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Spine fractures caused by horse riding

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Abstract *Study Design*: Retrospective study and review of literature. *Objectives*: Study of demographic data concerning spinal fractures caused by horse riding, classification of fractures according to the AO and Load Sharing classifications, evaluation of mid-term radiological results and long-term functional results. *Methods*: A review of medical reports and radiological examinations of patients presented to our hospital with horse riding-related spine fractures over a 13-year period; long-term functional follow-up is performed using the Roland Morris Disability Questionnaire (RMDQ-24). *Results*: Thirty-six spine fractures were found in 32 patients. Male to female ratio is 1:7. Average age is 33.7 years (8–58 years). The majority of the fractures (78%) are seen at the thoracolumbar junction Th11–L2. All but two patients have AO type A fractures. The average Load Sharing Classification score is 4.9 (range 3–9). Neurological examinations show ASIA/Frankel E status for all patients. Surgical treatment is performed on ten patients. Mean follow-up for radiological data is 15 months (range 3–63). Functional follow-up times range from 1 to 13 years with an average follow-up of 7.3 years. Mean RMDQ-24 score for all patients is 5.5 (range: 0–19), with significantly different scores for the non-operative and surgical group: 4.6 vs 8.1. Twenty-two percent of the patients have permanent occupational disabilities and there is a significant correlation between occupational disability and RMDQ-24 scores. Conclusions: Not only are short-term effects of spine fractures caused by horse riding substantial but these injuries can also lead to long-term disabilities.

Keywords Sports medicine · Spinal fractures · Horses · Review

Introduction

Horse riding is frequently complicated by injuries. In the Netherlands, every year, one out of seven riders will sustain an injury, resulting in a total number of 74,500 injuries. All these injuries result in 9,100 Emergency Department consultations, finally leading to over 900 hospital admissions. Annually, the in-hospital mortality amongst horse riders is five; the number of pre-hospital casualties is unknown [1]. The overall risk of injury from horse riding- and grooming-related activities per hour has been determined to be higher than car racing or riding a motorcycle and is in the same order of magnitude as Australian rugby [2–5]. A full-grown horse can weigh over 500 kg, gallops at speeds up to 50–65 km/h and can kick with a force of 1.8 times its bodyweight. The differences between horses and people predispose toward serious injury and are compounded by the potential for unpredictable behavior in both species [6].

In this article spine fractures associated with equestrian activities are described. The aim of this retrospective study of our own patient collective is to look at demographic data, to classify the spine fractures according to the AO Comprehensive Classification and Load Sharing Classification (LSC) and to evaluate both the mid-term radiological results and the long-term functional results using the Roland Morris Disability Questionnaire (RMDQ-24). Additionally, a review of the literature concerning injuries caused by horse riding with emphasis on spine fractures is performed.

Methods and materials

For this retrospective study covering a 13-year period (1990–2003) the medical reports and radiological examinations of patients presented to the Vrije Universiteit medisch centrum (VUmc) with horse riding-related spinal injuries were reviewed. Classification of the spine fractures was performed according to the AO Comprehensive Classification and the LSC of spine fractures as described in the original articles [7, 8]. Magnetic resonance imaging (MRI) was not routinely performed.

Standard mid-term radiological evaluation involved the measurements of the local and regional sagittal angles and comparison with the original post-traumatic situation. Positive regional sagittal angles indicate lordosis, and negative angles indicate kyphosis (Fig. 1).

