecting the craniofacial area was common, as nearly one-third of the patients sustained these injuries. Despite this, only one patient developed a mild skin infection, which was associated with surgery for a midfacial fracture. All wounds were carefully revised and antimicrobial agents were used at low thresholds, aiming to prevent infections induced by soil or horse microbiota.

This retrospective study aims to descriptively express the injury profiles of facial fractures related to ERI. A significant deficiency was the unreliable description of helmet use among ERI-patients. Additionally, specific classification of the duration of unconsciousness and severity of post-traumatic amnesia were not clearly defined. As this study did not include all patients with ERI, it does not allow us to draw conclusions regarding the incidence rates of craniofacial fractures in ERI-patients. However, it does provide valuable descriptive data of how facial fractures are over-represented in the ERI-related craniofacial fracture population and provides evidence to support the need to increase the protective effect of safety gear. Especially the high rates of unconsciousness and amnesia bring new insight to current knowledge regarding this specific patient population.

In conclusion, ERI mechanisms are often multifactorial and a result of numerous simultaneous and succeeding events. Most importantly, both unmounted handlers and mounted riders are at risk of severe head and neck injuries. (7, 17) These craniofacial fracture patients require a careful primary examination by traumatologists, and clinicians treating craniofacial fractures should have close multi-disciplinary collaboration with orthopaedists and neurosurgeons during in-hospital treatment periods.

Disclosures

No conflicts of interest, financial or otherwise, are declared by the authors.

References

1. Adler CR, Hopp A, Hrelic D, et al. Retrospective analysis of equestrian-related injuries presenting to a level 1 trauma center. Emerg Radiol. 2019;26(6):639-45.
2. Sandiford N, Buckle C, Alao U, et al. Injuries associated with recreational horse riding and changes over the last 20 years: a review. JRSM Short Rep. 2013;4(5):2042533313476688.
3. Sorli JM. Equestrian injuries: a five year review of hospital admissions in British Columbia, Canada. Inj Prev. 2000;6(1):59-61.
4. Thomas KE, Annest JL, Gilchrist J, et al. Non-fatal horse related injuries treated in emergency departments in the United States, 2001-2003. Br J Sports Med. 2006;40(7):619-26.
5. Havlik HS. Equestrian sport-related injuries: a review of current literature. Curr Sports Med Rep. 2010;9(5):299-302.
6. Antoun JS, Steenberg LJ, Lee KH. Maxillofacial fractures sustained by unmounted equestrians. Br J Oral Maxillofac Surg. 2011;49(3):213-6.
7. Lee KH, Steenberg LJ. Equine-related facial fractures. Int J Oral Maxillofac Surg. 2008;37(11):999-1002.
8. Davidson SB, Blostein PA, Schrotenboer A, et al. Ten Years of Equine-related Injuries: Severity and Implications for Emergency Physicians. J Emerg Med. 2015;49(5):605-12.
9. Ball CG, Ball JE, Kirkpatrick AW, et al. Equestrian injuries: incidence, injury patterns, and risk factors for 10 years of major traumatic injuries. Am J Surg. 2007;193(5):636-40.
10. Gross I, Hadar A, Bala M, et al. The Epidemiology, Injury Patterns and Outcomes of Horse-Related Injuries in Israeli Children. Isr Med Assoc J. 2019;21(4):279-82.
11. Clarke CN, Tsuei BJ, Butler KL. Equine-related injury: a retrospective analysis of outcomes over a 10-year period. Am J Surg. 2008;195(5):702-4.
12. Islam S, Walton GM, Dean F, et al. Multidisciplinary management of a complicated orbital injury inflicted by a horse. Ophthalmic Plast Reconstr Surg. 2007;23(6):486-8.
13. Ueeck BA, Dierks EJ, Homer LD, et al. Patterns of maxillofacial injuries related to interaction with horses. J Oral Maxillofac Surg. 2004;62(6):693-6.
14. Weber CD, Nguyen AR, Lefering R, et al. Blunt injuries related to equestrian sports: results from an international prospective trauma database analysis. Int Orthop. 2017;41(10):2105-12.
15. Financial statement of the Finnish Federation of Horseback riding. https://www.ratsastus.fi/site/assets/files/21054/toimintakertomus_ja_tilinpaatos_2018_hyvaksytty_14_4_2019.pdf. 2019.
16. Carmichael SP, 2nd, Davenport DL, Kearney PA, et al. On and off the horse: mechanisms and patterns of injury in mounted and unmounted equestrians. Injury. 2014;45(9):1479-83.
17. Van Balen PJ, Barten DG, Janssen L, et al. Beware of the force of the horse: mechanisms and severity of equestrian-related injuries. Eur J Emerg Med. 2019;26(2):133-8.
18. Kruger L, Hohberg M, Lehmann W, et al. Assessing the risk for major injuries in equestrian sports. BMJ Open Sport Exerc Med. 2018;4(1):e000408.
19. Islam S, Gupta B, Taylor CJ, et al. Equine-associated maxillofacial injuries: retrospective 5-year analysis. Br J Oral Maxillofac Surg. 2014;52(2):124-7.
20. Murphy C, O'Connell JE, Kearns G, et al. Sports-Related Maxillofacial Injuries. J Craniofac Surg. 2015;26(7):2120-3.
21. Meredith L, Ekman R, Thomson R. Horse-related incidents and factors for predicting injuries to the head. BMJ Open Sport Exerc Med. 2018;4(1):e000398.
22. Puolakkainen T, Vahasilta L, Bensch F, et al. Blunt cerebrovascular injuries in the craniofacial fracture population-Are we screening the right patients? Int J Oral Maxillofac Surg. 2020.
23. Varjonen EA, Bensch FV, Pyhalto TT, et al. Remember the Vessels! Craniofacial Fracture Predicts Risk for Blunt Cerebrovascular Injury. J Oral Maxillofac Surg. 2018;76(7):1509 e1- e9.

24. Blyth BJ, Bazarian JJ. Traumatic alterations in consciousness: traumatic brain injury. Emerg Med Clin North Am. 2010;28(3):571-94.
25. Meredith L, Antoun JS. Horse-related facial injuries: the perceptions and experiences of riding schools. Inj Prev. 2011;17(1):55-7.
26. Bier G, Bongers MN, Othman A, et al. Impact of helmet use in equestrian-related traumatic brain injury: a matched-pairs analysis. Br J Neurosurg. 2018;32(1):37-43.
27. Hasler RM, Gyssler L, Benneker L, et al. Protective and risk factors in amateur equestrians and description of injury patterns: A retrospective data analysis and a case - control survey. J Trauma Manag Outcomes. 2011;5:4.