Distribution of Pelvic Fractures in Racing and Non-racing Sport Horses: A Retrospective Study of 86 Cases Examined in a Referral Centre

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Abstract

Objective The aim of this study was to analyse the pelvic fracture distribution and location in a referral centre caseload.

Materials and Methods Medical records of 6,717 horses examined in a referral centre over a 7-year period were reviewed to identify all horses diagnosed with a pelvic fracture. Eighty-six horses were identified and divided into three disciplines, namely Thoroughbred racehorses (TBR), Standardbred trotter racehorses (STR) and non-racing sport horses (NRSH).

Results A pelvic fracture was diagnosed in 1.3% of the cases examined during the study period. Prevalence was significantly higher in TBR (4.2%) and, regardless of the discipline, in horses under the age of 6 years (2.2%) ($p < 0.01$). STR were significantly younger than TBR and NRSH at the time of fracture (median ages = 1, 3 and 4 years old, respectively; $p < 0.01$). The fractures occurred most frequently in the ilium (44/86). No ilial wing fractures were diagnosed in STR and isolated acetabular fractures were only diagnosed in foals and yearlings. Fatigue fractures were diagnosed in TBR alone, affecting 9/22 TBR (foals and yearlings excluded) and most often located in the ilial wing (7 fatigue fractures out of the 12 ilial wing fractures) ($p < 0.01$). The median age of horses suffering from a pelvic fatigue fracture was 4 years.

Clinical Significance This study confirms that young horses (under the age of 6 years) as well as TBR are likely to be at higher risk of a pelvic fracture. Fatigue fractures of the ilial wing seem to be a rare condition in STR while they are more frequent in young TBR in training.

Keywords
- pelvis
- fracture
- racehorses
- sport horses
- equine

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Introduction

Pelvic fractures are uncommon injuries in horses and are reported to cause 0.9 to 4.4% of hindlimb lameness cases.[1] Young horses are more susceptible to pelvic fractures,[1–5] and some authors report an apparent predisposition in females.[1,2,5] Fractures of the pelvis are, in general, the result of external trauma or falls, but incomplete fatigue fractures can also occur in young Thoroughbred racehorses (TBR)[6] and can lead to complete pelvic fracture if they are not detected in time. An Italian survey on musculoskeletal injuries in Standardbred trotter racehorses (STR) during harness training reported a lower incidence rate of fatigue fractures of the pelvis in this discipline.[7] Nevertheless, these fractures and traumatic pelvic fractures have only been fully described in TBR.[1,5,6,8–14] Just three studies describe samples in which TBR were not over represented.[2,15,16] However, these publications lack epidemiological data for non-racing sport horses (NRSH), and particularly those used in jumping, eventing and dressage competitions. The samples involved either a larger proportion of horses used in 'western' competition such as Quarter Horses or Paint Horses,[15,16] American Saddlebreds or other breeds, but their disciplines were not specified.[2]

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The aims of this retrospective study were, first, to describe the distribution and location of pelvic fractures diagnosed in a French referral centre, and second, to identify potential risk factors for pelvic fracture occurrence in horses. We hypothesized that traumatic fractures were most common in young horses and that the location and incidence of fatigue fractures in adult horses were different according to the horse's discipline.

Materials and Methods

The medical records of horses admitted to the Center of Imaging and Research of the Equine Locomotor Affections (CIRALE—France) over a period of 7 years were reviewed. Any horse with a recent or an old fracture of the pelvis was included. A total of 86 horses were retained for the sample group. The age, breed, sex, discipline and cause of the fracture were recorded for each case.

Signs of asymmetry of the pelvis, gluteal muscle atrophy, pain relief attitude and pain during hindlimb mobilization were assessed during the physical examination. Depending on the severity of the clinical signs, horses were examined walking on hard ground or walking and trotting in a straight line. Flexion tests were performed on horses with low grade of lameness at trot, and these horses were also observed trotting in circles on hard and soft ground surface, and cantering on soft ground (except for STR). The severity of lameness and response to flexion tests were graded on a 0 to 5 points scale (American Association of Equine Practitioners grading scale[17]).

