Surgical and nonsurgical management of sagittal slab fractures of the third carpal bone in racehorses: 32 cases (1991–2001)

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Objective—To compare results (ie, return to racing and earnings per race start) of surgical versus nonsurgical management of sagittal slab fractures of the third carpal bone in racehorses.  

Design—Retrospective study.  

Animals—32 racehorses (19 Thoroughbreds, 11 Standardbreds, and 2 Arabians).  

Procedure—Medical records and radiographs were reviewed to obtain information regarding signalment and treatment. Follow-up information was obtained from race records. Robust regression analysis was performed to evaluate earnings per start in horses that raced at least once before and after injury.  

Results—22 (69%) horses raced at least once after treatment of the fracture. All 7 horses treated by means of interfragmentary compression raced after treatment, and horses that underwent interfragmentary compression had significantly higher earnings per start after the injury than did horses treated without surgery. Eight of 9 horses treated by means of arthroscopic debridement of the damaged cartilage and bone raced after treatment, but only 7 of 16 horses treated without surgery (ie, stall rest) were able to return to racing after treatment.  

Conclusions and Clinical Relevance—Results suggest that racehorses with sagittal slab fractures of the third carpal bone have a favorable prognosis for return to racing after treatment. Horses treated surgically were more likely to race after treatment than were horses treated without surgery. (J Am Vet Med Assoc 2005;226:945–950)

Slab fractures of the third carpal bone are not uncommon in racehorses. Most often, these fractures occur in the frontal plane and involve the radial facet. In Thoroughbred racehorses, slab fractures are more common in the right forelimb than in the left forelimb, whereas in Standardbred racehorses, such fractures occur equally often in both forelimbs. In 2 previous studies, 77% of Standardbred racehorses and 65% of Thoroughbred racehorses with a frontal slab fracture of the third carpal bone were able to return to racing, but mean earnings per race start were significantly decreased for both breeds, regardless of the treatment given. Overall, 68% of Thoroughbred racehorses with frontal slab fractures stabilized with lag screws were able to start in at least 1 race after the injury, but mean claiming value was significantly decreased.  

Sagittal slab fractures of the third carpal bone have also been identified in horses. Most often, such fractures are best seen on a dorsoproximal-dorsodistal (skyline) radiographic projection. However, a diagnosis of a sagittal slab fracture can be confirmed only if the fracture is shown to involve both the proximal and distal articular surfaces of the third carpal bone through the use of other radiographic projections or direct examination during surgery. A previous study of 12 horses with fractures in the sagittal plane of the third carpal bone reported that the prognosis for return to function following nonsurgical treatment was favorable (7/12), but only 5 of 10 racehorses were able to return to racing. However, fractures in these horses were seen only on the skyline radiographic projection, and the supposition that these represented sagittal slab fractures was not confirmed. Results of surgical treatment (ie, lag screw fixation or arthroscopic debridement) of sagittal slab fractures in horses have been published, but these reports involved few horses and did not attempt to compare results of various treatments.  

We hypothesized that in racehorses with a sagittal slab fracture of the third carpal bone, stabilization of the fracture fragment by means of interfragmentary compression would result in a more favorable outcome than would treatment with stall rest alone. The purpose of the study reported here was to compare results (ie, return to racing and earnings per race start) of surgical versus nonsurgical management of sagittal slab fractures of the third carpal bone in racehorses.  

Criteria for Selection of Cases  
Case records and radiographs of horses admitted to the George D. Widener Hospital for Large Animals at the University of Pennsylvania between January 1991 and December 2001 in which a diagnosis of a sagittal slab fracture of the third carpal bone was made were reviewed. Horses were included in the study only if a fracture line in a sagittal direction was seen on a skyline radiographic projection and the fracture line was seen to traverse the third carpal bone from the proximal to the distal articular surface on a dorsomedial-palmarolateral radiographic projection (Figure 1) or if the diagnosis was confirmed at the time of surgery. Horses with other sagittal plane injuries of the third carpal bone, including subchondral luencies, corner fractures, and comminuted fractures, were excluded.

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Information on signalment, history, clinical findings, and method of treatment was obtained from the medical records. Race records of horses included in the study were obtained from Bloodstock Research Information Services, Lexington, Ky, and the United States Trotting Association, Columbus, Ohio.

