Research Review

Spinal injuries resulting from horse riding accidents

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Injuries sustained as a result of horse riding are common. Serious injuries to the nervous system are the most dangerous. An analysis has been made of 11 papers, new figures produced by surveying Stoke Mandeville, Oswestry and Odstock spinal units and by searching the internet to determine their frequency and distribution. Head injuries outnumber spinal injuries by five to one. In contrast to other sporting accidents, there are more lumbar and thoracic than cervical injuries and more women are injured than men (though this may just be a reflection of the fact that there are more women riders than men). Of all horse riding activities, jumping is most likely to produce a spinal injury.

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Introduction

Injuries are an inevitable consequence of horse riding since the rider's head may be poised up to 4 m (13 feet) from the ground and the horse travels at a speed of up to 65 km/h (40 mph). The horse rider is trying to control an animal, which is less intelligent than a dog though, under some circumstances, the horse may be more intelligent than the rider! Although numerically few, catastrophic injuries to the brain and spinal cord from horse riding giving rise to paralysis have attracted considerable attention. The injuries to the spinal column and the injuries to the spinal cord are unremarkable. The first aid, immediate treatment, management of the fracture and long term rehabilitation follow conventional lines.

The following questions need to be addressed:

- How many spinal injuries occur per year as a result of horse-riding, compared with other sports?
- Are spinal injuries increasing or decreasing?
- How dangerous is the sport in terms of producing spinal injury?
- How do spinal injuries occur?
- Which riders are most at risk of sustaining a spinal injury?
- What type of riding is the most dangerous?
- If these questions could be answered, how could horse riding be made safer?

Material

The material reviewed is set out in Table 1. While it is easy enough to produce selected figures for the number of horse riding accidents with spinal injuries seen at an Accident Department or a Spinal Unit, the national figures are not available so that these questions cannot be answered. This is an exercise in epidemiology (Table 2).

It has been estimated that there may be over 3 million riders in the UK of whom as many as one-third are children.¹ In the USA up to 30 million will ride in a given year.²

It is a dangerous recreation as a large number of accidents occur; the British Horse Society is made aware of eight accidents per day involving horses and over one-third may result in head injuries. In 1992 the Office of Population Census listed 12 equestrian related fatalities in 2.87 million participants.² In a study of medical examiner reports from 10 states in the USA it was found that as many as 217 deaths per year were attributable to horseback riding.³

Horse riding carries a high participant morbidity and mortality. Whereas a motor-cyclist can expect a serious incident at the rate of 1 per 7000 h, the horse-rider can expect a serious accident once in every 350 h, ie 20 times as dangerous as motor cycling.⁴ This depends on the type of riding. A Cambridge University study of 1000 riding accident hospital admissions has shown:⁵

- One injury for 100 h of leisure riding
- One injury for 5 h for amateur racing over jumps
- One injury for 1 h of cross-country eventing

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Table 1 Analysis of material

Type of case	Source	Total*	Male	Female	(a)	(p)	Type of riding	Mechanism of injury	Spinal injuries
Admissions to hospital	Edixhoven ¹⁹	622	483 (p) 25 (a)	71 (p) 43 (a)	68	554	X	✓	24; 3 crush fractures between T12 and L2. No cord injuries. All SI as a result of falls
Admissions to hospital	Barber ⁸	154	45	109	118	36	X	✓	
Admissions to spinal units	Inman: Oswestry [†]		4	22					✓
Admissions to spinal units	Inman: UK [†]		4	11					✓
Retrospective study	Whitlock ¹²	103		41 ?a/p	69	32?			10/69 amateurs 2/32 professionals
Accident Dept. 50 admissions	Lloyd ⁷	237	75	162	131 F 32 M	31 F 43 M	✓	✓	5 spinal fractures: 1 fracture dislocation CS, 4 lumbar fractures. all caused by falls
Accident Dept. 42 admissions	Chitnavis ⁹	236			133	44**		✓	4: 1 C6, 1 L3, 2 at L1. 16 soft tissue injuries. No cases of permanent neurological deficit
N/S admissions	Hamilton ¹⁰	156	X	X	X	X	✓	✓	19 pts had SI. Implication that the majority were caused by falls
Prospective study	Grossman ²²	110	X	X	>90%	X	X	X	1 severe back strain
	McGhee ²³ Brooks ^{3,24} Firth ²¹ Reckling ²								Head injuries No figures No figures No figures of his own