Imaging investigations were used to establish a final diagnosis and a description of the pelvic fracture. All pelvic fractures were assessed with ultrasonography that was performed externally using a 5-MHz convex probe (73 horses) or transrectally using a 7.5-MHz micro-convex (curvilinear) probe (64 horses). Both methods were used in 51 cases. Standing radiographic examination of the pelvis was performed in 33 cases and in dorsal recumbency under general anaesthesia in four cases. A bone scintigraphy examination was performed for 16 horses.

The population was divided into three discipline groups (TBR, STR and NRSH) and six fracture type groups: isolated ilial fracture, isolated ischial fracture, isolated pubic fracture, isolated acetabular fracture, isolated sacral fracture and multiple pelvic fractures (affecting more than one pelvic bone). Isolated ilial fractures were subdivided into three groups: fractures of the tuber coxae including fractures of the whole tuber coxae and fractures of at least one lobe of the tuber coxae, fractures of the ilial wing and other ilial fractures (including fractures of the ilial shaft or tuber sacrale). Ischial fractures were subdivided into two groups: fractures of the tuber ischiadicum (partial or complete) and other ischial fractures.

The general characteristics (age, gender, breed and discipline) of the whole study group were also compared with the general horse population presented at the centre during the same period to determine prevalence and to identify potential risk factors.

Data were collected in a spreadsheet for statistical analysis (XLSTAT Biomed; Addinsoft, Paris, France). The groups were compared using a chi-squared test or Fischer's exact test for qualitative variables, and the Kruskal–Wallis test for quantitative variables. The significance threshold was set at $p < 0.05$. Indicators used for qualitative variables were percentages (%) and quantitative variables were expressed with medians followed by their interquartile range (IQR) in square brackets (median [IQR]). The associations between two binary variables were quantified by calculating odd ratios and their 95% confidence interval (odds ratios [OR] [95% CI]). When the sample size permitted, major confounding biases (breed/age/gender) were considered using logistic regressions to provide adjusted OR (ORa).

Results

Population

Eighty-six horses were diagnosed with a pelvic fracture among the 6,717 cases examined at the CIRALE over the reviewed period, resulting in a prevalence of 1.3% (95% CI [1.0–1.5]) in this referral population (►**Table 1**).

The population studied included 31 TBR (36%), 23 French STR (27%) and 32 NRSH including 22 Selle Français warmbloods (26%) and 10 foreign warmbloods, Arabians or ponies. One TBR was used in eventing and was included in the NRSH group. Among the 33 NRSH, 22 were jumpers, 3 were dressage horses, 3 were eventers, 2 were leisure horses and the discipline was unknown for the remaining 3 horses. The sample was composed of 36 females (42%), 31 geldings (36%) and 19 males (22%). Median age at the time of the fracture was 3 years old [1–5]. The STR were significantly younger (1 year old [1–2]) than TBR (3 years old [2–4]) and NRSH (4 years old [3–7]; $p < 0.01$) when the fracture occurred (►**Fig. 1**).

Independently of breed (TBR vs. other) and gender (female vs. other), the prevalence of pelvic fractures was significantly higher in horses under 6 years old (2.2%) than in older individuals (0.5%; $OR_a = 3.4$ [1.9–5.8]; $p < 0.01$). The prevalence was especially high in foals (5.7%) and yearlings (3.5%) (►**Table 1**). It was also significantly higher in TBR (4.2%) than in other breeds (0.9%), irrespective of age (<6 vs. $\geq$ 6 years old) and gender (female vs. other) ($OR_a = 3.2$ [2.0–5.0]; $p < 0.01$) (►**Table 1**). The prevalence did not differ significantly between females (1.6%) and males + geldings (1.1%) ($OR_a = 1.4$ [0.9–2.1]; $p = 0.16$), with the exception of the group presenting with an isolated pubic fracture. Here, the proportion of females was significantly greater (4/5) than in the general caseload of the CIRALE (33%) (OR = 8.1 [1.3–5.1]; $p < 0.05$).

Cause

The main cause of pelvic fractures was external trauma (42/86), with 20 horses that fell, 6 that suffered direct trauma to the pelvic area and 16 horses in which external trauma was highly suspected, either in the field for 10 horses or in the stall for 6 horses. Nine horses suddenly became lame during or immediately after exercise without any prior evidence of external trauma; these fractures were confirmed to be fatigue fractures. The cause was unknown for 35 horses.

