Outcome of Pelvic Fractures Identified in 75 Horses in a Referral Centre: A Retrospective Study

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Abstract

Objective The aim of this study was to evaluate the reliability of fracture location and horse sporting discipline as prognostic indicators after a pelvic fracture in a referral centre caseload.

Materials and Methods Data were collected for the short- and long-term follow-up of all cases with a diagnosis of pelvic fracture in a 7-year period. Information was obtained for 75 horses through a postal and internet survey. The proportion of horses returning to competition following fractures was compared between groups according to the competition discipline and the characteristics of the fracture.

Results Forty-six of 75 horses returned to or began their intended activity. This proportion was significantly lower in the group of horses that sustained a comminuted fracture irrespective of the fracture location (11/25, $p = 0.05$). The proportion of Standardbred trotter racehorses returning to a sporting career after pelvic fracture (9/20) was not significantly different from horses competing in other disciplines (37/55). Cases of multiple pelvic fractures in the study population, and particularly those involving the acetabulum, had the worst sports prognosis (2/8 and 0/4). Nevertheless, two foals and one yearling (3/5) with isolated fracture of the acetabulum went on to race.

Clinical Significance A clear characterization of the fracture is essential for prognosis, as comminuted fractures seem to entail a poorer athletic prognosis. Despite a lack of significance, prognosis seems poorer for Standardbred trotter racehorses and for cases with acetabulum involvement in multiple fractures. These results should be confirmed in larger samples.

Keywords
- pelvis
- fracture
- athletic prognosis
- racehorses
- sporthorses

Introduction

Pelvic fractures are uncommon injuries in horses and are reported to represent 0.9 to 4.4% of the causes of hindlimb lameness.[1] Young horses are more susceptible to pelvic fractures.[1–6] Thoroughbred racehorses (TBR) seem to be more at risk of sustaining a pelvic fracture, and more specifically a fatigue fracture of the ilial wing during training.[6]

Reported rates of return to athletic function after a fracture of the pelvis vary from 28% to 62%.[3,7] Different athletic prognoses are reported depending on the fracture location, and the best rates of return to athletic function are generally described for fractures of the tuber coxae (66%–93%)[3,8] or for fractures of the ilial wing (60%–92%)[9,10]. While pelvic fractures involving the acetabulum and those involving the ilium shaft were significantly associated with a poorer prognosis in other studies[7,11], older reports did not demonstrate any correlation between the fracture location and the long-term outcome of pelvic fractures.[2,3] It is therefore not clear whether prognosis is

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linked to the location of the fracture. Moreover, some authors have reported very different outcomes than those commonly reported to date. For example, negative outcomes were reported after a fracture of the tuber coxae[12] or of the tuber ischiadicum.[13] It is important to note that most of the publications to date concern racehorses, and especially TBR[1,3,5,7,9–11,14–18]; the potential influence of the horse's discipline on the athletic outcome post fracture has yet to be investigated.

This retrospective study had two aims, namely to evaluate and compare athletic outcomes according to the discipline, and to evaluate and compare athletic outcomes according to the location of the fracture to highlight potential prognostic indicators. The following hypotheses were considered: (1) the specific athletic needs of a horse's discipline will affect the athletic prognosis of a specific pelvic fracture location and (2) articular fractures of the acetabulum are expected to carry the worst athletic prognosis, while fractures of the tuber coxae or the ilial wing should evolve more favourably.

