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Diagnostic exercise
From The Latin Comparative Pathology Group and the Davis-Thompson Foundation

Scapular fracture in a racehorse with a long career of uninterrupted intense exercise

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Clinical history:

A thee-year-old Thoroughbred gelding racehorse completed 12 races in 13 months at high-level competition. The horse had a catastrophic injury on the left front leg during high-speed five-furlong workout on a dirt racetrack in California. It was the second official timed high-speed workout withing 27 days of his last race. The horse pulled up during workout, could not bear weight on the left forelimb, had the shoulder region swollen and elicited pain in the shoulder joint upon extension and adduction.

Necropsy findings:

The main findings are shown in Figures 1-3.

Follow-up questions:

- *Fracture classification and description*
- *Morphologic diagnoses*
- *Etiology and pathogenesis*
- *Predisposing factors*

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Answers

1. Fracture classification and description:

The scapula had complete, displaced, comminuted, closed, transverse and longitudinal fractures of the neck, with an incomplete, displaced, simple, closed, longitudinal fracture of the infraspinous fossa. The main transverse fracture coursed through the neck of the scapula (at the level of the distal end of the scapular spine) and divided the bone into two major, proximal and distal, fragments (Figure 1). The proximal fragment had an incomplete, mildly displaced, comminuted, non-articular, longitudinal fracture that originated in the transverse fracture and coursed proximally in the infraspinous fossa (roughly parallel to the scapular spine) for 11 cm (Figures 1 and 2A). The distal fragment had a complete, displaced, comminuted, articular, longitudinal fracture that originated in the transverse fracture, coursed distally and split the glenoid into cranial and caudal fragments, with comminution of the main distal fragment into 3 fragments (Figure 1). The transverse fracture through the scapular neck was bridged by a well-consolidated, exuberant callus consisting of a 3-5 mm thick, porous, sub-periosteal bone proliferation peripheral to a thickened spine with compacted trabecular bone that had resulted from extensive bone remodeling (Figures 2C and 3A-B). Additionally, a pink-red callus characterized by a thin layer of porous woven bone along the tuber of spine (Figure 3C) and in the proximal caudal border of the scapula was observed. The muscles and other soft tissues surrounding the fracture had multifocal to coalescing, severe hemorrhage and lacerations (Figure 3D). The contralateral non-fractured right scapula had similar pre-existing lesions and it can be compared in Figures 1 and 2B-D.

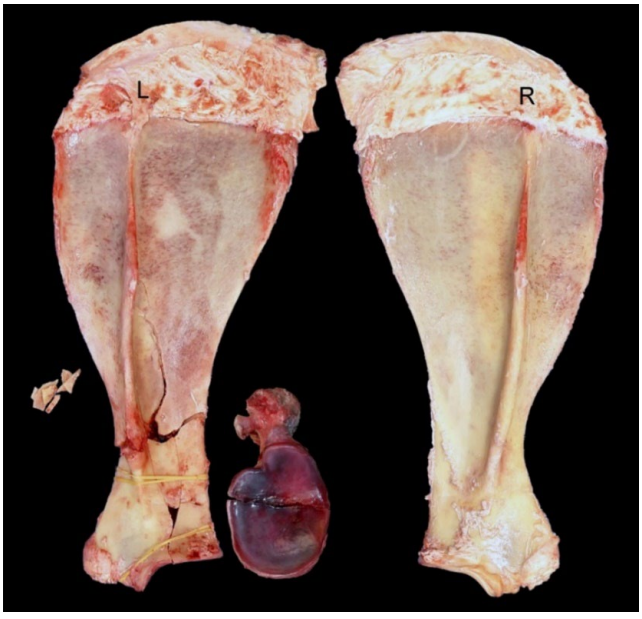

Figure 1. Lateral view of the left and right scapula (L and R, respectively). The left scapula has a complete, displaced, transverse fracture of the neck, with an incomplete, longitudinal fracture in the infraspinous fossa and a complete, articular, longitudinal component extending to the glenoid. The longitudinal articular fracture splits the distal fractured segment into two cranial and one caudal fragment.

2. Morphologic diagnoses:

- **Scapula:** acute, complete, displaced, comminuted, closed, articular, transverse, and longitudinal fracture with chronic pre-existing periosteal callus.
- **Muscles:** multifocal to coalescing severe haemorrhage.

3. Etiology and pathogenesis:

Scapular fractures occur commonly due to direct trauma, including falls during racing, training, or jumping (2,3).