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Table 1 Fracture distribution and prevalence according to the breed and the age

Breed	TBR		French STR		NRSH		Total		Prevalence
Age at referral (year)	Number of pelvic fracture	Number of case load	Number of pelvic fracture	Number of case load	Number of pelvic fracture	Number of case load	Number of pelvic fracture	Number of case load	
<1	4	40	1	35	1	31	6	106	5.7%
1	2	111	6	85	1	64	9	260	3.5%
2	4	118	5	196	1	67	10	381	2.6%
3	9	178	5	462	1	179	15	819	1.8%
4	7	98	1	372	7	298	15	768	2.0%
5	2	63	3	285	8	414	13	762	1.7%
>5	3	133	2	417	13	3,054	18	3,604	0.5%
Unknown	–	–	–	2	–	15	–	17	–
Total	31	741	23	1,854	32	4,122	86	6,717	1.3%
Prevalence	4.2%		1.2%		0.7%		1.3%		

Abbreviations: N, number; NRSH, non-racing sport horses (Warmbloods and other breeds used in non-racing competitions); STR, Standardbred trotter racehorses; TBR, Thoroughbred racehorses.

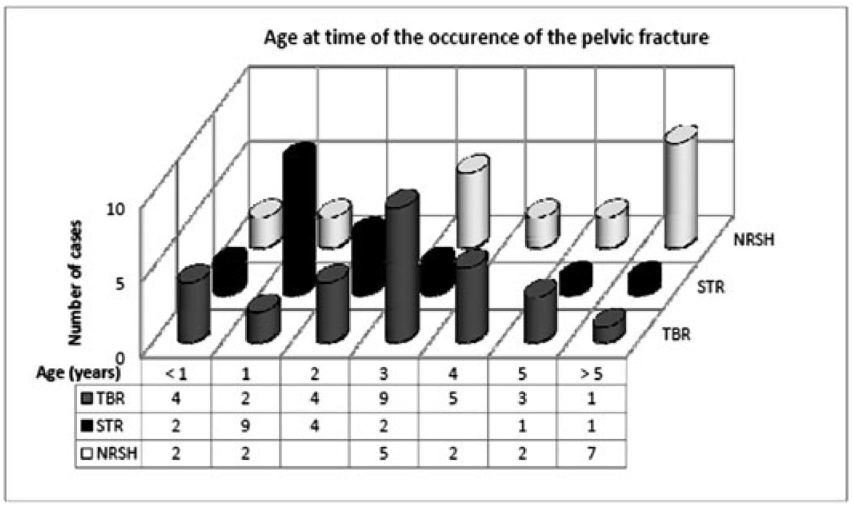

Fig. 1 Age distribution at the occurrence of the pelvic fracture according to the discipline. $n = 77$ horses (28 TBR, 19 STR, 30 NRSH): the age was not known for nine cases because some were already presenting old pelvic fractures and/or the circumstances and especially the day of occurrence of the fracture was unknown. NRSH, non-racing sport horses; STR, Standardbred trotter racehorses; TBR, Thoroughbred racehorses.

The median age of cases with fatigue fractures was 4 years old (3–5) and all horses with fatigue fractures were TBR. This type of fracture was diagnosed in 9/22 TBR aged 2 years or more at the time of fracture. In the group of horses aged of 2 years or more (56), fatigue fractures significantly affected the ilial wing (7/12) more often than any other pelvic site (2/44) (OR = 29.4 [5.5–158.5]; $p < 0.01$). Fatigue fractures of the ilial wing were incomplete in four out of seven cases. The two remaining fatigue fractures were located in the tuber ischiadicum. One TBR was diagnosed with an incomplete fatigue fracture of the ilial shaft, but the real circumstances and date of occurrence of the fracture were unknown.

Clinical Presentation

Examination at CIRALE was performed in a period ranging from 1 week to 2 years after the fracture occurrence.