Materials and Methods

The medical records were reviewed for all horses admitted to the Center of Imaging and Research of the Equine Locomotor Affections (CIRALE–France) over a period of 7 years. Any horse diagnosed with a recent or healed fracture of the pelvis was included. Signalment, anamnesis and clinical information data were collected for 86 horses with pelvic fracture as previously described.[6] The short- and long-term follow-up of these cases was obtained in two different ways. First, a postal survey was performed by sending a questionnaire to the referring veterinarian and the owner of the horse. People who did not respond to the questionnaire were contacted by phone. Second, the databases of French equine official Web sites (FFE website [https://ffecompet.ffe.com/cheval] for sporthorses performances; Haras Nationaux website [http://www.haras-nationaux.fr/utilitaires/moteurs-de-recherche/info-chevaux.html] for sporthorses breeding career; France Galop website [http://www9.france-galop.com/fgweb/domaines/chevaux/cheval_perf.aspx] for Thoroughbreds racehorses performances and breeding career; Le Trot website [http://www.letrot.com/fr/fiche-horse] for French Standardbreds trotter racehorses performances and breeding career) were consulted to obtain the performances of each horse in official events and acquire information on the breeding career of the females. Data were recorded concerning the horse's outcome, time spent in stall confinement and resting, medical treatment and management, the clinical sequelae and the opinions of the owner and veterinarian about the influence of the fracture on the horse's athletic career.

Eleven horses were not included in the follow-up due to a lack of response to the questionnaire and the absence of online information. As defined in the descriptive epidemiology study of the 86 cases diagnosed in our center,[6] the remaining 75 horses were divided into three discipline groups (TBR, Standardbred trotter racehorses [STR], nonracing sports horses [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 (i.e. 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 (between the base of the tuber coxae and the tuber sacrale) 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 outcome of the studied sample group was compared (1) between the three discipline groups, (2) between the six fracture location groups and (3) between the three discipline groups for each specific pelvic fracture location.

Data were collected in a spreadsheet and analysed with statistical software (XLSTAT Biomed; Addinsoft, Paris, France). The groups were compared using the chi-squared test or the Fischer's exact test for qualitative variables, and the Kruskal–Wallis test for quantitative variables. The significance threshold was set at $p \leq 0.05$. 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 association between two binary variables was quantified by calculating odds ratios and their 95% confidence intervals (OR [95% CI]). The following potential confounding biases were tested: discipline, gender, age (median age was chosen as a cut-off value), acetabulum involvement (including isolated acetabular fracture and multiple fracture of the pelvis involving the acetabulum), fractures involving more than one bone of the pelvis ('multiple' pelvic fractures) and finally, comminuted and displaced fractures. When the sample size was sufficient, major confounding biases were taken into account using logistic regressions to obtain adjusted odd ratios (OR_a).

Results

Population and Characteristics of the Fractures

The 75 cases of pelvic fracture considered here included 27 TBR, 20 STR and 28 NRSH. Among the 28 NRSH, 19 were jumpers, 3 were dressage horses, 2 were eventers, 1 was a leisure horse and the intended discipline was not specified for the 3 remaining individuals. There were 32 females, 27 geldings and 16 males. The median age at the time of the fracture was 3 [1–4] years old.

The population studied included 38 ilial fractures, 18 ischial fractures, 8 multiple fractures, 5 isolated acetabular fractures, 4 pubic fractures and 2 sacral fractures. Ilium fractures included 17 tuber coxae fractures, 13 fractures of the ilial wing and 8 cases of other ilial fractures. Ischial fractures included 15 tuber ischiadicum fractures and 3 cases of other ischial fractures (i.e. fractures of the lateral branch of the ischium, the ischiatic arch or the ischiatic table) (►**Table 1**). All types of fracture (simple and comminuted/complete and incomplete/displaced and not displaced) were observed at different stages of healing (►**Table 2**). The distribution of the different variables was similar between the 75 horses followed and the 86 cases initially included.[6]

Table 1 Number of horses that returned to racing or competition according to the discipline and the fracture location

Discipline groups		Total	Fracture groups								
			One fracture location ('isolated' fracture)								Multiple
			Ilium			Ischium		Pubis	Acetabulum	Sacrum	
			Wing	Tuber coxae	Other	Tuber ischiadicum	Other				
STR	Number	20	–	6	3	2	1	2	3	1	2
	Number return to races (%)	9 (45%)	–	3	2	1	–	1	2	–	–
TBR	Number	27	7[a]	4	3	5	1	2	2	1	2
	Number return to races (%)	18 (67%)	7	3	1	3	1	1	1	–	1
NRSH	Number	28	6	7	2	8	1	–	–	–	4
	Number return to compet. (%)	19 (68%)	4	6	1	8	–	–	–	–	1
Total	Number	75	13	17	8	15	3	4	5	2	8
	Number return to compet. (%)	46 (61%)	11 (85%)	12 (71%)	4 (50%)	12 (80%)	1 (33%)	2 (50%)	3 (60%)	–	2 (25%)
			27 (71%)			13 (72%)					