Treatment—For all horses, lateromedial, flexed lateromedial, dorsopalmar, dorsomedial-palmarolateral oblique, dorsolateral-palmaromedial oblique, and skyline radiographic projections were obtained. Treatment consisted of surgical or nonsurgical management. Decisions regarding case management were made on the basis of the owner’s economic resources and attending clinician’s preferences. Horses managed surgically underwent arthroscopic debridement of damaged cartilage and bone or interfragmentary compression. The decision on which surgical technique to use was made on the basis of the attending surgeon’s preference and experience with performing interfragmentary compression.

Nonsurgical management consisted of 4 to 6 weeks of stall rest followed by turnout or by hand walking for an additional 4 to 6 weeks and then turnout. Follow-up radiographs were obtained after 4 months, before the horse was returned to training. One clinician recommended 6 to 9 months of rest before the horse was returned to exercise.

In horses that underwent surgical management, a complete physical examination and CBC were performed and plasma fibrinogen concentration was measured prior to induction of anesthesia. Depending on surgeon preference, horses were or were not treated with antimicrobials prophylactically. In horses that received antimicrobials, either procaine penicillin G (22,000 U/kg [10,000 U/lb], IM) or potassium penicillin G (22,000 U/kg, IV) was administered in combination with gentamicin sulfate (6.6 mg/kg [3 mg/lb], IV); in all horses, antimicrobial administration was discontinued after 48 hours. All horses were treated with phenylbutazone before surgery (4.4 mg/kg [2 mg/lb], IV) and for 7 to 10 days after surgery (2.2 mg/kg [1 mg/lb], PO, q 12 h). Phenylbutazone administration was continued as needed for continued discomfort or inflammation.

Horses that underwent arthroscopic debridement were positioned in lateral recumbency with the affected limb uppermost. Standard arthroscopic portals were used for insertion of arthroscopic instruments in the middle carpal joint. The fracture line in the radial facet was directly examined, and damaged cartilage and debris were removed (Figure 2). A sterile dressing was routinely placed over the incisions for recovery, and a full-limb bandage was placed once the horse had recovered from anesthesia. Aftercare consisted of 4 to 8 weeks of stall rest followed by 4 to 6 months of turnout. Follow-up radiographs were obtained before the horse was returned to work.

Horses that underwent interfragmentary compression were also positioned in lateral recumbency but with the unaffected limb uppermost. A routine dorsomedial arthrotomy was made into the middle carpal joint. If a lag screw could not be properly positioned through the arthrotomy, a separate stab incision for screw placement was made over the articulation between the second and third carpal bones, midway...
between the proximal and distal articular surfaces of the third carpal bone. A 3.5-mm cortical bone screw was placed in lag fashion, as perpendicular as possible to the fracture line, between the articulation of the second and third carpal bones (Figure 3). The screw was placed so that it would not interfere with this articulation. A sterile dressing and full-limb bandage were placed for recovery; the bandage was replaced once the horse had recovered. Postoperative recommendations included 4 to 8 weeks of stall rest followed by 4 weeks of hand walking and 4 to 12 weeks of turnout. Follow-up radiographs were obtained before the horse was returned to training.

Statistical analyses—The exact binomial test was used to compare breed distribution of horses with sagittal slab fractures of the third carpal bone with breed distribution of all racehorses examined during the study period. The Fisher exact test was used to determine whether the left or right forelimb was overrepresented. Cox regression analysis was used to compare mean time to return to racing among horses grouped on the basis of treatment type. Robust regression analysis was used to relate earnings per race start after the injury with earnings per start prior to the injury between treatment groups by breed in horses that raced both before and after the injury by controlling for earnings prior to the injury. All analyses were performed with standard software. Values of \( P < 0.05 \) were considered significant.

Results
Thirty-two racehorses met the criteria for inclusion in the study. This included 11 Standardbreds, 19 Thoroughbreds, and 2 Arabians. Standardbreds were significantly \( (P = 0.04) \) overrepresented, compared with the hospital population of racehorses examined during the study period.

Signalment—The Thoroughbreds consisted of 7 females, 4 sexually intact males, and 8 geldings. Mean age at the time of admission was 4.1 years (range, 2 to 8 years). The Standardbreds consisted of 3 females, 3 sexually intact males, and 5 geldings. Mean age at the time of admission was 3.5 years of age (range, 2 to 6 years). The Arabians were both sexually intact males. One was 4 years old and the other was 5 years old at the time of admission.