On physical examination, the most constant clinical sign was a pelvic asymmetry that was not characteristic of the fracture location. Gluteal muscle atrophy on the fractured side was present in 60/86 of the cases. Signs of pain, such as painful hindlimb mobilization, were only observed in certain recent fractures (≤3 months) (6/43). Nonweight-bearing hindlimb position when standing was present in 13 horses, mostly in cases of multiple fractures (6/10).

Lameness grade varied from the absence of lameness to grade 5/5 hindlimb lameness. No lameness was detected in 20 horses. The majority of these cases had sustained an isolated fracture of the ilium or of the ischium more than 3 months before examination (13/20). However, lameness disappeared within 1 month of the fracture for three horses (one horse after a fracture of the tuber coxae and two after a fracture of the tuber ischiadicum). In contrast, lameness grades above 3/5 were mostly observed in horses presenting

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Table 2 Pelvic fracture distribution according to the discipline and the fracture location

Discipline groups	*n*	Fracture groups								
		Ilium			Ischium		Pubis	Acetabulum	Sacrum	Multiple
		Wing	Tuber coxae	Other	Tuber ischiadicum	Other				
TBR	30	16			6		3	2	1	2
		8	5	3	5	1				
STR	23	11			3		2	4	1	2
		–	8	3	2	1				
NRSH	33	17			10		–	–	–	6
		7	8	2	9	1				
Total group	86	44			19		5	6	2	10
		15	21	8	16	3				

Abbreviations: *n*, number; NRSH, non-racing sport horses; STR, Standardbred trotter racehorses; TBR, Thoroughbred racehorses.
Note: One TBR was used in eventing and was therefore included in the NRSH group.

with multiple or acetabular fractures (7/8) which occurred less than 3 months before examination (6/7). One TBR was severely lame (grade 4/5) 2 weeks after sustaining a displaced fracture of the ilial wing passing through the sacroiliac joint, while another individual was still markedly lame (grade 3.5/5) more than 6 months after the occurrence of a severe multiple pelvic fracture involving the coxofemoral joint.

Characteristics of the Fractures

Ilial fractures were the most common pelvic fracture observed (44/86) (►**Table 2**), followed by ischial fractures (19/86), multiple fractures (10/86), acetabular fractures (6/86), pubic fractures (5/86) and sacral fractures (2/86). Fracture sites are illustrated in ►**Fig. 2**. Ilial fractures (►**Fig. 3**) included 21 cases of fracture of the tuber coxae, 15 cases of fracture of the ilial wing, and 8 cases of other ilial fractures (in 4 of these cases, the fracture line involved the ilial shaft). Ischial fractures (►**Fig. 4**) included 16 cases of fractures of the tuber ischiadicum and 3 cases of other ischial fractures (lateral branch of the ischium, the ischiatic arch or table). Details of the discipline and age distribution according to the location of the pelvic fractures are presented in ►**Table 2** and ►**Fig. 5**, respectively. Isolated acetabular (►**Fig. 6**) and isolated sacral fractures were only diagnosed in foals and yearlings (TBR and STR), and isolated pubic fractures were only observed in racehorses under 5 years of age. No fractures of the ilial wing were diagnosed in STR during the study period.

All types of fracture (simple and comminuted/complete and incomplete/displaced and not displaced) were observed at different stages of healing.

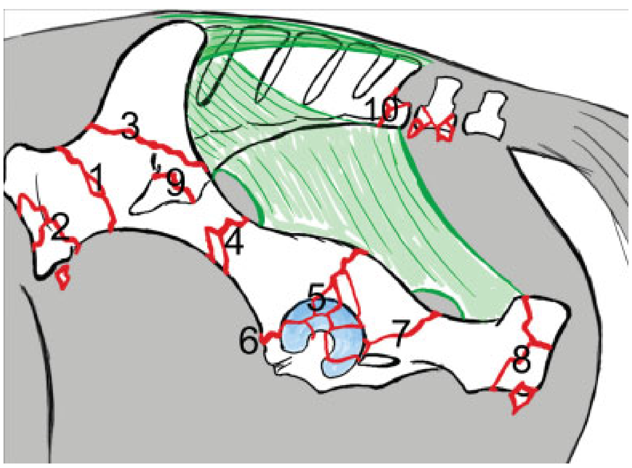

Fig. 2 Schematic drawing illustrating the main fracture sites observed on the pelvis. 1: complete fracture of the tuber coxae; 2: partial fractures of the tuber coxae; 3: fracture of the ilial wing; 4: fracture of the ilial shaft; 5: fractures of the acetabulum; 6: fracture of the cranial branch of the pubis; 7: fracture of the lateral branch of the ischium; 8: fractures of the tuber ischiadicum (partial or complete); 9: fracture of the sacral wing; 10: fracture of the apex of the sacrum.

