

Palmar carpal osteochondral fragments in racehorses: 31 cases (1994–2004)

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Objective—To evaluate records of racehorses with palmar carpal osteochondral fragments and determine whether the fragments were indicators of the severity of pathologic joint changes or prognosis.

Design—Retrospective case series.

Animals—31 racehorses.

Procedures—Medical records, radiographs, and videos of arthroscopic procedures were reviewed. Information gathered included signalment; location, number, and size of the primary lesion; number and size of palmar carpal fragments; and details pertaining to surgical procedures. Outcome variables were obtained from race records.

Results—31 horses met the selection criteria. Multiple palmar fragments were diagnosed in 58% of horses; small fragments (< 3 mm in diameter) were most common (52% of horses). Fifty-two percent of the horses returned to racing, 48% returned to racing and earned money, and 32% had at least 5 more starts. Horses with multiple fragments had significantly less earnings per start and lower performance index values after surgery than those with 1 fragment. Horses with palmar fragments < 3 mm in diameter were significantly less likely to return to racing and have 5 starts or to win money after surgery than horses with larger fragments.

Conclusions and Clinical Relevance—Palmar carpal osteochondral fragments can be used as an indicator of clinically important joint pathology and as a prognostic indicator in racehorses. Horses with multiple small fragments were less likely to successfully return to racing than horses with only dorsally located carpal fragments or horses with 1 or 2 large palmar fragments. When possible, removal of palmar carpal osteochondral fragments should be considered. (*J Am Vet Med Assoc* 2006;228:1551–1558)

Carpal osteochondral fragments, or chip fractures, are a common cause of lameness in racehorses. These fragments develop as a result of overrotation of the ACJ or highly loaded closing of the MCJ and may be exacerbated by fatigue of the palmar carpal soft tissues, poor conformation, poor shoeing, and dirt racing surfaces.^{1,2} In Thoroughbreds and Quarter Horses, the primary site of osteochondral fragmentation is the distal portion of the RCB; other common locations are the distolateral portion of the radius, proximal portion of the ICB, and proximal portion of C3.^{3–6} Standardbreds

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ABBREVIATIONS

ACJ	Antebrachiocarpal joint
MCJ	Middle carpal joint
C3	Third carpal bone
RCB	Radial carpal bone
ICB	Intermediate carpal bone
UCB	Ulnar carpal bone
ACB	Accessory carpal bone

are predisposed to fragmentation of the distal portion of the RCB and proximal portion of C3 but rarely develop fragments in the ACJ.^{5,7}

Although the dorsal aspect of the ACJ and the dorsomedial aspect of the MCJ are the primary areas where carpal osteochondral fragments occur and these injuries have been well described,^{1–7} little information is available regarding fragments in the palmar aspect of the joints. Most reports^{2,8–10} of palmar carpal osteochondral fragments refer to large fractures that are the result of a single traumatic event, such as those sustained during a fall or recovery from general anesthesia. Historically, small osteochondral fragments in the palmar aspect of the carpal joints have been referred to as dystrophic mineralization and were thought to develop secondary to repeated intra-articular corticosteroid injections.^{10,11} It has become more apparent, however, that most of these types of radio-opacities are osteochondral fragments that have migrated from the dorsal aspect of the carpal joints.¹⁰ Palmar carpal osteochondral fragments have been observed in association with slab fractures of C3,¹² although there was no mention of such associations in 2 large retrospective studies^{13,14} of C3 slab fractures.

To the authors' knowledge, these smaller palmar carpal osteochondral fragments have not been described in previous studies of carpal chip fractures and are only briefly mentioned in most textbooks. It is our clinical impression that these fragments are the result of extensive pathologic changes in the dorsal aspect of the joint and represent a poor prognostic indicator for future athletic performance. The purpose of the present study was to retrospectively evaluate a series of racehorses with palmar carpal osteochondral fragments. The objectives were to determine whether the fragments were useful as an indicator of pathologic joint changes or as prognostic indicators, determine the outcome of horses with palmar carpal osteochondral fragments, and determine factors affecting outcome. We hypothesized that palmar carpal osteochondral fragments were associated with severe pathologic joint changes, that the presence of such fragments would be useful as an indicator of poor prognosis for successful return to racing, and that small palmar fragments and C3 slab fractures would be associated with a poor prognosis.

Criteria for Selection of Cases

Medical records of all horses admitted to the George D. Widener Hospital for Large Animals for carpal arthroscopic surgery from January 1994 through September 2004 were reviewed. Horses were included in the study if osteochondral fragments in the palmar aspect of the carpal joints were observed on preoperative radiographs. Additionally, the radiology reports of all horses for which carpal radiographs were obtained during the same time period were reviewed, and horses were included if they had osteochondral fragments in the palmar aspect of the carpal joints. Nonracehorses were excluded from the study.