Abbreviations: compet., competition; NRSH, non-racing sports horses; STR, Standardbred trotter racehorses; TBR, Thoroughbred racehorses.
[a]Ilial wing fractures in TBR: 6 were fatigue fractures and 1 was traumatic (fall).

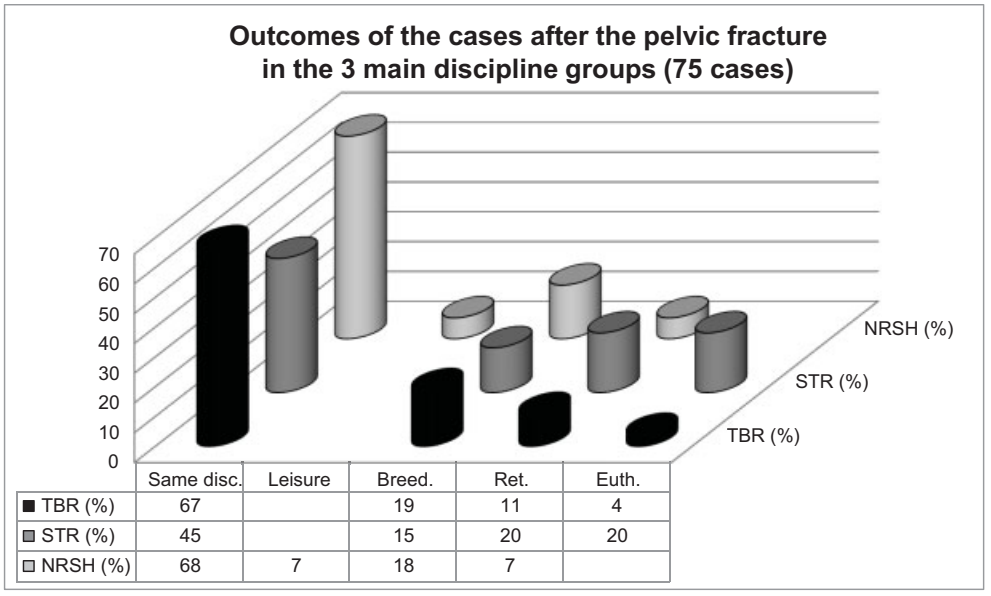
Table 2 Number of horses which returned to racing or competition according the fracture location and type (comminuted, displaced, articular or incomplete)

		Total group	Fracture groups								
			One fracture location ('isolated' fracture)								Multiple
			Ilium			Ischium		Pubis	Acetabulum	Sacrum	
			Wing	Tuber coxae	Other	Tuber ischiadicum	Other				
Total group *(n)*		75	13	17	8	15	3	4	5	2	8
Fracture characteristics											
Comminuted	*n*	25	–	5	5	6	2	3	1	–	3
	Return to compet. (*n*)	11 (44%)[a]	–	3	2	4	0	1	0	–	1
Displaced	*n*	37	6	14	4	7	1	1	–	1	3
	Return to compet. (*n*)	23 (62%)	5	9	1	6	0	1	–	0	1
Articular	*n*	18 (9 SIj, 9 CFj)	8	–	–	–	–	–	5	–	5 (1 SIj, 4 CFj)
	Return to compet. (*n*)	11 (61%) (89% SIj, 33% CFj)	7	–	–	–	–	–	3	–	1 (1 SIj, 0 CFj)
Incomplete	*n*	5	4	–	1	–	–	–	–	–	–
	Return to compet. (*n*)	5	4	–	1	–	–	–	–	–	–

Abbreviations: CFj, coxofemoral joint; CI, confidence interval; *n*, number; OR_a, adjusted odds ratio; SIj, sacroiliac joint.
[a]Proportion significantly lower after having taken into account discipline (Standardbred trotter racehorses vs. others) and location of the fracture (isolated ilial fracture vs. others) ($OR_a = 0.4$; 95% CI [0.1–1.0]; $p = 0.05$).