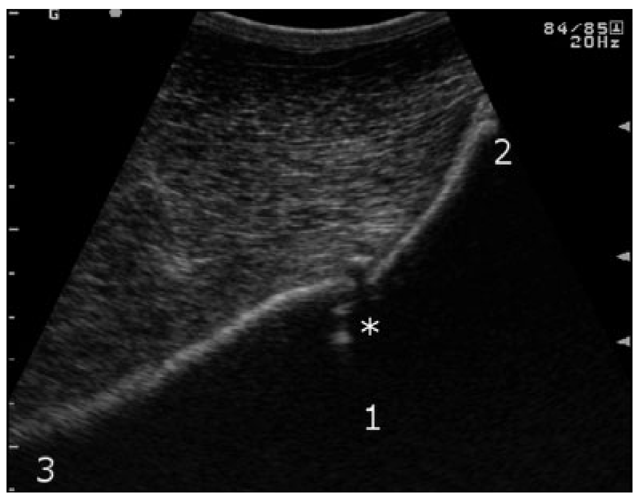

Fig. 3 Ultrasonographic image of an articular fatigue fracture of the left ilial wing in a 6-year-old steeplechaser gelding (external approach). The horse stopped and presented an acute severe left hindlimb lameness during racing 3 months ago. The horse has been resting for 3 months (including box confinement for 1 month) before referral to our centre. The gelding was not lame during our examination. The ilial wing presented an altered shape with a heterogeneous callous (*) at the fracture site. 1: ilial wing; 2: tuber sacrale; 3: lateral part of the ilial wing.

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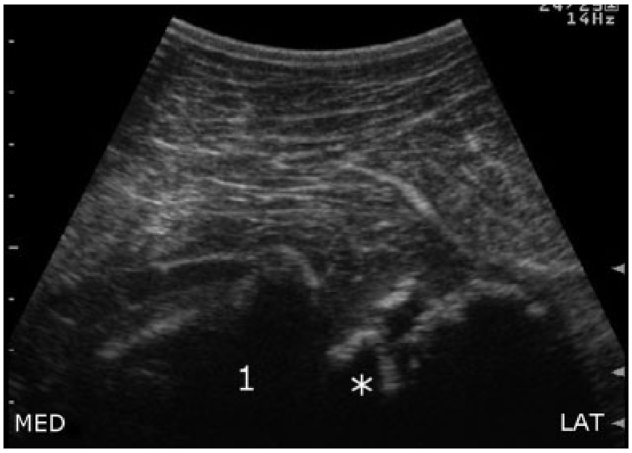


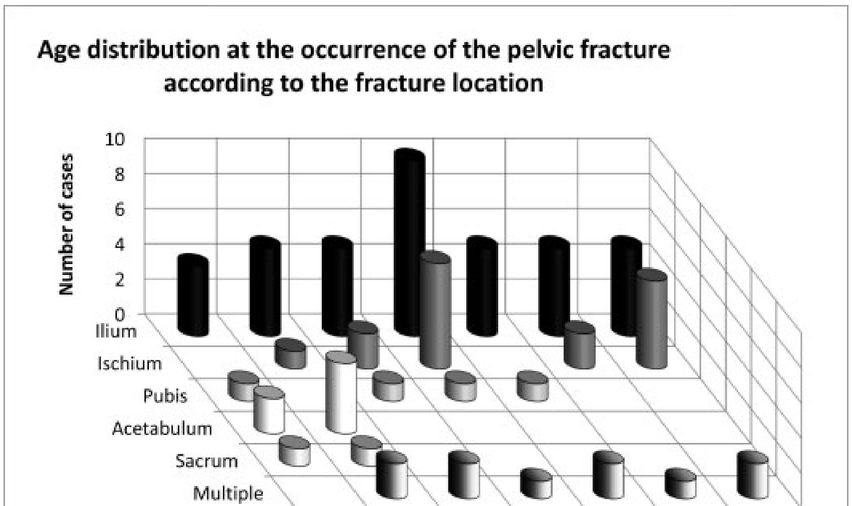
Fig. 4 Ultrasonographic transverse image of a fracture of the distolateral part of the right tuber ischiadicum in a 7-year-old jumper gelding. The horse presented an intermittent low-grade right hindlimb lameness for 4 months. The circumstances of the fracture occurrence were unknown. 1: tuber ischiadicum. LAT, lateral; MED, medial; *fracture of the distolateral part of the tuber ischiadicum.

