
J. Brett Woodie, DVM; Alan J. Ruggles, DVM; Alicia L. Bertone, DVM, PhD; Joanne Hardy, DVM, PhD; Robert K. Schneider, DVM, MS

Objective—To determine whether fracture fragment dimensions, suspensory ligament damage, and racing status at the time of injury were associated with outcome in Standardbred horses with apical fracture of the proximal sesamoid bone.

Design—Retrospective study.

Animals—43 Standardbred racehorses.

Procedure—Medical records, racing records, and radiographs were reviewed, and ultrasonographic findings were scored. Measurements of the fractured portion of the proximal sesamoid bone were made.

Results—Seventy-four percent (32/43) of horses were pacers, and 26% (11/43) were trotters. Statistical differences between trotters and pacers regarding ability to start, number of starts, or amount of money earned after injury were not detected. Females earned significantly more money per start after injury than males. Eighty-six percent (37/43) of fractures involved hind limbs and 14% (6/43) involved forelimbs. Horses with forelimb injuries earned less money per start. Severity of suspensory ligament damage did not affect postinjury racing performance. A higher proportion of horses that had raced before injury returned to racing after surgery than horses that had not raced before injury, although a significant difference between these groups was not detected. Eighty-eight percent of horses that raced before injury raced after injury. Fifty-six percent of horses that did not race before injury raced after injury. Fracture fragment dimensions did not affect outcome.

Clinical Implications—Dimensions of the apical fracture fragment of the proximal sesamoid bone in Standardbred horses and degree of suspensory ligament damage did not affect outcome. Prognosis for return to racing soundness is good in horses that had raced before injury and fair in horses that had not raced before injury. (J Am Vet Med Assoc 1999;214:1653–1656)

The proximal sesamoid bones (PSB) are important structures that provide support to the metacarpal- and metatarsophalangeal joints. They provide points of attachment for the suspensory apparatus, which consists of branches of the suspensory ligament, collateral sesamoidean ligaments, and distal sesamoidean ligaments. The suspensory apparatus supports the metacarpal- and metatarsophalangeal joints and prevents excessive dorsiflexion. The PSB are subjected to substantial tensile forces in exercising horses, especially at high speed, and fractures are common in racing breeds such as Standardbreds and Thoroughbreds. Apical fractures of the sesamoid bone involve the proximal third of the bone and are the most common.

Stress remodeling develops in the PSB in response to exercise and is most intense at the junction of the proximal third and distal two-thirds of the bone. Alterations in bone porosity and, therefore, strength are thought to predispose this area to fracture. The suspensory apparatus also undergoes adaptive changes during training, which affects the strength of the suspensory ligament as well as site of failure. In trained horses, the PSB failed when the metacarpophalangeal joint was loaded to failure; conversely, in untrained horses, the suspensory ligament failed. The tension at which the suspensory apparatus failed was significantly higher in trained versus untrained horses.

In a study of 23 horses with apical fractures of the proximal sesamoid bones that underwent surgery to remove the fracture fragment, 48% (11/23) resumed racing. It was reported that for best results, the fracture should be removed <30 days after injury, should only involve the apex of the PSB, and should consist of less than a third of the total mass of the PSB.

In a study of 109 cases, 80 (73%) horses were treated with surgical removal of the fracture fragment, and 40 (50%) of these horses raced at least once after surgery. A higher percentage (64% [23/36]) of horses that had raced before injury returned to racing after surgery, and horses treated surgically within 30 days of fracture had better racing performances than did horses treated surgically after 30 days. It was also suggested that desmits of the suspensory ligament resulted in a poorer prognosis for a return to racing performance.

Surgical removal of the apical fragment is currently recommended, because conservative management is less successful for return to athletic performance. In 29 horses with apical fracture of the PSB treated nonsurgically, 10 (37%) had reduced postinjury racing performance. In another report, 3 horses with apical fracture of the PSB were treated with stall rest; 2 did poorly, and the third was lost to follow-up.

The suspensory branch is injured along the abaxial border of the affected sesamoid bone when the fracture is incurred and during surgical removal of the fragment. Extent of injury has been suggested to have an effect on prognosis for return to racing. It has also been reported that horses with concurrent suspensory ligament desmitis and involvement of >25% of the abaxial surface of the PSB should have a poor prognosis for racing soundness, although ultrasonographic evaluation of the suspensory ligament was not routine.