a = amateurs; p = professionals, M = male, F = female, SI = spinal injury. *Total equestrian related injuries. **Horse related occupations. †Unpublished figures from Oswestry and the UK units (CJ Inman, personal communication, 2001)

Table 2 Epidemiological definitions

Incidence	New accidents in a specified period of time
Prevalence	The total number of cases existing in a population at a given time
Prevalence rate	The prevalence rate should be age-related, and if possible the skill and experience of the participants should be considered
Classification and severity of injury	This must be defined whether it is a major head injury, a spinal injury or a minor injury
Population	The number of horse riders in the UK is known (over 3 million) but not the number of times they ride
Identifying causative factors	Factors that are causally related – mechanism of injury: falls from a horse on to the head or buttocks, kicks from horse etc., type of riding, temperament of the horse, the equipment
Predictive studies	To determine whether the injury varies in frequency from place to place or has changed in frequency over time, or whether it varies with different types of riding

Recent surveys have shown that 20% of injured riders attending hospital are admitted and approximately 60% of these have head injuries.

Incidence

The incidence of horse riding accidents is difficult to derive since, although many minor accidents occur, riders will not always consult a doctor. In the United States the National Electronic Injury Surveillance System⁶ found that in 1997 58 647 people attended hospital with horse related injuries and in 1998 this figure had risen to 64 693.

Accident Department – non selected cases

Three papers have been identified of attendances at Accident Departments in hospital following horse-riding accidents (Table 3).

Of 78 000 attendances at Addenbrooke's Accident Department, Cambridge, only a small proportion of whom were admitted, 0.3% were due to horse-related injuries.⁷ Of these there were five spinal injuries. In those patients who sustained neurological injuries, head injuries predominated.

The first paper from the Radcliffe Infirmary Accident Department, Oxford⁸ was a retrospective study of people who sustained injuries as a result of horse riding related accidents, who attended the Accident Department and were admitted to hospital. This was followed up by a comparison 20 years later by Chitnavis *et al*⁹ who undertook a prospective study of attendance at the Accident Department in 1991. They found a reduction in total admissions of 46% because of a fall in head injuries most likely due to the use of riding helmets. Of 177 patients seen with 236 injuries, 42 (24%) were admitted to hospital. There were four spinal fractures. The most commonly injured group remained amateur young female riders.

Those in the first Oxford paper⁸ had more serious injuries because these were admission figures. Both units had a small number of spinal injuries with a preponderance of females over males and lumbar over cervical injuries.

Neurosurgical admissions – selected cases

Hamilton and Tranmer¹⁰ reviewed riders attending three Canadian Neurosurgical Units following horse riding accidents resulting in nervous system injuries (Table 4). These cases were selected by virtue of being neurosurgical admissions to the Neurosurgical Department. There was a 6:1 preponderance of head injuries

over spinal injuries. The male/female distribution for spinal injuries was not given but the distribution of cervical injuries to lower spinal injuries showed the same broad pattern as the figures from Cambridge⁷ and Oxford.^{8,9}

Admissions to spinal units

In contrast to the previous tables, Table 5 shows the incidence of spinal cord injury due to horse riding accidents and these are all patients who were admitted to spinal units. The proportion of horse riding accidents resulting in spinal cord injury has increased but the denominator is not known since the catchment area of Stoke Mandeville has fallen. When the 1951–1968 figures were produced, Stoke Mandeville was the only spinal unit serving the south of England but in 1984 two further units, Stanmore serving London and Odstock serving the West Country, opened.