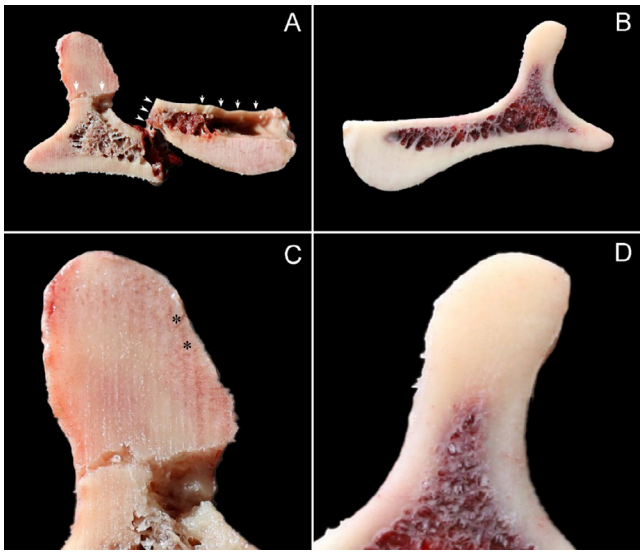

Figure 2. Transverse section of the distal end of the spine of both left (A,C) and right (B,D) scapula. A. View of the section of the proximal fractured fragment of the left scapula. Note the incomplete, simple, displaced, and longitudinal fracture of the body (arrowheads) and the complete transverse fracture crossing the spine (arrows). **B. View of the contralateral non-fractured right scapula**. The scapula has a normally shaped and sized scapular spine with compact bone in a distinct cortical shell enclosing trabecular bone tissue. **C. Close view of the left spine (distal end)**. The scapular spine is markedly enlarged with obliteration of intramedullary trabecular bone by extensive bone remodeling. Note the numerous small red areas (asterisks), particularly in the peripheral tissue of the spine, associated with highly vascular (intensely remodeling) bone tissue. **D. close view of the right spine (distal end)**. The scapular spine is within normal limits at gross examination.

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Alternatively, high strains and loads applied during repetitive exercise create microdamage, which is normally removed during bone repair by bone remodeling (1,7,8). Microdamage accumulation that exceeds the ability of the bone to repair results in a "*stress fracture*" which alters the structural properties and predisposes the bone to complete fracture (5,10). The complete, catastrophic fracture occurs when a normal or high load is applied to the weakened bone.

4. Predisposing factors:

Thoroughbred and Quarter Horse racehorses that have not yet raced or had < 2.5 exercise events (race or official workout) are at higher risk of scapular fracture (10). In general, horses with a scapular fracture have a history of lay-ups (>60 days without a high-speed official work or race) probably due to stress fractures or another musculoskeletal injury. A second high risk category for scapular fracture has been observed for Thoroughbred racehorses that have raced greater than 10 times whose mean rate of high-speed exercise distance in the last 12 months (11.9 furlongs/month) exceeded the rate for event, age, and sex matched live, control horses (8.4 furlongs/month) (9,10). Gender is another associated factor, i.e., stallions and geldings are at higher risk of scapular fracture than females (9).

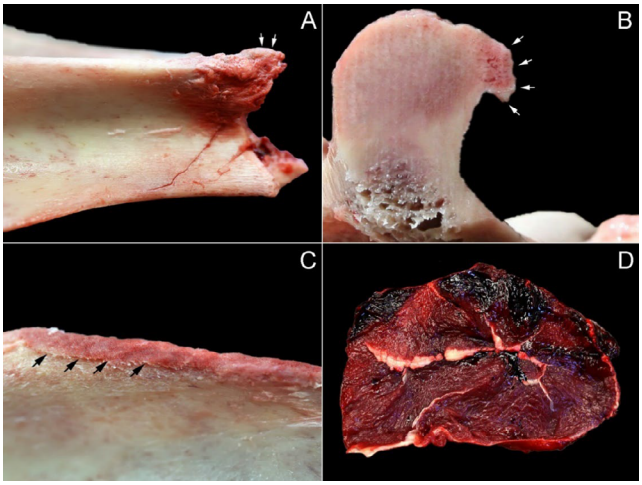

Figure 3. **Left scapula**. **A.** Cranial view of the proximal fractured fragment with a transverse fracture on the scapular neck. Observe pre-existent sub-periosteal bone proliferation (callus, arrows) with an irregular shape that was attempting to buttress an underlying stress fracture. **B.** Transverse section of the distal end of the spine (distal and adjacent to the transverse fracture) of the distal fractured fragment showing the most recent (note the red vascular features) pre-existent callus (arrows). The scapular spine is markedly enlarged with obliteration of intramedullary trabecular bone by extensive bone remodeling. **C.** Caudal view of the tuber of spine. Note the pink-red, thin layer, of porous woven bone (callus; arrows). **D.** Supraspinatus muscle with multifocal to coalescing hemorrhage.