From the Department of Veterinary Clinical Sciences, College of Veterinary Medicine, The Ohio State University, Columbus, Ohio 43210. Dr. Ruggles' present address is Rood and Biddle Equine Hospital, 2150 Georgetown Rd, Lexington, KY 40509. Dr. Schneider's present address is Department of Clinical Sciences, College of Veterinary Medicine, Washington State University, Pullman, WA 99164.
ly performed in these studies. Previous studies have thus been limited by lack of quantification of fragment size, ultrasonographic data, and statistical comparisons of pre- and postinjury performance.

The purpose of the study reported here was to determine whether fracture fragment dimensions, suspensory ligament damage, and racing status at the time of injury were associated with outcome in Standardbred horses with apical fracture of the PSB. Our hypotheses were that horses with substantial abaxial involvement of the fractured bone, severe lesions of the suspensory ligament, and that had not started in a race prior to injury would have a poor prognosis for racing soundness.

**Criteria for Selection of Cases**

Medical records of horses treated at The Ohio State University College of Veterinary Medicine from January 1990 to December 1996 for PSB injuries were reviewed. Inclusion criteria consisted of a single PSB fracture involving < 33% of the axial height of the bone in a racing Standardbred horse that had the fragment surgically removed. Other breeds and horses with other types of PSB fractures were excluded. Information obtained from medical records included signalment, affected limb and PSB, duration of lameness prior to admission, degree of lameness at time of admission, stage of training or racing at time of injury, prior treatments, results of ultrasonographic examination of the suspensory ligament and its branches, radiographic findings, concurrent musculoskeletal problems, method of surgical treatment, and postoperative complications. Follow-up information regarding outcome and complications was obtained via telephone conversation with owners, trainers, or referring veterinarians. Information regarding pre- and postinjury racing performance was obtained from the United States Trotting Association.

Ultrasonographic images of suspensory ligaments were scored as follows: grade 0—no evidence of abnormality; grade 1—thickening, edema, and/or a lesion that was less echogenic than normal (type-1 core lesion) in the suspensory branch; grade 2—half echogenic, half anechoic lesion (type-2 core lesion) or mostly anechoic lesion (type-3 core lesion) in the suspensory branch; grade 3—totally anechoic lesion (type-4 core lesion) in the suspensory branch. Horses that did not have an ultrasonographic examination were not assigned a score and were not included in analysis of ultrasonographic image data. Follow-up ultrasonographic examinations were not performed.

Measurements of the affected sesamoid bone were made from radiographs, and other osseous abnormalities were recorded if evident. Measurements of the PSB fracture taken from single dorsopalmar or dorsoplantar projections included abaxial length of the distal fracture fragment, abaxial length of the proximal fracture fragment, axial height of the distal fracture fragment, axial height of the proximal fracture fragment, and proximal displacement (Fig 1). Data calculated from measurements included total axial length (sum of axial lengths of proximal and distal fracture fragments), total abaxial length (sum of abaxial lengths of proximal and distal fracture fragments), percentage involvement of abaxial surface (abaxial length of proximal fragment fracture divided by the entire abaxial length of the PSB multiplied by 100), and percentage involvement of axial surface (axial length of proximal fragment fracture divided by the entire axial length of the PSB multiplied by 100).

Proximal fracture fragments were removed by arthroscopic technique or by means of arthrotomy. Typical postoperative care of the horses in our study included bandaging for 14 days, administration of phenylbutazone, box-stall confinement for 30 days, and hand walking after 2 weeks. After stall confinement, 4 to 12 weeks of pasture turnout was recommended.

Information related to pre- and postinjury performance was obtained from racing records, and included number of preinjury starts, number of postinjury starts, preinjury earnings, postinjury earnings, preinjury earnings per start, postinjury earnings per start, total earnings per start, lifetime earnings, time from injury to first start, and ability to make > 3 postinjury starts. A start was defined as a recognized pari-mutuel race or a race at a fair that offered a purse.

Factors that were evaluated for effect on the outcome variables included: age, sex, gait, limb involvement, pre- and postinjury racing performance, ultra-
sonographic score, surgical method of fracture fragment removal, and time from injury to first start. The outcome variables were defined as starting a race after surgery, starting > 5 races after surgery, and earnings after surgery. The Mann-Whitney rank sum test was used to compare median values of nonparametric data, whereas a t-test was used to compare mean values of parametric data. The χ² test was used to test for associations among categorical nonparametric data. A value of P < 0.05 was considered significant.