It would seem that the proportion of horse riding accidents has increased as wealth and leisure have increased. In the USA horse riding is a rare cause of spinal sporting injuries and a very rare cause of admission compared with the UK units.¹¹ Nevertheless the female to male preponderance remains and taking the injuries as a whole, injuries of the cervical spine are not nearly so common as the lower spinal injuries.

Table 3 Horse-related injuries presenting to Accident Departments at Oxford and Cambridge Hospitals^{7–9}

Unit	Dates	Total attendances	Total admissions	Horse-related injuries	Spinal injuries	Sex
Oxford Accident Dept	1971–2		8768	154 (1.8%)	3 cervical 2 thoracic and lumbar	1 male 4 female
Oxford Accident Dept. (Radcliffe Infirmary)	1991			236 (in 177 patients)	1 cervical 3 lumbar	
Addenbrooke's Accident Dept.	1982–4	78,000		237 (0.3%)	1 cervical 4 lumbar	All female

Table 4 Horse riding accidents resulting in nervous system injuries in three Canadian Neurosurgical Units¹⁰

Unit	Dates	Horse-riding accidents resulting in nervous system injuries	Males	Females	Deaths due to head injury	Head injuries	Spinal injuries
Admissions to three Canadian neurosurgical units	1983–88	156	77	79	11	121	19*: 8 had neurological impairment 6 Cervical 11 Thoracic 3 No bony injury

*Spine injuries occurred in a total of 19 patients on 20 occasions. Head injury was associated with spine injury on eight occasions. There were six cervical fracture-dislocations and 11 thoracic and lumbar fractures. Three patients had evidence of neurological impairment without evidence of fracture or dislocation. Eight of the 20 accidents were associated with neurological impairment. There were three incomplete cervical cord injuries, two spinal cord concussions, one patient with a cervical radiculopathy and two with cauda equina syndrome. Two patients required surgery to stabilise cervical fracture-dislocations. Sex distribution of spinal cases not given

Prevalence

Prevalence cannot be calculated because the total number of horse riders is not given.

Prevalence rate

Sometimes age is given but this is not usual. Skill and experience of the participants has to be asked for specifically. Whitlock¹² compared professional and amateur horse riding injuries (Table 6).

Identifying causative factors

Mechanisms of injury, types of equestrian activities and methods of riding, details of the horse and riders involved in accidents and the circumstances of the accident are illustrated in Tables 7, 8, 9 and 10. Either these factors are not given at all or, if they are, the information is incomplete.

The only figures in the UK that attempt to analyze the relative risks on proper epidemiological grounds are the figures from the Jockey Club¹³ (Table 11). In the United States and Australia causative factors have been identified.^{6,14,15}

NEISS⁶ figures from the USA for 1998 show most injuries occurred at home/sports, 36.9% were males, 63.1% were females. The riders 25–44 years of age

had a higher per cent of injuries than in 1997 and 1992–1996. There was a fall in injuries in the 15 to 24-year-olds which was attributed to safety regulations. The United States Pony Clubs Accident report for 1999¹⁵ states that cross country schooling accounted for 22.5% of accidents, a percentage that was much larger than the time and numbers involved.

In Australia¹⁴ injury rates were found to be especially high among event riders, with frequent falls, injuries, and even deaths. The highest injury rates were among the riders competing at the highest levels.

Table 7 Causative factors

Mechanism of injury	Thrown, dragged, crushed, trampled, kicked, butted, bitten, scalped, lacerated, abraded
Types of equestrian activities	Hacking, trekking, racing, course racing, show jumping, dressage, horse trials and eventing, hunting, polo, riding for the disabled, non riding equestrian sports, rodeo events, point to point
Methods of riding	Jockey style: head forward Classic style: head held high, feet thrust out Bare back

