

## Mechanisms of Head Injury in Bull Riders with and without the Bull Tough Helmet – A Case Series

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### Introduction

Bull riding is one of the most dangerous sporting activities of the modern era. Head injuries are common in bull riders, yet helmets and faceguards are rarely mandated in competitive bull riding events and few participants use such protective headgear.

**Objective.** The purpose of examining this case series was to characterize head and face injuries in bull riders, to gain a better understanding of the mechanisms associated with the various injury types and to assess the effect of wearing the Bull Tough Helmet (BTH).

**Methods.** A survey was sent to 320 bull riders, asking them to provide details about the head and face injuries they had sustained while bull riding with and without the BTH. Eighty-one (31%) of the 265 surveys that reached their intended athlete were completed and returned. Riders were also asked to describe specific incidents where the BTH had saved them from head injury.

**Results.** Respondents described 84 incidents of injury while not wearing the BTH; 110 injuries resulted. Respondents described 33 incidents of injury while wearing the BTH; 39 injuries resulted. Specific mechanisms and injury types were reported for both cohorts with concussions, lacerations and facial fractures being the most common injury types. In addition, respondents described 170 events in which an injury was prevented by the BTH.

**Conclusions.** Bull riders are at great risk of suffering severe head and facial injuries. Safe and effective helmets with protective face guards must be worn by bull riders if the incidence of these injuries is to be diminished. Organizations, promoters and schools that sponsor bull riding events, especially for minors, should mandate protective headgear in order to better protect these athletes.

**Key Words:** Injury, Mechanism, Incident

### Introduction

Bull riding is a mainstay event in American competition rodeo. Bull riding is a popular event in Oklahoma rodeos.

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This sport has been implicated in up to 31-37% of rodeo injuries and is one of the most dangerous sporting activities of the modern era.<sup>1,2</sup> The rate of injury associated with bull riding has been shown to be two times higher than with other major rodeo events (3.2 versus 1.39 per 100 competitor exposures).<sup>3</sup> In one small, amateur bull riding series in Oklahoma, the likelihood of head injuries in participants was 5.1% per ride.<sup>4</sup> Bull riding participants frequently suffer head and neck injuries, which sometimes result in permanent neurological sequelae or death.<sup>5,6</sup>

Despite the known risks of head injury while bull riding, there is little research on the specific mechanisms of head injury. The cause of concussion in bull riders is often unknown.<sup>2</sup> Rodeo organizations, high schools and promoters rarely require bull riders to wear protective headgear when competing.<sup>7,8</sup> In one rulebook, a mouthpiece and sternal vest is mandated for each bull riding participant. It is mentioned that "helmets may be worn in lieu of western hats," but no requirements have been established.<sup>7</sup> It has even been suggested in the medical literature that mandatory use of helmets in rodeo events is unwarranted.<sup>9</sup>

A recent study of the data obtained from the same surveys used in this study, however, revealed the first evidence that protective head gear can decrease the incidence of head and face injury in bull riders by nearly 50%.<sup>10</sup>

### Methods

#### Survey Technique

This study was performed by survey mailings. The names and last known addresses of the bull riders who purchased Bull Tough helmets from June 5, 1995, to July 19, 1999, were obtained from the customer database of Bull Tough, Inc. A total of 320 surveys was sent out to bull riders, professional and amateur. Riders were asked to record and describe each incident of head injury they had sustained, both while riding without head protection and while wearing the BTH, and to describe the mechanism by which each injury occurred. Riders were also asked to describe specific incidents in which the BTH had saved them from a head

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injury. These incidents spanned the riders' careers and it was not possible to obtain a total number of rides with which to calculate likelihood of injury per exposure. Riders were also asked to record and describe specific incidents in which the BTH had saved them from a head injury.

### Definitions of Injuries

The descriptions of sustained injuries and mechanisms of injury were placed into specific categories (i.e., concussion, benign closed head injury, facial fracture, laceration) based upon the survey descriptions. A concussion was defined as any injury in which the athlete sustained impairment of neurological function, while a benign closed head injury (bCHI) was defined as a minor head injury without any of the other injury types being present, and was usually limited to a headache, abrasion or contusion.

### Results

#### Age, Weight and Height of Respondents

Of the 320 surveys sent to purchasers of the Bull Tough helmet, 81 completed surveys, or 25%, were returned. However, 55 surveys were undeliverable by the U.S. Postal Service. Of those reaching the intended address, 31% (81/265) of the surveys were completed and returned.