Management and Treatment Following Diagnosis

This section was poorly completed by the owners or the referring veterinarians. The basis of the management was stall confinement (median = 2 months [1–3]) and progressive rehabilitation (median time for trotting introduction = 6 months [4–12]). Almost half of the cases did not receive any other treatment (drugs, physical therapies, surgery) after diagnosis (22/46). The most common medical treatment in the acute stage of the fracture was nonsteroidal anti-inflammatory drugs.



	Same disc.	Leisure	Breed.	Ret.	Euth.
TBR (%)	67		19	11	4
STR (%)	45		15	20	20
NRSH (%)	68	7	18	7	

Fig. 1 Outcome after pelvic fracture in the three main discipline groups ($n = 75$). Same disc.: same discipline; Breed.: breeding (mare sent to breeding shortly after pelvic fracture recovery without beginning an athletic or racing career); Ret.: retired at pasture; Euth.: euthanatized; TBR: Thoroughbred racehorses; STR: Standardbred trotter racehorses; NRSH: non-racing sports horses.

Short- and Long-Term Outcomes

►**Figure 1** summarizes the outcomes of the 75 cases of pelvic fracture. Forty-six of 75 horses returned to competition in their disciplines, namely 9/20 STR, 18/27 TBR and 19/28 NRSH (►**Table 1**). None of the dressage horses returned to competition (0/3). However, independently of age (>3 vs. ≤3 years old), gender (female vs. others) and location of the fracture (acetabulum involvement vs. no involvement), the proportion of horses returning to athletic activity did not significantly differ between STR and the other disciplines (TBR and NRSH) (9/20 vs. 37/55; $OR_a = 0.5$ [0.2–1.8]; $p = 0.31$). A lower proportion of females (15/32) returned to competition than for males and geldings (31/43). Nevertheless, the association between gender (females vs. others) and returning to athletic activities was not significant when considering discipline (STR vs. others) and age (>3 vs. ≤3 years old) ($OR_a = 0.4$ [0.1–1.1]; $p = 0.06$).

Regarding the fracture location, the greatest proportion of return to athletic activities was observed after a fracture of the ilial wing (11/13) (►**Fig. 2**), especially for TBR (7/7, 6 fatigue fractures and 1 traumatic fracture) and after a tuber ischiadicum fracture (12/15) (►**Fig. 3**), especially in NRSH (8/8)