Table 5 Incidence of spinal cord injury (SCI) due to horse-riding accidents²⁷

Unit	Dates	New patient admissions with SCI	SCI due to horse riding	Females	Males	Level	No neurology
Stoke Mandeville‡	1951–68	588	8 (1.4%)				
Stoke Mandeville‡	1984–88	343	16 (4.7%)				
Stoke Mandeville‡	1994–99	604	18 (3%)	12	6	8 cervical 6 thoracic 1 lumbar	3
Odstock	1997–99	126	4 (3%)	3	1	2 thoracic 2 lumbar	
Oswestry†	1985–98	1333	26 (2%)	22	4	10 cervical 9 thoracic 7 lumbar	
All spinal units, UK† 2000			15	11	4	1 cervical 4 thoracic 3 lumbar	7

†Unpublished figures from Oswestry and the UK units (CJ Inman, personal communication, 2001). ‡Unpublished figures from Stoke Mandeville (D Wang, personal communication, 2001)

Table 6 Comparison of professional and amateur horse-riding injuries¹²

Author	Dates	Total horse riding injuries	Amateurs	Amateurs with spinal injury	Professionals	Professionals with spinal injury
Whitlock	1983–4	103	69	10	35	2

Information was obtained from the Ambulance Service, the Jockey Club and the St John Ambulance Brigade. Of these 12 spinal injuries, two involved the lumbar spine with partial paralysis

Table 8 Details of the horse

Age
Sex
Height
Purchase value
Type TB (thoroughbred)
No of previous owners
Stabling: riding school or farm
Exercised within previous two days
Veterinary examination prior to accident
Shoeing prior to accident
Shoeing within previous six weeks
Feet condition thought satisfactory
Teeth condition thought satisfactory
Sound, wind/limb/temper
Horse under treatment
Feed; hard and hay
Well-behaved boxing and grooming
Good in traffic
Good with other horses
Competition experience
Hazardous traits Equipment, saddle, bridle etc. good condition
Snaffle bit
Running martingale as extra

Table 9 Details of the rider

Female or male
Age: <20 years
20–29
30–39
40–49
>50
Previous head injury
Previous fractures
State of health at the time of the accident
Normally of calm temperament
Inexperienced
Previous qualified instruction
Good knowledge of stable management
Wearing hat and boots
BS 4472 jockey skull cap (recommended standard at that time)
Hat not secured or inadequate
Condition of personal equipment good
Carrying stick
Competitive experience

Predictive studies

Predictive studies can only be carried out if the previous information is available.

Discussion

Figures are available from the UK, the USA, Australia, Canada and the Netherlands⁵ but they are not comparable. Some have not been reported by

Table 10 Circumstances of the accident

Spring/Summer/Autumn/Winter
Am/Pm
Dry/Wet weather
Indoors
Fall
Knocked off
Reared
Thrown
Unbalanced
At speed
Jumping
Preventable accident
Accident happened at unapproved riding stables
Experience adequate
Stress at the time or immediately before
Type of spinal injury
Cervical
Thoracic
Lumbar
Minor fractures
Concussion

Table 11 Horse race meetings: figures from the Jockey Club¹³

Type of meeting	Falls	Injuries
Flat	1 in 292 rides	1 in 2.5 falls (40%) 1 in 720 rides
Jump (National Hunt)	1 in 15 rides (6.7%)	1 in 6 falls (16.8%) 1 in 88 rides (1.1%)
Point to point	1 in 7 rides (14.3%)	1 in 4.5 falls (22.4%) 1 in 42 rides (2.4%)

medical personnel, but by untrained personnel such as technical delegates¹⁶ or district commissioners/local leaders.¹⁵

There are selected figures from Accident Units and comparison can be made between the attendances at Addenbrooke's Hospital, which show 0.3% of total attendances were due to horse related injuries, and the Radcliffe Infirmary which show that 1.8% of admissions were due to horse related injuries (but because these are admissions they are among the more serious injuries).

Overall figures from the USA¹¹ show that between 1973 and 1985 a total of 9647 new admissions with spinal cord injury, 14.2% were due to sport, of which 2% represented horseback riding injuries.

In an overall review of horse riding injuries,¹⁰ head injuries outnumbered spinal injuries at about 5:1 which would indicate that the force required to cause a head injury is rather less than that required to fracture the spine (Figure 1).