Affected limb—The right forelimb was affected in 5 Standardbreds, and the left forelimb was affected in 6. The right forelimb was affected in 13 Thoroughbreds, and the left forelimb was affected in 5; the remaining Thoroughbred had bilateral fractures. The percentage of Thoroughbreds in which the right forelimb was affected was not significantly \( (P = 0.09) \) different from the percentage in which the left forelimb was affected. The right forelimb was affected in 1 Arabian, and the left forelimb was affected in the other.

History and physical examination findings—A detailed history was available for 11 horses. Of these, 9 had a history of lameness after a race, 1 had a history of becoming lame after a fall during training, and 1 had a history of poor performance. Three Thoroughbreds had previously undergone arthroscopic surgery for treatment of distal radial carpal bone chip fractures in the affected limb, and 1 Thoroughbred had previously undergone arthroscopic surgery for treatment of a distal lateral radial chip fracture in the opposite limb.

Physical examination findings were available for 23 horses, and all 23 had clinical evidence of middle carpal joint effusion. Results of a lameness examination were recorded for 14 horses. Severity of lameness, scored on a scale from 0 to 5 with 0 being clinically normal and 5 being non–weight-bearing lame, was recorded as 1, 2, or 3 in 12 of the 14 horses. In the remaining 2 horses, lameness severity was assigned a score of 4. Results of a carpal flexion test were positive in 9 horses and negative in 5.

Radiographic findings—In all 32 horses, the fracture involved the medial aspect of the third carpal bone...
Radiographic findings other than the sagittal slab fracture included mild (4 horses) and moderate (1 horse) osteoarthritic changes. These changes include sclerosis of the radial facet, osteoporotic changes along the distal or proximal aspect of the radial carpal bone, and mild osteoporotic changes along the distal aspect of the intermediate carpal bone. Seven horses had concurrent carpal bone fractures at the time of diagnosis. Six of the 7 had osteochondral fragmentation of the distal aspect of the radial carpal bone, and 1 had osteochondral fragmentation of the distal aspect of the intermediate carpal bone. All horses with concurrent fractures were managed with either arthroscopic debridement (5 horses) or interfragmentary compression (2 horses).

Treatment—Sixteen of the 32 horses were managed surgically. Six of these 16 horses were sexually intact males, 5 were females, and 5 were geldings. Nine horses were treated with arthroscopic debridement, and 7 horses were treated with interfragmentary compression. The remaining 16 horses were treated without surgery. Three were sexually intact males, 5 were females, and 8 were geldings. Treatment distribution was similar between breeds and among sexes.

Overall outcome—Twenty-two of the 32 (69%) horses raced at least once after treatment for the sagittal slab fracture. This included 9 of the 11 Standardbreds, 12 of the 19 Thoroughbreds, and 1 of the 2 Arabians. All 7 horses that underwent interfragmentary compression and 8 of 9 horses that underwent arthroscopic debridement raced at least once after treatment, whereas only 7 of the 16 horses treated without surgery did. All horses with concurrent fractures raced before and after the injury. Of the 4 horses with mild osteoarthritic changes, 2 were treated without surgery, and 1 of the 2 returned to racing. The other 2 horses underwent interfragmentary compression, and both returned to racing. The 1 horse with moderate osteoarthritis was treated without surgery and did not race after treatment.

Eighteen of 21 Standardbred and Thoroughbred racehorses that raced after surgery raced before surgery as well. However, complete race records were not available for 2 Standardbreds. After we controlled for preinjury earnings per start, horses that raced at least once before and after the injury earned significantly ($P = 0.04$) less money after the injury than they did before the injury (mean ± SE earnings, $0.38 ± 0.16/dollar earned prior to the injury; 95% confidence interval, $0.02$ to $0.75/dollar earned prior to the injury). Horses treated without surgery earned significantly ($P = 0.02$) less after the injury than did horses that underwent interfragmentary compression. For horses treated without surgery, mean ± SE earnings were $2,031 ± 748/race start (95% confidence interval, $383$ to $3,677/race start) less than earnings for horses that underwent interfragmentary compression.

Convalescence—Mean time to return to racing was significantly ($P = 0.028$) shorter for Standardbreds ($n = 9$; mean ± SD, 255 ± 156 days) than for Thoroughbreds ($n = 12$; 381 ± 110 days). Standardbreds that underwent arthroscopic debridement had a significantly ($P = 0.043$) longer time to return to racing ($n = 8$; $453 ± 189$ days) than did Standardbreds that underwent interfragmentary compression ($3; 205 ± 93$ days) or Standardbreds treated without surgery ($3; 232 ± 72$ days). For the Thoroughbreds, mean time to return to racing was not significantly different among horses that underwent arthroscopic debridement ($n = 3$; 417 ± 164 days), horses that underwent interfragmentary compression ($4; 368 ± 73$ days), and horses treated without surgery ($3; 401 ± 61$ days).