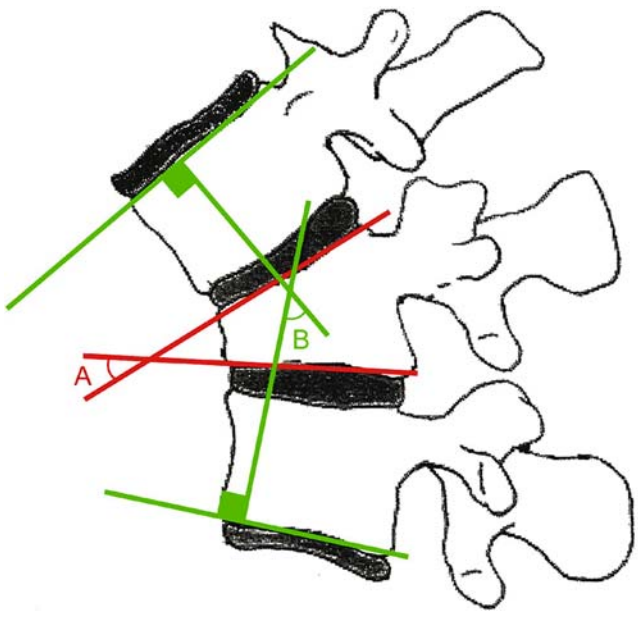


Fig. 1 a Local sagittal angle. b Regional sagittal angle

Long-term functional results were reviewed using the RMDQ-24 score which has been described in other studies concerning the evaluation of functional results on spine fractures [9–11]. The RMDQ-24 score ranges from 0 to 24 points with 0 points indicating no disability at all and 24 points indicating severe disability [12]. RMDQ scores were obtained by written questionnaires and scoring was performed by an independent observer for statistical analysis, uninformed about treatment protocol. The Mann–Whitney test for statistical analysis was used to show a correlation between RMDQ-24 scores and permanent occupational disabilities.

A literature review concerning equestrian activities and spine fractures was performed using Medline database engines and restrictions for English and German language articles. Search terms involved were horse, injury and spine. With these search terms five articles were found that addressed spinal injuries related to equestrian activities. With cross-referencing, additional literature was found.

Results

In the period from December 1990 to December 2003, 32 patients with a total number of 36 spine fractures due to horse riding accidents were admitted to the VUmc. Females outnumbered males by a factor of seven (28 females and 4 males, respectively). Mean age was 33.7 years (range 8–58 years).

Seventy-eight percent of the fractures occurred at the thoracolumbar junction (Th11–L2). Only one patient was presented with cervical fractures of the transverse processes at levels C5 and C6 (Fig. 2). According to the AO classification, the 34 thoracolumbar fractures could be classified as: 15 A1 type, 17 A3 type and 2 B1 type fractures (Table 1). Additional MRI studies were performed to diagnose the ligamentous injury in one of the B1.2 type fractures (Fig. 3). The mean LSC score of all thoracolumbar spine fractures was 4.9 (3–9), with mean LSC scores of the non-operative group and surgical group reaching 4.1 and 6.8, respectively. Statistical analysis showed a significantly higher LSC in the surgical group ($P < 0.001$). Detailed physical examination did not point out neurological deficits based on spine fractures in any patient; hence, all patients were classified as ASIA/Frankel E. Accompanying injuries consisted of distal radial fractures in two patients and cervical spine fractures at levels C5 and C6 in one patient who sustained a serious brachial plexus injury as well as a peripheral facial nerve injury which led to chronic impairment. A summary of all demographic and fracture-related data is shown in Table 1.

Twenty-two patients were managed non-operatively and ten patients received surgical therapy. Average hospital admittance times were 11.8 days for non-