The mean age of the respondents was 20 years, (while the median was 20.5 years). The youngest riders were 7 and 8 years old. There were six riders less than 13 years of age. The oldest riders were 51 and 52 years old. Seven riders were older than 30 years. (Figure 1)

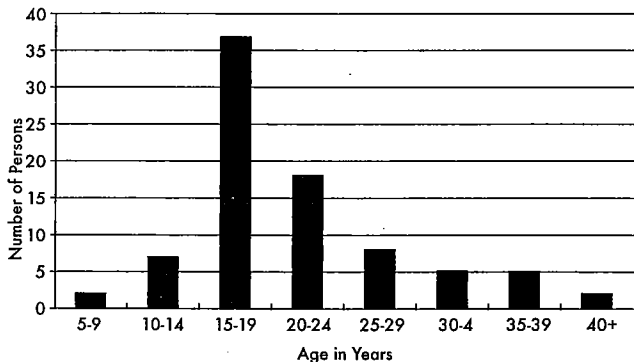


Figure 1. Age Distribution of Bull Riders

The mean weight of the bull riders was 139 pounds, while the median was 144 pounds. The range was 42 to 220 pounds. The mean height of the bull riders was 67 inches (5 feet, 7 inches), while the median was 68 inches. The range in height was 47 inches (3 feet, 11 inches) to 76 inches (6 feet, 4 inches).

#### Percentage of Professional Riders versus Amateur Riders

Seven of the respondents (9%) were full-time, professional bull riders, while the rest (91%) were part-time competitors.

Table 1. Types of Injury Without Head Gear and While Wearing the BTH

Type of Injury	Number of Injuries Without Head Gear. (%)	Number of Injuries While Wearing the BTH (%)
Concussion	42 (38%)	16 (41%)
Laceration	31 (28%)	8 (20%)
Facial Fracture	21 (19%)	4 (10%)
Benign Closed Head Injury	7 (6%)	10 (26%)
Permanent Brain Damage	2 (2%)	—
Skull Fracture	2 (2%)	—
Avulsed Ear	2 (2%)	—
Eye Injury	2 (2%)*	1 (3%)
Seizure	1 (1%)	—
Total	110 (100%)	39 (100%)

\*Includes loss of an eye and a detached retina.

#### Incidence of Head Injuries Without Protective Head Gear

Respondents were asked to record each incident of injury they had suffered over the course of their riding careers and to describe the mechanism by which the injury occurred. These incidents spanned the riders' careers and it was not possible to obtain a total number of rides with which to calculate likelihood of injury per exposure.

#### Incidence of Head Injury While Not Wearing the BTH

Thirty-seven bull riders suffered at least one career head injury while not wearing a helmet. A total of 84 incidents were recorded with 110 head or facial injuries being reported.

#### Description of Injuries While Not Wearing the BTH

A total of 110 career injuries were reported by the respondents; Ten types of injury were reported. The most common type of injury was concussion (38%), followed by lacerations (28%), facial fractures (19%), and benign closed head injuries (6%). (Table 1) Other types of injuries sustained included permanent brain damage, skull fractures, avulsed ears, detached retina, loss of an eye and a seizure.

#### Mechanisms of Injury While Not Wearing the BTH

A total of 6 injury mechanisms were identified from the 84 separate incidents of injury. Head-to-head impact (HHI) with the bull was the most common mechanism and was noted in 56% of the incidents (Table 2). Being stepped on by the bull was associated with 14% of incidents, and head impact with the ground with 13%. Other mechanisms of injury reported included being kicked by the bull, being

**Table 2. Mechanisms of Injury  
Without Head Gear and While Wearing the BTH**

Mechanism of Injury	Number of Injuries Without Head Gear (%)	Number of Injuries While Wearing the BTH (%)
Head-to-Head Impact	47 (56%)	16 (49%)
Stepped on by Bull	12 (14%)	5 (15%)
Head Impact with Ground	11 (13%)	4 (12%)
Kicked by Bull	7 (8%)	4 (12%)
Thrown Against Chute Gate/Wall	4 (5%)	2 (6%)
Thrown into Arena Wall/Fence	3 (4%)	—
Chinstrap Laceration	—	2 (6%)
Total	84 (100%)	33 (100%)

thrown against the chute gate/wall, and being thrown into the arena wall/fence.

In 22/84 (26%) of the aforementioned incidents the bull riders suffered multiple injuries. Among the 47 incidents of HHI, multiple injuries occurred in 16 (34%). Multiple injuries also occurred among persons kicked by the bull (4/7, 57%), stepped on by the bull (1/12, 8%), thrown into the arena wall or fence (1/3, 33%). Multiple injuries did not occur among riders who impacted the ground or were thrown against the chute gate/wall.