Procedures

Information collected from the medical records included signalment (age, breed, and sex), affected limb (left forelimb or right forelimb), affected joint (ACJ or MCJ), whether arthroscopic surgery was performed on the affected joint, whether a palmar approach was used for surgery, and whether the palmar osteochondral fragments were removed at surgery. The site of the primary lesion or lesions in the joint was also obtained from the medical records and was categorized as follows: proximodorsal aspect of the RCB, distodorsal aspect of the RCB, dorsal aspect of C3, proximodorsal aspect of the ICB, distodorsal aspect of the ICB, dorsal aspect of the radius, C3 slab fractures, palmar aspect of the RCB, palmar aspect of C3, palmar aspect of the UCB, and ACB.

Radiographic evaluation—Radiographs (lateral, flexed lateral, dorsal-palmar, dorsolateral-palmaromedial oblique, and dorsomedial-palmarolateral oblique views as well as a skyline view of the distal row of carpal bones) of each case were examined for the number and size of dorsally located lesions. The number of lesions in the dorsal aspect of the carpus was categorized as 0 (horse had only palmar lesions), 1, 2, or 3. Lesions were graded according to size: grade 1 fragments were < 9 mm in diameter, grade 2 fragments were from 9 to 19 mm in diameter, and grade 3 fragments were > 19 mm in diameter; if multiple fragments were observed, the sum of all fragment sizes was used. Radiographs were also evaluated for location of palmar carpal fragments (ie, palmarolateral aspect of the MCJ, palmaromedial aspect of the MCJ, or palmar aspect of the ACJ), number of palmar carpal fragments, and size of fragments. The number of palmar osteochondral fragments was categorized as 1, 2, or multiple fragments. Fragments were graded according to size: grade 1 fragments were < 3 mm in diameter (Figure 1), grade 2 fragments measured from 3 to 5 mm in diameter, grade 3 fragments measured from > 5 to 9 mm in diameter, and grade 4 fragments were > 9 mm in diameter (Figure 2). When multiple fragments were observed, size was classified on the basis of the largest fragment detected. Additionally, radiographs of horses with slab fractures of C3 were examined for the dorso-palmar thickness (depth; mm) of the fracture fragment at the proximal articular surface, width of displacement or fracture gap (mm), and width of the fracture fragment as a percentage of the total width of C3.

Surgical procedures—Horses were positioned in dorsal or lateral recumbency after induction of anes-



Figure 1—Flexed lateral radiographic view of the carpus of a horse with multiple small (grade 1) palmar carpal osteochondral fragments (arrow).



Figure 2—Dorsomedial-palmarolateral oblique radiographic view of the carpus of a horse with a single large (grade 4) palmar carpal osteochondral fragment of the RCB (arrow).

thetia, and the affected limb was routinely prepared and draped. The affected joint was distended with sterile crystalloid fluids, and the arthroscope and instrument portals were introduced on the dorsal aspect of the joint via a 6-mm stab incision on both sides of the extensor carpi radialis tendon. When arthroscopic surgery of the palmar aspect of the joint was performed, portals were made by distending the affected joint with sterile fluid and making a stab incision into the palmar-lateral outpouching of the affected joint. Joints were inspected, lesions were debrided routinely, and after copious articular lavage, stab incisions were closed with 1 or 2 simple interrupted skin sutures.

Videotapes of the arthroscopic procedure were reviewed when available. Information recorded included confirmation of the primary lesion site or sites, severity of articular cartilage damage, and severity of medial palmar intercarpal ligament damage. Damage to articular cartilage was assessed in the dorsal aspect of the joint and was graded on a scale of 1 to 4 (grade 1 = minimal damage, grade 2 = loss of 30% to 50% of the articular cartilage, grade 3 = loss of \geq 50% of the articular cartilage, and grade 4 = substantial subchondral bone loss).² Damage to the medial palmar intercarpal ligament was graded on a scale of 1 to 4 (grade 1 = mild damage with fraying of a small number of fibers, grade 2 = up to a third of the ligament torn or damaged, grade 3 = one to two thirds of the ligament torn or damaged, and grade 4 = complete rupture of the ligament).¹⁵

Outcome—Race records were obtained^{1a,b} for horses that raced before or after surgery and were used to determine outcome. Categorical data collected included whether the horse returned to racing and had 1 start, whether the horse returned to racing and had \geq 5 starts, and whether the horse earned money after surgery. Continuous data collected included number of starts after surgery, money earned after surgery, and money earned per start after surgery. The time between surgery and the first start (in months) was recorded for horses that returned to racing. When applicable, a performance index¹⁶ was calculated for the last 3 races before surgery and the first 3 races after surgery. Variables included in the calculation were finish position and race rating (for Thoroughbreds) or race purse (for Standardbreds), with higher performance index values indicative of superior performance and lower values indicative of inferior performance. The difference between the pre- and postoperative performance index values was determined for horses that had 3 starts both before and after surgery, with a negative change in index values indicating decreased postoperative performance and a positive change indicating improved postoperative performance.