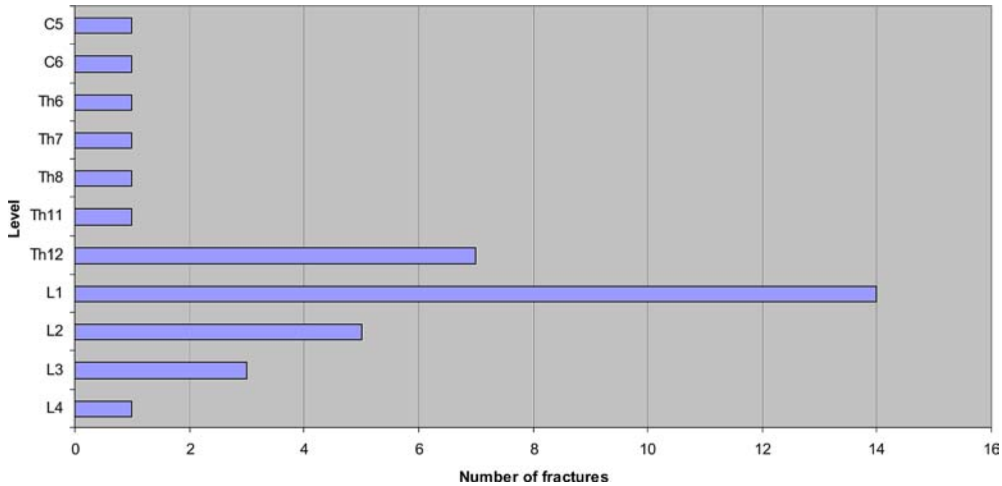


Fig. 2 Fracture levels; total number of 36 fractures

Table 1 Demographic and fracture-related data

	Male/Female	Age (years)	Level	AO	LSC	Local angle	Regional angle
1	Female	33	Th12	A3.1	7	−25	−24
2	Female	17	L2	A1.2	3	−8	−6
			L3	A1.2	3	−6	−3
3	Female	27	Th12	A1.1	3	−3	−3
			L2	A1.2	3	−5	−7
4	Female	36	L2	A3.1	5	−7	−3
5	Female	48	Th12	A3.2	8	−28	−14
6	Male	52	C5	n.a.	n.a.	n.a.	n.a.
			C6	n.a.	n.a.	n.a.	n.a.
7	Female	29	L2	A1.1	3	−7	−7
8	Male	16	L1	A3.1	6	−21	−16
9	Female	37	Th6	A1.2	5	−12	−10
10	Female	37	Th7	A3.2	8	−18	−16
11	Female	36	L1	A1.2	4	−14	−9
12	Female	58	L4	A1.2	3	−6	−5
13	Male	29	L1	A3.1	5	−10	−10
14	Female	38	Th12	B1.2	7	−18	−20
15	Female	24	Th11	A1.2	4	−8	−3
16	Female	28	L1	A3.1	6	−14	−10
17	Female	49	L3	A3.1	4	−5	−5
18	Female	31	L1	A3.3	6	−9	−5
19	Female	29	L1	A3.3	5	−5	0
20	Male	52	L1	A3.1	6	−20	−16
21	Female	25	L1	A3.1	6	−20	−14
22	Female	36	L1	A3.1	5	−20	−19
23	Female	8	L1	A1.2	3	−5	−2
			L2	A1.2	3	−5	0
24	Female	37	L1	A1.2	5	−10	−8
25	Female	56	L1	A3.1	5	−15	−13
26	Female	38	Th12	A3.3	9	−16	−12
27	Female	11	Th8	A3.1	4	−6	0
28	Female	23	Th12	A1.2	3	−5	0
29	Female	39	Th12	A1.2	4	−9	−9
30	Female	31	L1	A1.2	4	−8	−7
31	Female	37	L1	B1.2	7	−6	−5
32	Female	31	L1	A3.1	5	−4	−5

Positive sagittal angles indicate lordosis, negative angles indicate kyphosis.
n.a., not applicable.

Fig. 3 MRI of patient with AO type B 1.2 fracture showing a lesion of the posterior ligamentary complex between the spinous processes of Th11 and Th12, a peridural hematoma and a compression fracture of the upper endplate of Th12

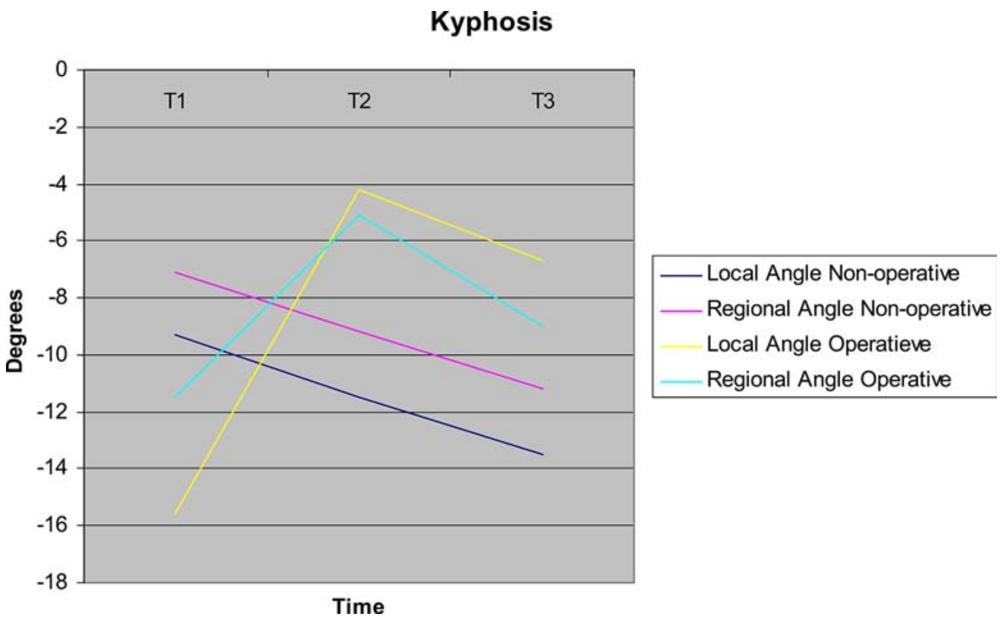
operatively managed patients with early functional treatment, 43.0 days for patients receiving late functional treatment and 17.3 days for surgically stabilized patients.