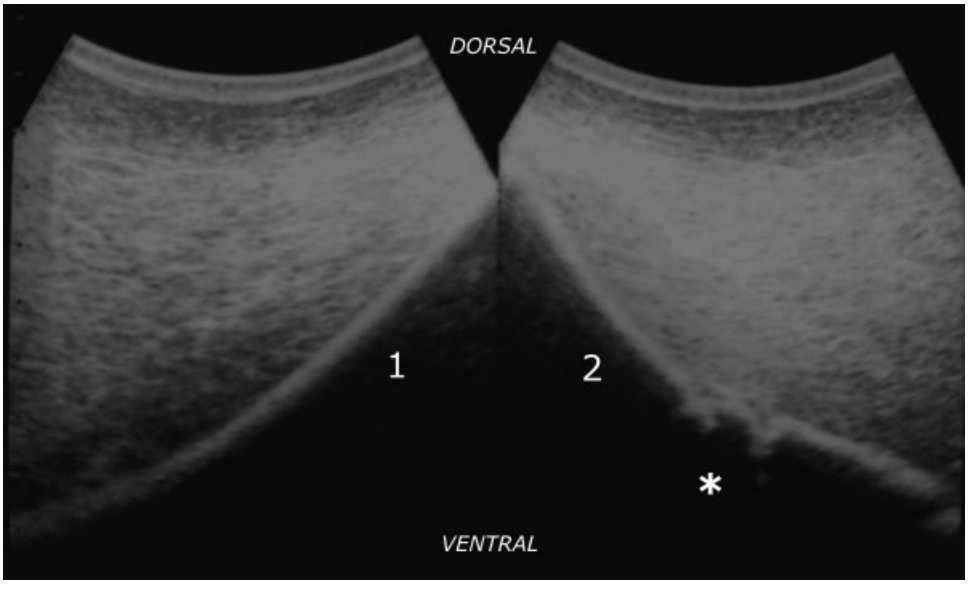


Fig. 2 Ultrasonographic comparative images of the left (1) and right (2) ilial wing, using external approach, in a 3-year-old steeplechaser gelding with a non-displaced complete fatigue fracture of the right ilial wing (*). The horse had presented sudden severe right hindlimb lameness at the end of a race, 6 weeks before examination. Transrectal ultrasonographic examination revealed an involvement of the right sacroiliac joint in the fracture. The horse was sound and returned to racing 9 months after the fracture occurrence, with good results (winner and placed) at the level expected by its owners.

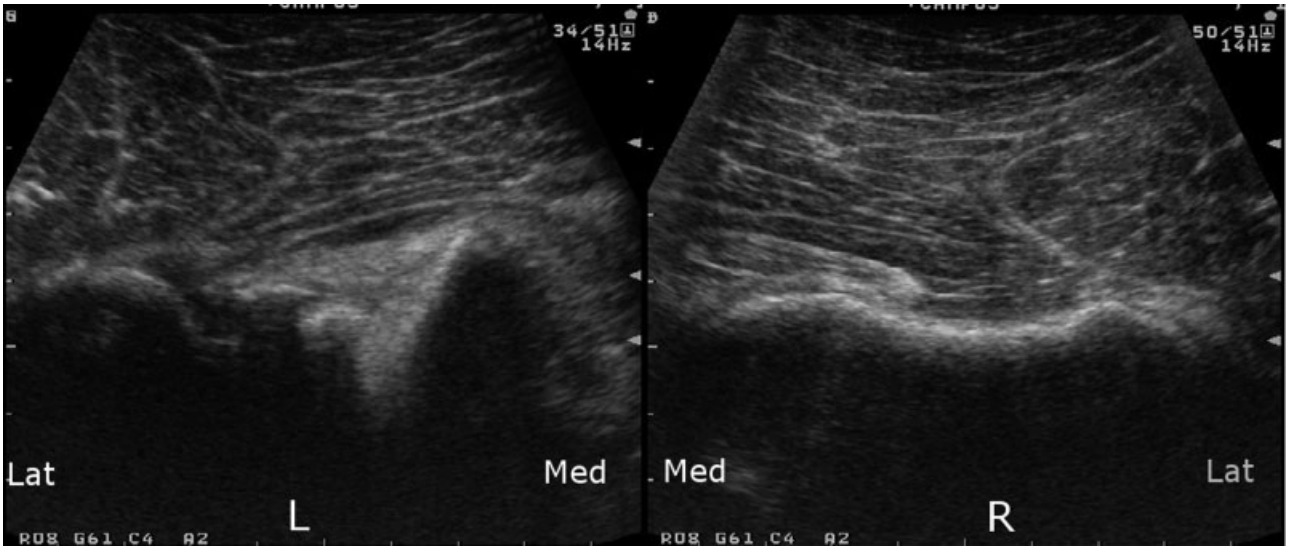


Fig. 3 Transverse ultrasonographic comparative images of the left and right tuber ischiadicum in a 7-year-old showjumper gelding showing a comminutive fracture of the left tuber ischiadicum. The horse had fallen 2 weeks previously and presented a 3/5 left hindlimb lameness during examination at Center of Imaging and Research of the Equine Locomotor Affections (CIRALE). This horse was sound and returned to competition 4 months after the fracture occurrence. The referring veterinarian reported that the fracture did not impair the performances of the horse, which competed in 2-star international show jumping competitions. L: left; R: right; Lat: lateral; Med: medial.