With regard to admission to spinal units for horse riding accidents, there are far more lumbar and thoracic injuries than cervical in contrast to all other sporting injuries (Table 12) which are almost entirely cervical injuries, indicating that there are different mechanisms involved.¹⁷ In all other sporting injuries where the head leads it is almost inevitable that the cervical spine, which is more vulnerable, will be fractured rather than the lumbar or thoracic spine. The only rugby injury in which the thoracic spine was involved was when a drunken rugby player fell downstairs after a game. This would be in keeping with the speculation that in horse riding accidents there are two methods of riding: either jockey style (cross country position) with the head forward, where the rider would be more likely to sustain a cervical injury accompanied inevitably by a head injury, and classical style where the head is held high and the rider would be likely to fall on to the buttocks.⁸

Jumping is the most dangerous horse riding activity.^{13–16,18} In Australia, injury rates were found to be especially high among event riders¹⁴ (Figure 2) and in the USA cross country schooling accounted for 22.5% of accidents at pony clubs.¹⁵ USCTA statistics¹⁶ show that most serious injuries occurred in a jumping phase (Figure 3). There were 12 back injuries in 1993 and seven in 1995, all occurring in cross country.

Jockeys in the USA had a very high injury rate in 1997¹⁸ and dorsal/lumbar spine injuries were the most common injury. In the UK the Jockey Club reports that point to pointing is more dangerous than any other horse riding activity, carrying the risk of a fall in one in seven rides, injury one in 42 rides and one in 4.5 falls.¹³

The simplest information about how the rider was injured, by a fall or some other mechanism, is only available in five of the papers^{7–10,19} and even here the information is incomplete. Articles from the USA and

Figure 2 Injury rates are especially high among event riders

Figure 1 A dangerous activity. Head injuries outnumber spinal injuries at about 5 : 1

Figure 3 The most serious injuries occur during the jumping phase

Table 12 Analyses of 121 cervical sports injuries and their distribution¹⁷

<i>Sport</i>	<i>Date of paper</i>	<i>Period of study</i>	<i>No</i>	<i>Male/Female</i>	<i>Age range</i>	<i>No of cervical injuries</i>	<i>Other lesions</i>
Rugby	1984	1952–82	67	67/0	15–40	47	20
Rugby	1988	1983–87	19	19/0	13–43	18	1
Trampolining	1986	1963–78	16	13/3	10–43	15	1
Gymnastics	1986	1954–84	38	33/5	12–54	35	3
Horse riding	1991	1976–85	10	3/7	10–70	6	4
Total			150	135/15		121	

Australia^{6,14–16,18} give this information but are defective in other areas. Of a total of 50 back and spine injuries Edixhoven¹⁹ stated 16 were caused by kicks and 33 to falls. Of these 24 were spinal injuries including three crush fractures but there were no spinal cord injuries. Barber⁸ cited five patients with spinal cord injuries as a result of falls, only one had neurological damage. Lloyd's survey⁷ identified 237 patients with horse related injuries. He does not identify how many of the spinal injuries were caused by falls from a horse. In Hamilton's paper¹⁰ 19 patients had spinal injury. The implication is that the majority of these were caused by falls. Chitnavis *et al*⁹ state that the majority of the injured were riders (138, 78%) of whom the majority fell from their mounts (115, 83%). Some were crushed as their horse fell (20, 14%) and others struck obstacles whilst mounted (7, 5%) or were injured by entrapment of the reins (7, 5%).

Thoraco-lumbar fractures are almost unique to equestrian activities. Branches of trees have unseated riders backwards as have rearing horses. The speed of falling is thought by many to be relevant to the likelihood of serious injury as slow falls are sometimes the worst in this respect. The proximity of other horses seems to be the major problem for jockeys as their tuck and roll technique seems to ameliorate quite a lot of injuries. Recent fatalities in eventing have nearly always been when the horse has fallen on the prone rider.