Three patients showed complications: one patient with an anterior stabilization had a superficial wound infection needing surgical debridement combined with a prolonged period of oral antibiotics and another patient had persistent mechanical complaints of the posterior implant materials without signs of infection which led to early implant removal at 9 months. A non-operatively managed patient had a pulmonary embolism despite prophylactic LMW-heparins and was treated with intravenous heparins and a 12-month period of oral coumarines.

Mean local and regional sagittal angles measured −9.3° and −7.1° kyphosis, respectively in the non-operatively treated group and −15.6° and −11.5° kyphosis in the surgical group. Surgical reduction corrected local and regional sagittal angles to −4.2° and −5.1° kyphosis. After a mean radiological follow-up of 15 months, local and regional sagittal angles in the non-operatively treated group measured −13.5° and −11.2° kyphosis, resulting in a further loss of −4.2° and −4.1°. Mid-term local and regional sagittal angles in the operatively treated group were measured after implant removal. The follow-up results still showed a minimal correction, resulting in local and regional sagittal angles of −6.7° and −9.0° kyphosis (Fig. 4).

Mean follow-up for the functional scores was 7.3 years (1–13 years). The response rate for RMDQ-24 scores was 84%. The RMDQ-24 is specifically developed for the measurement of disability of low-back pain, hence patient 6 with cervical injury was not included in the average RMDQ-24 scores [12]. The mean overall RMDQ-24 score was 5.5 (range: 0–18). Average RMDQ-24 scores for non-operatively treated patients and surgically stabilized patients showed a significant difference: 4.6 and 8.1, respectively

Fig. 4 History of kyphosis in non-operatively treated group and surgically stabilized group; *T1* hospital admission, *T2* 1–3 months and *T3* 9–12 months (after posterior implant removal)



($P < 0.01$). A summary of all radiological and functional outcome data is shown in Table 2. Six patients (22%) have permanent occupational disabilities for their previous professions and four of those patients ended up in social welfare or stopped working while two patients continued in another profession on a therapeutic base. The Mann–Whitney test showed a significant relation between RMDQ-24 scores and permanent disability for work ($P < 0.001$). All five patients with RMDQ-24 scores of 14 or higher had permanent occupational disability.

Review of literature

General epidemiologic data of severe injuries caused by horse riding

Compared to other sports, horse riding accounts for the largest number of hospital admittance days by far [13]. The incidence of serious injuries due to horse riding is higher than motorized sports and can only be equaled by Australian rules football [2–5, 14, 15]. In the western world, 25% of all fatal sports accidents are caused by