(►**Table 1**). At least half of them were performers and winners in their respective discipline at their expected level. The smallest proportion of return to competition was observed after multiple pelvic fracture (2/8), particularly if the fracture involved the coxofemoral joint (0/4) (►**Tables 1** and **2**). Half of the horses suffering from an isolated fracture of the pubis and 3/5 of those suffering from an isolated fracture of the acetabulum (►**Fig. 4**) resumed or began a racing career. No horses began or returned to athletic activities after a sacral fracture (0/2). The proportion of returns to athletic activities did not differ significantly between the different groups in terms of pelvic fracture location. In contrast, a significantly lower proportion of horses (11/25) that had sustained a comminuted fracture of the pelvis returned to competition than those that had sustained a noncomminuted pelvic fracture (35/50), regardless of the discipline (STR vs. others) and the location of the fracture (isolated ilial fracture vs. others) ($OR_a = 0.4$ [0.1–1.0]; $p = 0.05$).

The owners and veterinarians of 45 horses gave their opinion on the influence of the pelvic fracture on the horses' sporting careers (12 STR, 14 TBR and 19 NRSH). According to the owners and veterinarians, 12 out of these 45 horses recovered completely and performed at the expected level. Higher rates of complete recovery were observed for fractures of the tuber ischiadicum (5/9) and especially for NRSH (4/5). Owners and referring veterinarians said that pelvic

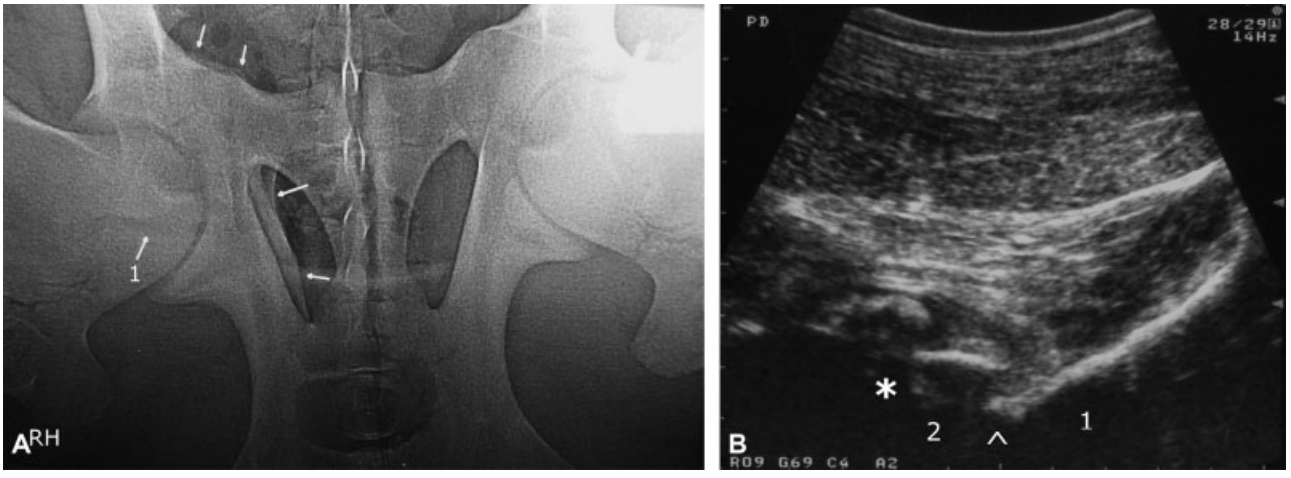


Fig. 4 Traumatic non-displaced articular fracture of the acetabulum in a 6-month-old Standardbred trotter female. The filly started training 1 year after the fracture occurrence and raced 1 year later. The filly performed at the level expected by the owner and the fracture did not impair its racing career, according to the referring veterinarian. (**A**) Ventrodorsal radiographic view of the pelvis under general anaesthesia. The arrows indicate the fracture line (1) and the callus with more bone remodelling on the cranial area of the acetabulum. (**B**) Ultrasonographic image of the coxofemoral joint (CFj) showing the fracture of the acetabulum (*) and no effusion of the CFj (^). 1: femur; 2: acetabulum.