Of the 6 injury mechanisms causing 110 injuries, HHI caused the greatest number of injuries (67, 61%). Being stepped on by the bull resulted in 13 injuries (12%), while head impact against the ground caused a total of 11 injuries (10%). Being kicked by the bull resulted in 11 injuries (10%), being thrown into the arena wall or fence resulted in 4 injuries (4%) and being thrown against the chute gate or wall, 4 injuries (4%).

#### **Multiple Injuries**

In 22/84 (26%) of the aforementioned incidents, bull riders suffered multiple head injuries. Multiple injuries occurred among persons who were kicked by the bull (4/7, 5%), suffered HHI with the bull (16/47, 19%) stepped on by the bull (1/12, 1%), thrown into the arena wall or fence (1/3, 1%). Multiple injuries did not occur among riders who were injured when striking the ground or thrown against the chute gate/wall.

#### **Head-to-Head Impact While Not Wearing the BTH**

The most common mechanism of injury reported by the bull riders was HHI (56% of incidents & 61% of injuries). A total of 67 injuries were reported in 47 incidents of HHI in 34 riders. As previously noted, over one-third of the time (16/47, 34%) HHI was associated with multiple injuries. Specific injuries were as follows: concussion (25/67, 37%), facial fractures (17/67, 25%), lacerations (20/67, 30%), bCHI (4/67, 6%) and seizure (1/67, 2%).

#### **Incidence of Head Injuries While Wearing the Bull Tough Helmet**

Twenty bull riders suffered at least one head injury while wearing a helmet over the course of their careers. A total of 33 incidents of injury was reported, with a total of 39 head or facial injuries being reported. There were multiple injuries in 4/33 (12%) incidents.

#### **Description of Injuries While Wearing the Bull Tough Helmet**

A total of 39 career injuries in 33 incidents were reported by the respondents. Five injury types were reported — including concussion (41%), laceration (20%), facial fracture (10%), bCHI (26%) and eye injury (3%) (Table 1). No cases of ear injury, skull fracture, seizure or permanent brain damage were reported to have occurred while riders were wearing the BTH.

The likelihood of sustaining a bCHI in an incident was greater when riders were wearing the Bull Tough helmet, probably accounting for the fewer facial fractures and other severe types of head injury (i.e., skull fractures, ear injuries, eye injuries and seizures). The overall number of head injuries in the helmet-wearing cohort was less, but the likelihood of injury could not be calculated since the total number of career exposures was not obtained.

#### **Mechanisms of Injury While Wearing the Bull Tough Helmet**

A total of 6 injury mechanisms were identified. Head-to-head impact with the bull was the most common mechanism and was noted in almost 50% of incidents. (Table 2) Other mechanisms of injury included being stepped on by the bull (15%), head impact with the ground (12%), being kicked by the bull (12%), being thrown against the chute gate/wall (6%), and lacerations from the helmet's chinstrap (6%).

#### **Multiple Injuries**

In 4/33 (12%) of the aforementioned incidents bull riders suffered multiple head injuries. Multiple injuries occurred among persons who were kicked by the bull (1/33, 3%), suffered HHI with the bull (1/33, 3%) stepped on by the bull (1/33, 3%), and injured when thrown against the chute gate/wall (1/3, 33%). Multiple injuries did not occur among riders who were injured when striking the ground or thrown into the arena wall or fence.

#### **Head-to-Head Impact While Wearing the Bull Tough Helmet**

The most common mechanism of injury reported was that of HHI (49% of incidents and 46% of injuries). A total of 18 injuries were reported in 16 incidents of HHI in 13 riders. In the HHI incidents bCHI occurred 6/39 times (15%), concussion — 5/39 (13%), laceration — 4/39 (10%), facial fractures — 2/39 (5%) and eye injury — 1/39 (3%). Only 1/16 of HHI incidents resulted in multiple injuries.

Once again, some riders reported multiple facial bones

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being broken in HHI incidents. They were reported in the following frequencies: jaw (2), nose (2), sinus (1), orbit (1), teeth (1).

The likelihood of sustaining a bCHI in an incident was greater when riders were wearing the Bull Tough helmet, probably accounting for the fewer facial fractures and other types of head injury (i.e., skull fractures, ear injuries, eye injuries and seizures.) The overall number of head injuries in the helmet-wearing cohort was less, but the likelihood of injury could not be calculated since the total number of career exposures was not obtained.

### Incidents of Head Injury Prevention with the Bull Tough Helmet

Bull riders were asked to describe any instances in which the BTH prevented a head injury. Sixty-two of 81 (76%) riders provided descriptions of 170 such events in which an injury mechanism levied a significant impact against the BTH worn by the rider. In all of these events, the rider escaped without injury; however, it was the rider's belief that an injury would have occurred without the helmet. The helmet most commonly prevented injury from HHI's; 84 of these injuries were prevented. (Table 3) In addition, 32 injuries as a result of being stepped on by the bull were averted. Additional mechanisms of injuries that were prevented included being thrown into the arena wall/fence (19), being kicked by the bull (13), head impacting the ground (11), and being thrown against the chute gate/wall (11).