Outcome for Standardbreds—Six of the 11 Standardbreds were treated surgically, including 3 that underwent arthroscopic debridement and 3 that underwent interfragmentary compression. All 3 horses that underwent arthroscopic debridement raced after the injury, and 2 of the 3 had raced before the injury. All 3 horses that underwent interfragmentary compression raced before and after the injury; however, race records were complete for only 2 of these horses. Of the 5 Standardbreds treated without surgery, 3 raced before and after the injury, but race records were complete for only 2 of these horses.

Number of starts and mean earnings per start were evaluated for horses that raced both before and after injury. Mean numbers of starts during the 1-year period before the injury and during the 1-year period after the injury were not significantly different among treatment groups. Mean earnings per start during the year after the injury were not significantly decreased, compared with earnings during the year before the injury, in horses that underwent arthroscopic debridement (mean ± SD, $8,200 ± 9,285$ before injury and $1,271 ± 730$ after injury), in horses treated without surgery ($1,408 ± 838$ before injury and $645 ± 286$ after injury), or in horses that underwent interfragmentary compression ($803 ± 538$ before injury and $993 ± 877$ after injury).

Outcome for Thoroughbreds—Ten of the 19 Thoroughbreds were treated surgically, including 6 that underwent arthroscopic debridement and 4 that underwent interfragmentary compression. Five of the 6 horses that underwent arthroscopic debridement raced after the injury, but only 4 of these horses had also raced before the injury. All 4 horses that underwent interfragmentary compression raced before and after the injury. Of the 9 Thoroughbreds treated without surgery, 3 raced after the injury, but only 2 of these horses had also raced before injury.

Mean numbers of starts during the 1-year period before the injury and during the 1-year period after the injury were not significantly different among treatment groups. Mean earnings per start during the year after the injury were significantly ($P = 0.02$) decreased, compared with earnings during the year before the injury, in horses treated without surgery ($2,079 ± 1,729$ before injury and $362 ± 544$ after injury) or in horses that underwent interfragmentary compression ($2,053 ± 2,532$ after injury and $3,733 ± 2,101$ after injury).
Outcome for Arabians—Both Arabian racehorses were treated without surgery. One returned to its previous level of racing, according to its trainer. The other was retired as a show horse and breeding stallion.

Follow-up radiographic findings—Follow-up radiographic examinations were routinely performed by the referring veterinarian, and follow-up radiographs therefore typically were not available for review. However, follow-up radiographs were available for 1 horse that had undergone arthroscopic debridement, 2 horses that had been treated without surgery, and 2 horses that had undergone interfragmentary compression. Fracture lines were no longer visible between 7 months and 1 year after surgery in the 3 horses that had been treated surgically but were still visible 6 and 7 months after injury in the 2 horses treated without surgery.

Discussion

Horses included in the present study met strict selection criteria, and to our knowledge, this is the first description of horses with sagittal plane fractures of the third carpal bone that were confirmed to involve both the proximal and distal articular surfaces. In our experience, the fracture line could best be seen to extend from the proximal to the distal articular surface on the dorsomedial-palmarolateral radiographic view. However, radiographic views of various obliquities were sometimes necessary to identify the fracture line. Furthermore, underexposure of the radiograph obscured the fracture line. We found that the medial facet of the third carpal bone was occasionally underexposed on the dorsomedial-palmarolateral radiographic view, and careful attention to exposure of this area will help in identifying this fracture.

In all 7 horses that underwent interfragmentary compression in the present study, an arthrotomy was performed prior to screw placement, allowing direct viewing of screw placement. This helped to ensure that the screw was placed as perpendicular as possible to the fracture line without interfering with the articulation between the third and second carpal bones. Screws could have been inserted with arthroscopic assistance, but it can be difficult to position the screw between the third and second carpal bone. The flat head of the 3.5-mm cortical bone screws that were used allowed positioning of the screw in this articulation without the need for countersinking. Arthroscopic exploration of the middle carpal joint, particularly in horses with a sagittal plane injury that has not been confirmed to be a sagittal slab fracture, allows for evaluation of more of the articular surface and facilitates removal of concurrent osteochondral fragmentation. If the sagittal plane injury is confirmed to be a sagittal slab fracture during arthroscopic exploration, a decision to perform interfragmentary compression can be made at that time. If arthroscopic exploration of the joint is performed with the horse in lateral recumbency, placement of an interfragmentary screw through an arthrotomy would necessitate repositioning the horse to its other side. In contrast, placing the horse in dorsal recumbency for arthroscopic exploration would eliminate the need for intraoperative repositioning of the horse.