fracture caused the limitation of athletic performances for 14 of the 45 cases and claimed that it had prevented 15 horses from undertaking or continuing an athletic career. In contrast, four horses did not return to their previous activities because of another issue. Owner and veterinarian opinions also indicated that the proportion of horses removed from racing or competition due to pelvic fracture was greater in STR (6/12) and fillies (11/21).

The duration between the occurrence of the fracture and the return to competition was known for 37 horses (7 STR, 16 TBR and 14 NRSH). Horses returned to competition or races 2 months to 4 years after the pelvic fracture (median = 10 months [6–18]), depending on their age when the fracture occurred, their discipline and the location of the fracture. Horses belonging to the group with isolated fractures of the ilium or of the ischium returned to competitions significantly earlier (median = 8.5 months [5–12]) than the others (median = 18 months [16.5–23.5]; $p < 0.05$). The minimum complete recovery time to resume competition was observed after a fracture of the tuber coxae (2 months) or of the tuber ischiadicum (3 months).

Twenty-four of the 32 mares were oriented to a breeding career. Among them, 13 were never sent to training after the pelvic fracture.

Five horses were euthanatized, two of which shortly after diagnosis because of the severity of clinical signs (one case diagnosed with a fracture of the sacrum and one with a multiple fracture involving the ischium and the pubis). One horse with a displaced fracture of the ilial shaft was euthanatized 2 months after the first examination due to a worsening of the fracture configuration that was observed during follow-up ultrasonographic examination. The other two cases were euthanized because of the sequela of the fracture (> 1 year after the fracture occurrence), namely a STR gelding euthanatized for poor performances and economic issues (comminuted tuber ischiadicum fracture) and one mare during a dystocic parturition (fracture of the body of the pubis).

Discussion

Relationship between Athletic Prognosis and Fracture Location or Characteristics

Similar to other studies[2,3], this study did not find any significant association between athletic prognosis and fracture location. Nevertheless, the aforementioned studies reported a much poorer athletic prognosis (23% and 28%, respectively) than the results in our study (61%). This could be explained by the large proportion of fractures involving the acetabulum (56 and 58%) and/or multiple pelvic fractures (27 and 26%) in their samples. Indeed, the results of our study highlighted similar poor athletic prognosis for fractures involving the acetabulum (33%) and multiple fractures (25%), although these lower rates were not statistically different to those of the other groups. The reported prognosis for fractures of the acetabulum as well as for those of the ilial shaft is usually poor[1,7,11,13,19–21]; these two pelvic regions both bear weight, while the acetabulum is an articular surface. Nevertheless, Little and Hilbert reported 50% full recovery after a fracture of the acetabulum[2] and 60% (3/5) of the horses in the present study were able to have an athletic career after an isolated fracture of the acetabulum. Pilsworth mentioned that acetabular fracture prognosis is better for foals than for older horses, because foals did not develop arthrosis as a fracture sequela.[16] This is consistent with our results: of the three horses that raced after an acetabular fracture, two were foals and one was a yearling when the fracture occurred. The other two yearlings diagnosed with an isolated acetabular fracture did not race. None of the horses that had sustained a multiple pelvic fracture involving the acetabulum were able to have an athletic career: all were yearlings or older at time of the fracture occurrence. However, a possible relationship between the prognosis and the location of the pelvic fracture remains to be confirmed, as diverging outcomes are reported in the literature for the same fracture location. For example, the athletic prognosis is usually good for fracture of the tuber ischiadicum or the tuber coxae,[1,4,10,16,19,20] as observed in our study (80% of tuber ischiadicum fracture cases (including all NRSH individuals) and 71% of horses with tuber coxae fractures returned to their previous activities). Surprisingly, other authors reported a poor prognosis for fracture of the tuber ischiadicum with 3/4 cases euthanatized.[13] Likewise, one study reported only 1/5 horses returned to an athletic activity after a tuber coxae fracture,[12] while other authors reported rates of return to athletic activities after a tuber coxae fracture that ranged from 66 to 93%.[3,8]