### Discussion

The results in this descriptive study demonstrate the most common mechanism of head injury in bull riders to be HHI, impact with the ground and with the feet of bulls when being stepped on or kicked. The most common head injuries in bull riders are concussion, lacerations and facial fractures, a majority of each injury type being caused by HHI. When riders were not wearing protective head gear and were involved in an injury incident, they were more likely to sustain multiple injuries (26%) than if they were

wearing the BTH (12%).

### Head-to-Head Impact with the Bull

In comparing the incidents of injury caused by the HHI that occurred in the two cohorts, riding with and without the BTH, when a head injury did occur the likelihoods of concussions (31% vs. 53%) and facial fractures (12% vs. 36%) were less when riders were wearing the BTH. Also, the number of HHI incidents was only slightly different in the two cohorts (No Helmet – 56% vs. BTH – 48%), yet the proportion of injuries sustained was greater in the cohort not wearing protective head gear (No Helmet – 61% vs. BTH – 46%). When riders sustained an HHI they were more likely to suffer multiple head injuries when riding without protective head gear (34%) than they were when riding with the BTH (6%).

While riders were not wearing the BTH, 82% of all facial fractures were a result of HHI.

The results of this retrospective analysis support the contention that the Bull Tough helmet decreases the incidence of head and facial injuries in the sport of bull riding.

These data also shed more light on the serious problem of head injuries in the sport of bull riding and should assist makers of bull-riding helmets in designing helmets and face masks to better protect bull riders. Facial fractures are one of the most common head injuries in bull riders and this makes the faceguard a critical component of these helmets.

Recently, a group of rodeo research and clinical care experts published an agreement statement recommending the use of protective head gear in bull riding. "It is imperative that promoters and organizers of bull riding events give serious consideration to mandatory protective head gear especially children. Facial fractures are on of the most common head injuries in bull riders and this makes the faceguard a critical component of these helmets."

### Weaknesses in this Study

The surveys were sent out to the last known addresses of bull riders who purchased the Bull Tough helmet. Eighty-one (31%) of the surveys were filled out and returned. Many of the surveys were returned unopened because the purchaser of the helmet had moved to an unknown address while others were simply never returned. One reason for the low survey return rate could be the fact that bull riders tend to be young and more likely to be on the move from one residence to another. Future studies might be more successful if telephone follow-up calls are made in an effort to increase the survey response rate.

Also, this is a retrospective study, the results of which could be more accurate if performed in prospective fashion.

Finally, this study sample was a heterogeneous group of bull riders, ranging in age from 7 to 52 years. Other variables include the size, strength and ferocity of the bucking stock, as well as the skill levels of riders; there exists a potential for varied results depending upon these factors.

**Table 3. Mechanisms of Injury Prevented While Wearing the BTH**

Mechanism of Injury	Number of Incidents With Injury Prevented (%)
Head-to-Head Impact	84 (49%)
Stepped on by Bull	32 (19%)
Thrown into Arena Wall/Fence	19 (11%)
Kicked by Bull	13 (8%)
Head Impact with Ground	11 (7%)
Thrown Against Chute Gate/Wall	11 (7%)
Total	170 (100%)

Therefore, it is difficult to apply or compare these results to a specific group of bull riders, as there might be significant differences in injury rates between various groups. In the future, it might be necessary to narrow the subject sample so that interpretations between study groups can be accurately made.

### Further Research

In the United States, continuous attempts are being made to prevent physical injuries, especially in children. Organized sports such as bicycling, skate boarding, rock climbing, motor cross, horseback riding and football all have requirements for the use of protective headgear. In football, helmets are an integral part of the game and are considered standard safety equipment.<sup>12</sup> It has been shown that the use of helmets by horseback riders can decrease the frequency and severity of head injuries.<sup>13</sup> And there is evidence to support the hypothesis that helmets are effective in preventing head injuries in bull riders, too.<sup>8</sup>

With the high risk of head injury in bull riding, more research is needed to better characterize the injuries and the precise mechanisms causing these injuries in order to assess and evaluate the safety and effectiveness of protective headgear in this sport.

### Children's Issues

Finally, a large number of respondents in this study were children; 16% were less than 16 years of age and 40% were less than 18. This finding points to the fact that bull riding is as much a sport for children as it is for adults. More emphasis must be placed on the safety of minors who participate in the sport of bull riding. High schools and other organizations that sponsor bull-riding events should mandate that children wear helmets.

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