It is therefore virtually impossible to correlate the injuries with the mechanism of injury on a scientific basis in contrast to rugby injuries where, as a result of numerous lawsuits, research has been carried out and accurate information has been obtained as to how accidents occur and can be prevented. In particular, Schneider's pioneering work in the USA, correlating X-rays, videos and accidents and the setting up of a national register for major accidents, has to be acknowledged.²⁰

From these five papers, a fall from a horse would appear to be most likely to cause a spinal cord injury. Just as in rugby, a kick, whilst it may cause a fracture of a transverse process, does not cause spinal cord injury.

Does a greater degree of skill give rise to greater safety? Paix¹⁴ found the highest injury rates were among the riders competing at the highest levels. The USA Pony Club report for 1999¹⁵ states that it was the child with the greatest number of years experience who was having the accidents. This is confirmed by the USCTA statistics¹⁶ which show that in horse trials advanced and intermediate divisions had the highest injury rates (0.83% and 0.84% respectively). Injuries are occurring less to young riders and more frequently to older riders perhaps because younger riders are more willing to accept safety concepts.⁵

Greater skill leading to greater safety is contentious in the sporting context as the demands increase at the higher competitive levels. Only two papers^{12,17} made a

clear distinction between amateur and professional riders although Chitnavis *et al*⁹ stated that in their survey 133 patients (75%) were amateurs and the remaining 44 (25%) were in various horse related occupations. The problem with these two papers is that the total numbers of amateur and professional riders, the number of hours that they ride and the type of riding are unknown. On general grounds it might be said that in the UK an amateur rider who indulges in hunting without wearing an appropriate protective riding hat, suitably harnessed, is more at risk than someone who hacks in a field wearing a riding hat. In the USA good hunting is enjoyed in Virginia and the Carolinas where prudence, sense and habitual effective head protection in no way distract from the furore of the chase, but leave the clinical spectrum of injury incomparably less disastrous than the experience of many British accident departments.²¹ This question cannot be answered from the figures presented.

Figures from the Jockey Club¹³ (Table 11) attempt to analyze the relative risks on proper epidemiological grounds in terms of the number of rides as opposed to the numbers of riders. They show that point to pointing is more dangerous than any other horse riding activity carrying risk of a fall in one in seven rides, injury one in 42 rides (2.4%) and one in 4.5 falls (22.4%). There are figures from the USA, in particular the Pony Club figures,¹⁵ but it is acknowledged that no figures related to total horse participants and gender are available in the USA so they are not in a form which is amenable to proper analysis.

In the UK, where space is limited, a lot of riding is done on the roads and accidents happen when cars come into collision with riders. In contrast, in the USA, riding is organised in special off-road rides, and similarly in Germany rides are better organised and controlled. But these are just anecdotes and no thorough analysis has been made of how different styles of riding and equipment can modify accidents.

In view of this lack of information, Silver and Lloyd Parry¹ carried out a retrospective study of 20 horse riders, 10 with spinal injuries and 10 with minor injuries. Detailed questionnaires covering the horse, the rider and the circumstances of the accident (Tables 8, 9, 10) were completed in an attempt to determine the importance of these factors involved. This was a small study and the hope was that it would be implemented prospectively on a much larger scale to answer the type of questions posed in this paper. Unfortunately it has not been followed up but hopefully it will be.

Conclusion

Horse riding is a dangerous sport. There has been an increase in spinal cord injury admissions due to horse riding. Women riders are more likely to be admitted with serious injury but there are more women riding and the number of accidents to female riders is probably in proportion to the total number of women

riders. Lumbar and thoracic fractures are much more common than cervical fractures, the likelihood being that this is due to fall on the buttocks or being thrown against obstructions. The injuries are more likely to occur in point to point and jumping than in flat racing or in social riding. Figures about hunting are not available and are pure speculation.

There are over 27 000 websites concerning spinal injuries on the internet, 6533 on horse riding injuries and 676 on horse riding spinal injuries so deriving this information is not an easy task.

Note added in proof

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