Discussion

The results of this retrospective study confirmed our two hypotheses. First, traumatic pelvic fractures were more frequent in young horses. Median age at the time of the fracture was 3 years old, and almost one-third of the cases sustained this type of fracture when they were foals or yearlings. Second, the incidence of fatigue fracture in adult horses was different according to the discipline. Indeed, fatigue fractures were only diagnosed in TBR in this study, making it impossible to verify the differences in fatigue fracture location according to the horse discipline in this population.

Most of the previous reports about pelvic fractures were performed on racehorse populations and particularly in TBR.[1,5,6,8–14] The interest of the present study was therefore to compare the distribution of pelvic fractures in three main disciplines: STR, TBR and NRSH (mainly jumpers). The pelvic fracture distribution in our study was consistent with previous reports showing that ilial and ischial fractures are the most common pelvic fractures. Our referral caseload echoes the findings in the literature that TBR are more likely to be at risk of a pelvic fracture[1,11] than STR or NRSH, as well as foals and young horses under 6 years old.[1,3] Moreover, pelvic fractures in STR tend to occur at a younger age compared with other breeds (1 vs. 3 years old). Differences in breeding methods or the temperament of yearlings could explain this observation.

Females seemed predisposed to fractures of the pubis in our population. This may be correlated to gender differences in anatomical features: females have a thinner pubis, a longer and narrower ilial shaft and a larger obturator foramen than males.[18] This pelvic conformation involves longer lever arms that could weaken the pelvis.[2,5] Other authors also observed gender-specific differences in distribution according to the fracture location: a higher proportion of females were diagnosed with acetabular fractures,[1,19] while ischial fractures predominantly occurred in males.[1] Although not significant, we also observed a lower proportion of females in the isolated



Age (years)	< 1	1	2	3	4	5	> 5
Multiple		2	2	1	2	1	2
Sacrum	1	1					
Acetabulum	2	4					
Pubis	1		1	1	1		
Ischium		1	2	6		2	5
Ilium	4	5	5	10	5	5	5

Fig. 5 Age distribution at the occurrence of the pelvic fracture according to the location of the fracture. $n = 77$ horses: 39 cases of isolated ilial fracture, 16 of isolated ischial fracture, four of isolated pubic fracture, six of isolated acetabular fracture, two of isolated sacral fracture and 10 of multiple pelvic fracture. The age was not known for nine cases because some were already old pelvic fractures and/or the circumstances and especially the day of occurrence of the fracture were unknown.

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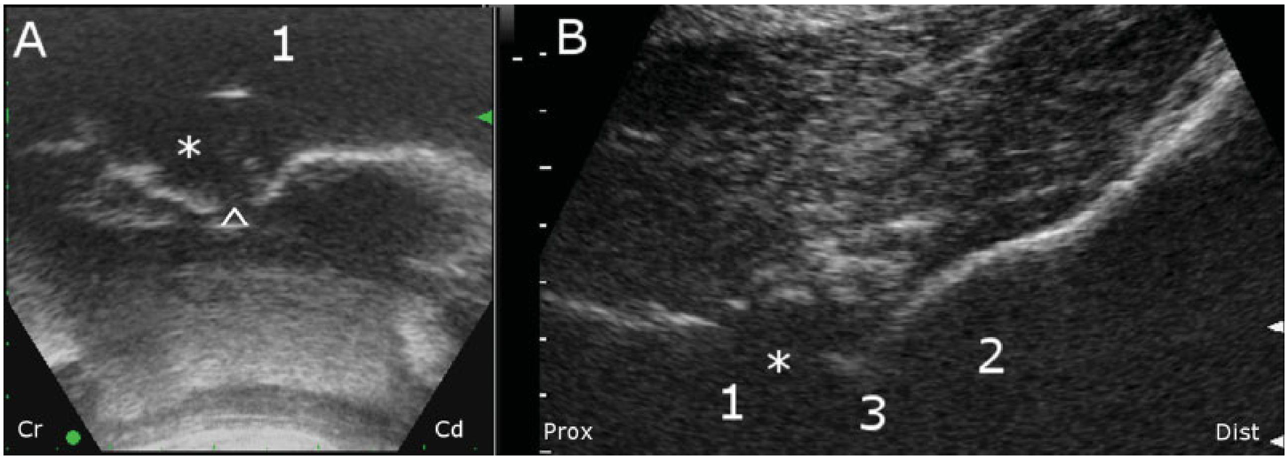