Results

Medical records of 225 horses were reviewed; 43 horses (median age, 2 years; range, 2 to 9 years) met the study criteria. Horses that were ≤ 3 years of age earned more money per start after injury than before injury (P = 0.023). Seventy-four percent (32/43) of horses were pacers, and 26% (11/43) were trotters; statistical differences between trotters and pacers regarding ability to start, number of starts, or amount of money earned after injury were not detected. Sixty-five percent (28/43) of horses were female, and 35% (15/43) were male. Females earned significantly (P = 0.018) more money per start after injury (median, $165; range, 0 to $2,817) than males (median, $67; range, 0 to $1,185).

Eighty-six percent (37/43) of fractures involved a PSB in a hind limb and 14% (6/43) involved a PSB in a forelimb. All horses with forelimb PSB fractures earned less money per start after injury (P = 0.021). A lateral PSB was fractured in 79% (34/43) of cases and a medial PSB in 21% (9/43) of cases. Forty percent (17/43) of the fractures involved the left rear lateral PSB and 33% (14/43) involved the right rear lateral PSB. Location of the fracture did not affect postinjury racing performance.

Length of time between fracture and surgery was recorded in 35% (15/43) of cases in our study. In 13 of the 15 cases, surgery was performed between 1 and 21 days after fracture, whereas in 2 cases, surgery was performed > 30 days after fracture. In 53% (23/43) of horses, additional radiographic abnormalities, including osteochondral fragments (n = 6), osteochondrosis (8), enthesiophyte formation (6), and sesamoiditis (3), were detected but were not predictive for postinjury racing performance. Mean abaxial length of the proximal fracture fragment was 9.7 mm (range, 2 to 20 mm), and mean percentage involvement of abaxial surface was 35.9% (range, 8 to 74%). Mean axial height of the proximal fracture fragment was 7.3 mm (range, 3 to 12 mm), and mean percentage involvement of axial surface was 22.1% (range, 10 to 32%). Mean proximal displacement was 2.6 mm (range, 0 to 14 mm). Effects of measurements of fracture fragments on outcome were not detected.

Ultrasoundography was performed in 49% (21/43) of horses, with scores as follows: 24% (5/21) had scores = 0; 38% (8/21) had scores = 1; 38% (8/21) had scores = 2; and mean score was 1.1 (range, 0 to 2). A significant association between score and postinjury racing performance was not detected.

The proximal fracture fragment was removed by means of arthrotyomy in 81% (35/43) of cases and by arthroscopic techniques in 19% (8/43) of cases. Median surgical time for arthrotyomy was 49 minutes (range, 20 to 90 minutes), whereas median surgical time for arthroscopy was 40 minutes (range, 30 to 85 minutes). Surgical times for horses that had additional procedures (eg, removal of osteochondral fragments) were not included in these calculations. Method of removal did not affect postinjury racing performance or outcome.

Thirty-seven percent (16/43) of horses started in a race prior to injury, whereas 63% (27/43) had not started prior to injury. Eighty-eight percent (14/16) of horses that started before injury started after injury. Fifty-six percent (15/27) of horses that did not start before injury started after injury. Overall, 67% (29/43) started a race after injury. Of the 29 horses that started after injury, 79% (23/29) made > 5 starts, 72% (21/29) earned more money after injury than before injury, median number of postinjury starts was 12 (range, 2 to 128), and median earnings per start was $265 (range, $8 to $2,817). Median lifetime earnings of horses that raced after surgery was $11,735 (range, $26 to $248,101).

Median lifetime earnings of all horses in this study were $3,948 (range, $0 to $248,101). Median preinjury earnings were $0 (range, $0 to $244,996), and median preinjury earnings per start were $0 (range, $0 to $2,506). Median postinjury earnings were $1,342 (range, $0 to $67,729), and median postinjury earnings per start were $161 (range, $0 to $2,187). Median number of months from injury to first start was 9 (range, 3 to 27).

Discussion

To our knowledge, this is the first study to quantify fracture fragment size and surface involvement as well as objectively evaluate ultrasonographic data in Standardbred racehorses with apical fractures of the PSB. A higher proportion of horses that had raced before injury returned to racing after surgery than horses that had not raced before injury, although a significant difference between these groups was not detected. Severity of suspensory ligament damage did not significantly affect postoperative racing outcome, nor did percentage involvement of the abaxial surface of the PSB or other lesions detected by radiography. We did determine that horses with forelimb involvement earned less money than horses with hind limb involvement.