Comments:

Scapular fracture should be considered if the horse has a high-risk history (e.g., unraced or long career of uninterrupted high intense exercise), shows lameness, reluctance to bear weight in the forelimb, difficulty to advance the forelimb, focal swelling, and pain during physical examination of the shoulder, especially after exercise (3,7). The case illustrated in this report is consistent with the second high risk category observed for Thoroughbred racehorses, i.e. those horses that have raced greater than 10 times (10). Specifically, the case horse performed high speed exercise at a rate of 15 furlongs/month in the last 12 months (13 furlong the first two months and 17 furlong the last 10 months) (Figure 4), which exceeds the 11.9 furlongs/month mean rate for Thoroughbred horses with more than 10 races and scapular fracture, and the 8.4 furlongs/month mean rate for Thoroughbred horses that did not have scapular fracture. In this case, the horse had a high number of events including 12 races and 23 high-speed timed workouts, with a total distance of 196 furlongs (92 during races and 104 during workouts) (Table 1). Whereas the horse had no time in lay-up, the total distances were higher than the median distances observed in a study of 47 Thoroughbreds with scapular fractures (9). Further, our case horse had fewer days between events which compromises the ability for recovery and repair of microdamage, and a higher rate of distance accumulation for active-days (Table 1) than the median, of the same variable, observed in the study of horses with scapular fracture (9).

Most scapular fractures involve the spine, neck, glenoid cavity, body, and supraglenoid tubercle. Complete scapular fractures of the neck occur in 2 – 8% of the racehorse musculoskeletal fatalities in California and are more common in the right scapula of young males early in their career (4,6,9). The current case is consistent with the most common site and configuration of scapular fracture in racehorses and

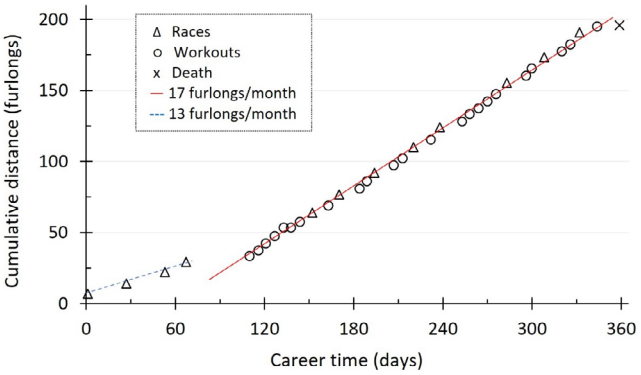

Figure 4. Exercise history, races, and high-speed workouts, of the affected Thoroughbred racehorse.

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Table 1. Exercise history variables comparison between the present case and the median observed in a study (9) of 47 Thoroughbred racehorses that died related to scapular fracture.

	Case	Vallance et al. (2012)
Age (*y*)	3	4
Events (*n*)	36	10
Race (*n*)	12	1
Workout (*n*)	24	9
Total event distance (*f*)	195.8	38.5
Total race distance (*f*)	91.3	4.5
Total work distance (*f*)	103.4	34
Time in Lay-up (*d*)	0	195
Rate distance(*f*)/days	0.56	0.44
Rate distance (*f*)/months*	15	12
Time between event (*d*)	9	11
Time between race (*d*)	29	33
Time between workout (*d*)	12	14

y, years; *d,* days; *f*, furlongs; *n*, numbers,
* last 12 months

is attributed to the location of high repetitive bone stresses associated with the occupation of training and racing on flat surfaces (8). In a study (9) the incidence of this fracture was low with 0.39 out of 1000 race starts for Thoroughbred horses and 0.98 out of 1000 race starts for Quarter horses.

Catastrophic scapular fracture can be prevented by diagnosing them ante-mortem (e.g., stress fracture periosteal callus or a focus of intense bone remodeling can be detected by ultrasound or scintigraphy, respectively) and with appropriate management, the horse can be rehabilitated successfully and return to full performance (1,7,8).

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