Fig. 6 Ultrasonographic images of a right acetabular fracture in a Thoroughbred yearling (18 months of age). The filly fell 2 weeks ago and presented an acute nonweight-bearing right hindlimb lameness. It was confined in box until the examination in our centre: the filly presented a grade 3/5 right hindlimb lameness at this moment. The transrectal (**A**) and external (**B**) ultrasound scan approaches revealed marked bone remodelling of the acetabulum (*) and interruption of the bone surface (^). 1: acetabulum; 2: femur; 3: coxofemoral joint. Cd, caudal; Cr, cranial; Dist. distal; Prox, proximal.

ischial fracture group. A lack of statistical power may explain why no other significant association has been found between gender and location of the pelvic fracture. Developmental features may also explain why isolated acetabular fractures were diagnosed only in foals and young yearlings, since the acetabulum is the weakest area until the three bones forming the acetabulum (ilium, ischium and pubis) have completely fused at around 1 year old.[18]

Training regimens and biomechanical strains exerted by the gluteal muscles on the pelvis also play a role in the occurrence of pelvic fractures. Indeed, tensile and compressive forces condition the architecture of the coxal bone[18] and other investigators have demonstrated that the locations of pelvic fracture lines are related to the mechanostructure of the latter.[20] This observation may explain why ilial wing fatigue fractures in our population were not diagnosed in STR while they were commonly reported in TBR.[6,10–12,14] In this study, ilial wing fatigue fractures represented 7/22 of the fractures in TBR (foals and yearlings excluded) and seven out of the eight ilial wing fractures diagnosed in TBR. This is consistent with previous reports about this racing population.[6,10] However, an ilial wing fracture has recently been identified in one high-level STR in our centre, and pelvic fatigue fractures (ilial wing and ischium) represented 3.3% of the musculoskeletal injuries diagnosed in a population of STR in training in Italy.[7] Although fatigue fractures of the pelvis involved the ilial wing in the majority of cases, it is interesting to observe that they may affect other locations on the pelvis, such as the tuber ischiadicum or ilial shaft and possibly the pubis.[3,7] A fatigue process could indeed be suspected in one TBR with a fracture of the pubis; this horse had no prior signs of external trauma and was in full training when the first gait irregularities were reported by the owner.

As the CIRALE is a referral centre, the studied population may not be representative of the population seen in ambulatory practices, especially for clinical presentation. Horses with serious pelvic fractures are sometimes euthanized for ethical and humane reasons by their veterinarians and are not sent to a referral centre. Only one-third of the cases were examined less than 1 month after the fracture had occurred.

This study nevertheless confirms that pelvic fractures are uncommon injuries that are more frequently diagnosed in young racehorses. The most frequent fracture location is the ilium. Thoroughbred racehorses are more likely to be at risk of pelvic fractures, and particularly ilial wing fatigue fractures, when they are in training.

Author Contribution

Claire H. Moiroud contributed to conception of study, study design, acquisition of data and data analysis and interpretation. Virginie Coudry contributed to conception of study and data analysis and interpretation. Jean-Marie Denoix contributed to conception of study, study design and data analysis and interpretation. All authors drafted, revised and approved the submitted manuscript.

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Conflict of Interest

None declared.

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