In the present study, horses that underwent interfragmentary compression earned a mean of $2,031 more per start after returning to racing than did horses treated without surgery. This difference in earnings was statistically significant and was also approximately equal to the cost of the surgery during the study time period. On the other hand, horses that underwent interfragmentary compression did not earn significantly more than horses that underwent arthroscopic debridement.

Horses were not randomly assigned to treatment groups in the present study, and some bias inherent to all retrospective studies may have been present. The 32 horses were treated by 9 clinicians, which should have diminished any strong clinician treatment bias. Owner bias related to personal and economic choices may have had an effect, however. Thoroughbreds treated without surgery earned less money per start before the injury than did Thoroughbreds that underwent surgery. However, Standardbreds that underwent interfragmentary compression earned less money per start before the injury than did Standardbreds in the other treatment groups. This suggests that the decision to treat a horse surgically may not have been based on the value of the horse prior to injury among Standardbreds in the present study. However, Thoroughbreds that had lower earnings prior to injury may have been more likely to have been treated without surgery. The number of geldings treated without surgery (n = 8) was equal to the number of sexually intact males and females treated without surgery (8), but more sexually intact males and females (11) than geldings (5) were treated surgically. Thus, it is unlikely that the decision was made to treat horses without surgery because they were more likely to be retired to breeding.

Fracture characteristics and concurrent pathologic conditions may also have affected outcome in the present study. Subjectively, there were no differences in fracture characteristics apparent on preoperative radiographs among treatment groups; however, fragment width was not measured. Fragment width can only be accurately measured on the skyline radiographic projection of the third carpal bone. However, because neither the radiographic technique used to obtain the skyline projection nor the degree of magnification was standardized, we chose to only evaluate fracture characteristics subjectively. Ideally, a prospective study with metallic markers of a known length to allow for correction of image magnification should be performed. Subjectively, however, 9 horses treated surgically had more severe disease, such as concurrent fractures (n = 7) or evidence of osteoarthritis (2), yet all 9 of these horses were able to return to racing. Of the 3 remaining horses with concurrent carpal abnormalities (2 horses with mild and 1 horse with moderate osteoarthritis) treated without surgery, only 1 returned to racing.

There were too few horses for which follow-up radiographs were available to draw firm conclusions on fracture healing. Although progressive remodeling of the fracture was evident, the fracture persisted for longer than 6 and 7 months in the horses treated without surgery, which was similar to results of a previous
Fractures in the sagittal plane of the third carpal bone for why fractures commonly occur at this site. The radial facet of the third carpal bone may account for why fractures commonly occur at this site. Five of 10 horses in another study\cite{1} with medially located sagittal plane fractures of the third carpal bone had concurrent fractures involving the distal aspect of the radial carpal bone. Concurrent fractures may occur because of the close proximity of the distal aspects of the radial and intermediate carpal bones to the proximal aspect of the third carpal bone during extension of the joint.

All horses in the present study had fractures of the radial facet of the third carpal bone. It has been proposed that unlike other carpal articulations in which load can be distributed to surrounding soft tissue structures, the concave surface of the radial facet receives all of the force transmitted to it through the radial carpal bone.\cite{2} This uneven distribution of load to the radial facet of the third carpal bone may account for why fractures commonly occur at this site. Fractures in the sagittal plane of the third carpal bone have also been reported to involve the intermediate facet.\cite{3}

In previous studies,\cite{4,5,6,7,8,9,10,11,12,13,14,15,16,17,18} third carpal bone injuries were more common in the right than in the left forelimb in Thoroughbreds but occurred with equal frequency in both forelimbs in Standardbreds. Differences in gait and training practices may explain this finding. Thoroughbreds race and train in a counterclockwise direction, placing asymmetrical loads on the forelimbs and predisposing the medial aspect of the right forelimb and lateral aspect of the left forelimb to injury. Standardbreds race in a counterclockwise direction but are frequently trained in a clockwise direction. Therefore, the medial aspect of both forelimbs would experience similar loads.

a. Stata, version 8, StataCorp, College Station, Tex.

References