Many factors can affect racing performance after removal of an apical fracture fragment from a PSB, including the nature and extent of the injury, athletic ability of the horse, case management and selection, and subsequent unrelated injury. In our study, 67% (29/43) of all horses and 88% (14/16) of horses that had raced prior to injury started in at least 1 race after surgery. These values are higher than those of other studies. In another report, 50% (40/80) of horses treated surgically and 64% (23/36) of horses that had raced prior to injury raced after surgery. Early surgical treatment may influence outcome, although comparisons between horses treated within 30 days of fracture and those treated after 30 days of fracture in our study were not possible because of small sample size. Previous work has shown that horses that had surgery within 30 days of injury had better performance after surgery as compared with horses that had surgery > 30 days after injury.
Postinjury training techniques for horses evaluated in previous studies may have been different from those used in the study reported here and may partially explain differences in results. In our study, it was common practice for trainers to return horses to training slowly, allowing gradual loading of the suspensory apparatus and stress remodeling of the PSB.1,2,5

Surgical technique used for fracture fragment removal did not affect outcome. Arthroscopy through the palmar or plantar pouch1 was used in 81% (35/43) of horses in our study, whereas arthroscopy1 was used in 19% (8/43) of horses. Arthroscopy allows more extensive examination of the palmar or plantar pouch of the metacarpal- or metatarsophalangeal joint and should be chosen if additional osteochondral fragments must be removed or complete evaluation of the joint is required. Surgical times were similar for the 2 techniques.

Several reports have stated that concurrent suspensory ligament desmitis results in poor prognosis for return to athletic function,1,3,5 although ultrasonographic evaluation was not performed in these studies. Twenty-one of the 43 horses in our study were examined by use of ultrasonography, and although none had severe damage to the suspensory ligament, severity of ligament damage did not seem to affect the outcome. Horses with severe suspensory ligament injury (eg, severe soft tissue swelling, dropped fetlock, or fracture of the second or fourth metacarpal bones) may have a less favorable prognosis for return to racing.

Other reports state that abaxial involvement > 25% results in poor prognosis,1,3 but for horses in the study reported here, mean percentage of abaxial involvement was 36%, and 70% (23/33) of horses with > 25% involvement returned to racing. Six of 10 horses that had < 25% abaxial involvement returned to racing. Thus, percentage of abaxial involvement did not affect return to racing.

Displacement of the proximal fracture fragment did not affect outcome in our study; although another study reported that prognosis for basal fractures was less favorable when the fragment was displaced > 3 mm.11 Distance of displacement is thought to be related to degree of separation of suspensory ligament fibers; therefore, large displacements should correspond with more separation of fibers and higher ultrasonographic scores. In our study, horses had mean proximal displacement of 2.6 mm, although horses with larger displacements had higher ultrasonographic scores, scores did not affect clinical outcome.

Results of our study are in agreement with results of other studies that indicate that apical fracture of the PSB is a disease of young racehorses.1,3,5,7 The PSB undergoes stress-adaptive remodeling as a consequence of training,6 but it is likely that the suspensory ligament strengthens more rapidly than the PSB, which explains why fractures are more common than suspensory ligament injuries in young racehorses. The region just distal to the apex of the PSB has lower porosity and greater trabecular width than other regions of the sesamoid bone, and may be a region of local stress concentration that is predisposed to fracture. This region was the site of fracture in all horses in our study.

Fractures were in hind limbs more often (86% of horses) than in forelimbs (14% of horses). The lateral PSB of right and left hind limbs were fractured in 40 and 33% of horses, respectively, whereas the medial PSB of right and left hind limbs were fractured in 2 and 12% of horses, respectively. Nuclear scintigraphy reveals greater uptake of radiopharmaceutical compounds by the lateral PSB than the medial PSB in racing Standardbreds,14 which likely indicates increased loading and stress remodeling. Proximal sesamoid bones that are undergoing active remodeling may be predisposed to fracture.

Horses typically sustain apical fractures early in the racing season, which is probably related to the strength of the PSB in relationship to the strength of the suspensory ligament. Thus, horses may be more likely to sustain PSB fractures early in the season because adaptive stress remodeling of the bone has not been completed. Period between injury and first start (median, 9 months) was similar to other studies of PSB fracture.1,13 It is typically late in the racing season when injured horses have completed 3 months of convalescence, and many trainers do not attempt to race these horses until the next racing season. The prolonged rest period may be important with regard to postinjury performance.

References


The United States Trotting Association, Columbus, Ohio.