Table 2 Clinical, radiological and functional outcome data

	Treatment	Hospital stay (days)	Complications	FU local	FU regional	After (months)	RMDQ	Functional follow-up (months)
1	Early functional	10		−26	−30	63	2	57
2	Early functional	8		−15	n.a.	12	4	47
3	Early functional	10		−10	n.a.	13	5	25
4	Posterior with posterolateral and transpedicular fusion	13		−7	−12	24	6	42
5	Posterior with posterolateral and transpedicular fusion	14	Complaints of osteosythesis	−14	−14	18	0	59
6	Early functional	20		n.a	n.a.	n.a.	n.a.	53
7	Early functional	3		−11	−7	9	2	39
8	Early functional	11		−21	−16	3	4	48
9	Early functional	14		−12	−10	9	9	39
10	Anterior with bisegmental fusion	9		[a]	[a]	[a]	[a]	[a]
11	Early functional	11		−14	−11	9	3	48
12	Early functional	13		−6	−5	9	7	33
13	Early functional	8		−15	−15	12	0	68
14	Anterior with bisegmental fusion	27	Superficial wound infection	−1	−7	12	15	11
15	Early functional	9		−14	−3	12	0	16
16	Posterior without attempted fusion	16		−12	−10	24	1	129
17	Early functional	11		−7	−5	9	1	137
18	Posterior with posterolateral fusion	27		−2	0	24	2	156
19	Late functional	34		−12	−12	15	0	132
20	Posterior with posterolateral and transpedicular fusion	22		−10	−10	24	19	130
21	Posterior with transpedicular fusion	14		−1	−10	24	14	104
22	Late functional	45	Pulmonary embolism	−28	−23	12	0	115
23	Early functional	15		−5	n.a.	9	0	141
24	Early functional	7		[a]	[a]	[a]	[a]	[a]
25	Late functional	50		−22	−18	9	16	133
26	Posterior with posterolateral and transpedicular fusion	15		[a]	[a]	[a]	[a]	[a]
27	Early functional	5		−8	−2	9	2	117
28	Early functional	9		−12	−5	9	18	143
29	Early functional	11		−12	−10	8	2	111
30	Early functional	8		−7	−7	9	12	118
31	Anterior with bisegmental fusion	16		[a]	[a]	[a]	[a]	[a]
32	Early functional	14		[a]	[a]	[a]	[a]	[a]

Positive sagittal angles indicate lordosis, negative angles indicate kyphosis.
n.a., not applicable.
[a] Lost for follow-up in other hospitals.

horse riding [16–18]. Horse riding is also the sport with the highest incidence of severe injuries and fatal accidents in children [13, 19]. Craniocerebral injuries dominate in lethal horse riding injuries, indicating the importance of protecting helmets [3, 5, 15, 18, 20].

Spine fractures

In some countries 70% of all spine fractures caused by sports activities are sustained by equestrian activities [21]. In a German study on horse riding injuries, spine fractures proved to be as common as clavicle fractures [16]. Another German study about fatal horse riding accidents showed that next to craniocerebral trauma, thoracolumbar spine fractures were the most commonly encountered injury in all fatalities with an overall incidence of 10% [18]. Several other studies confirmed that 7–10% of all riders requiring hospital admission will have a spinal injury [14, 22–25].

Discussion and conclusions

The gender distribution in the VUmc patient population (male vs female 1:7) confirms the expectations based on data of the total group of riders as known by the Royal Dutch Horse Riding Federation [26]. As expected, most of the spine fractures occur at the thoracolumbar junction Th11–L2 and this is simply a reflection of the most common location of compression type fractures. In the patient population only two AO type B fractures are found, but as described in literature it could be possible that other AO type B fractures, especially those with ligamentous posterior injuries, were not diagnosed because MRI was not routinely performed [27]. As expected, average LSC scores are significantly higher for the surgically stabilized patients. The initial local and regional sagittal angles in the surgical group show more kyphosis than the non-operatively treated group. After operative reduction, this sagittal alignment improves over the conservative group. Although a large part of the initial reduction is lost in the next 12 months, the operatively treated patients still have less kyphosis compared to the conservative group at mid-term radiological follow-up (after posterior implant removal at 9–12 months).

The significant relation between the RMDQ-24 score and permanent occupational disability shows the usefulness of functional outcome scores like the RMDQ-24 in the follow-up of patients with spine injuries.

Consequences of injury caused by horse riding can be profound and the long-term effects should not be underestimated. Even years after a major trauma, 43% of the patients have complaints and 11–20% will remain permanently unfit for work [28]. Spinal and pelvic trauma are the most important risk factors for these long-term effects [28].

In view of the many different injuries described in literature, one can say that there is no activity with horses which is entirely without risk of injury. One suggestion is to teach horse riders falling techniques as used in martial arts sports and parajumping [16, 29].

In conclusion, we can state that the respect that riders show toward their horses is entirely justified.

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