Peters and colleagues showed that comminution of the pelvic fractures was significantly associated with a poor short-term outcome but did not influence the long-term success.[7] Based on our results, comminuted fractures are likely to carry a poorer athletic prognosis (long-term), whatever the location of the fracture. The healing of a comminuted fracture may be poorer than a simple fracture, especially as secondary arthrosis or muscle fibrosis may occur as sequela if the fracture involves an articular surface or a muscle insertion area.

The large variety of fractures in our sample means that the subgroups were too small, thus weakening the statistical power of the tests. This may explain why no other significant association was found, whereas huge differences were observed in the proportion of individuals returning to competition or to racing according to the fracture location.

Relationship between Athletic Prognosis and the Sporting Discipline of the Horse

The interest of the present study was to compare the long-term follow-up of pelvic fractures in three main disciplines: STR, TBR and NRSH (mainly jumpers). After having taken the age, the gender and the location of the fracture into account, no significant association was found between the discipline of the horse and the chances of returning to the expected athletic activity. Nevertheless, STR had a poorer athletic prognosis in our study, and this is new data in the field. No STR in our sample sustained a fracture of the ilium wing, which is the fracture with the best prognosis in TBR. However, the proportion of horses returning to competition after

a tuber coxae fracture seemed to be lower in STR compared with TBR and NRSH. STR may tolerate the sequelae of pelvic fracture less because of the need for gait symmetry and the alternate stresses exerted on the pelvis and sacroiliac joints at high speed. The influence of the discipline has rarely been considered. Only Jeffcott mentioned that ischial fractures had a poor prognosis for dressage horses[1] and this is consistent with our results, since the three dressage horses did not return to competition (two had an ischial fracture, and the third sustained a multiple pelvic fracture). On the other hand, age may also have influenced the outcome of STR since most of them were foals or yearlings when the fracture occurred: they may have not been sent to training for economic rather than clinical reasons. A similar bias may explain the low proportion of females that had an athletic career after their pelvic fracture. Indeed, fillies are often sent for breeding after sustaining injuries because of their genetic potential and for economic considerations, so their ability to perform cannot be fully evaluated. This has already been reported previously[3] and was mentioned by some of the owners interviewed in the study. It is interesting to notice that the foaling prognosis was good in our sample: only one mare suffered from a dystocia among the 24 broodmares. This mare had a fracture of the body of the pubis that had caused a reduction of the pelvic inlet diameter.

In contrast, a very good prognosis is observed in this study for TBR after a fracture of the ilial wing, with all the horses studied returning to races. Horses diagnosed with this type of fracture were already in training at the time the fracture occurred and six of the seven cases were fatigue fractures. Others reported a similar prognosis for ilial wing fractures in TBR, with 11 horses of the 12 cases returning to racing.[10]

This study was conducted at the CIRALE, a referral centre where horses are sent after a first examination by the referring veterinarian. This may explain why the proportion of horses euthanatized is particularly lower (7%) than in previous reports ranging from 29 to 53%.[2,3,13] Horses with severe pelvic fractures may have been euthanatized for ethical and human reasons by their veterinarians and were therefore not referred to our centre.

In conclusion, almost two-thirds of the cases began or returned to an athletic activity after a pelvic fracture: one-third performed at the expected level and one-third were described by their owners to present limited performances that were attributable to pelvic fracture sequela. The remaining third was unable to have athletic activity after the pelvic fracture. It would be interesting to carry out a study with larger groups to confirm the poorer athletic prognosis that we observed for racing trotters (STR) after a pelvic fracture and to specify the athletic outcome after a fracture involving the acetabulum in foals as compared with older horses.

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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