Statistical analysis—Categorical data were analyzed by use of a Fisher exact test.^c Categorical data analyzed included the associations among signalment, affected limb, affected joint, primary lesion or lesions (eg, location, number, and size), whether arthroscopic surgery was performed, whether surgery was performed through a palmar arthroscopic approach, palmar osteochondral fragments (eg, number, size, and whether removed), articular damage grade, medial palmar inter-

carpal ligament damage grade, and outcome measurements (return to racing [1 start], return to racing [\geq 5 starts], and whether money was earned after surgery). Continuous data were analyzed by use of 1-way ANOVA.^d Independent variables evaluated were signalment, affected limb, affected joint, location of primary lesion or lesions, whether arthroscopic surgery was performed, whether a palmar arthroscopic approach was used, palmar osteochondral fragments (number, size, and whether removed), articular damage grade, and medial palmar intercarpal ligament damage grade. The dependent variable was outcome (number of starts after surgery, money earned after surgery, money earned/start after surgery, postoperative performance index, and change in performance index). A plot of the residual versus predicted values was used to test for equality of variance in the money earned postoperatively and money earned per start after surgery. If the variances were unequal, data were normalized via log transformation and reanalyzed. Analysis of the transformed data was reported; however, raw data are presented as mean \pm SE. Values of $P \leq 0.05$ were considered significant.

Results

Clinical data—Thirty-one horses fulfilled the criteria for inclusion in the study. Two other horses with palmar carpal osteochondral fragments were excluded because they were event horses. Of the 31 horses included, 10 (32.3%) were 2-year-olds, 12 (38.7%) were 3-year-olds, and 9 (29%) were \geq 4 years old. Twenty-six (83.9%) horses were Thoroughbreds and 5 (16.1%) were Standardbreds; 17 (54.8%) horses were female, 10 (32.3%) were sexually intact males, and 4 (12.9%) were geldings. The right forelimb was affected in 20 (64.5%) horses and the left forelimb was affected in 11 (35.5%) horses. The site with the highest number of palmar osteochondral fragments was the palmar lateral aspect of the MCJ (64.5% [n = 20]), followed by the palmar medial aspect of the MCJ (19.4% [6]) and the palmar ACJ (19.4% [6]); 1 horse had palmar fragments in both the MCJ and ACJ.

Primary lesions most commonly involved the distodorsal aspect of the RCB (58.1% [18]), followed by the dorsal aspect of C3 (25.8% [8]), slab fractures of C3 (19.4% [6]), proximal aspect of the RCB (19.4% [6]), distal portion of the radius (16.1% [5]), proximodorsal aspect of the RCB (9.7% [3]), proximodorsal aspect of the ICB (6.5% [2]), proximal aspect of C3 (6.5% [2]), distodorsal aspect of the ICB (3.2% [1]), ACB (3.2% [1]), and proximal aspect of the UCB (3.2% [1]). Seven (22.6%) horses had primary lesions that involved only the palmar aspect of the carpal bones; in 6 of those horses, lesions were on the proximal aspect of the RCB and 1 was on the proximal aspect of C3. Mean depth of the C3 slab fractures was 15 mm (range, 9 to 24 mm), mean width was 81% of the width of C3 (range, 51% to 100%), and mean displacement was 1.9 mm (range, 0 to 5 mm). Most (93.5% [29]) horses underwent arthroscopic surgery. In those 29 horses, 14 (48.3%) joints were entered via a palmar approach. Osteochondral fragments in the palmar aspect of the carpus were removed in 13 of 31 (41.9%) horses; there was no association between having the palmar frag-

ments removed and grade of articular cartilage damage observed at the time of surgery ($P = 0.450$).

Most (18 [58.1%]) horses had multiple palmar carpal osteochondral fragments, 11 (35.5%) horses had 1 fragment, and 2 (6.5%) horses had 2 fragments. Small fragments (grade 1) were most common (16 [51.6%]); 5 (16.1%) horses had grade 2 fragments, 7 (22.6%) horses had grade 3 fragments, and 3 (9.7%) horses had grade 4 fragments. The number of palmar osteochondral fragments and size of the fragments were significantly ($P = 0.004$) associated, with multiple fragments more likely to be small fragments (< 3 mm [grade 1]). Females were significantly ($P = 0.011$) more likely to have multiple fragments than males or geldings.

Videotapes of the arthroscopic procedures were available for review for 25 of the 29 (86.2%) horses that had surgery on the affected joint. In all instances, the primary lesion site recorded in the medical record was the same as that observed on the videotape. All horses for which videotapes were available for review had some degree of articular cartilage damage; 3 (12%) horses had grade 1 damage, 10 (40%) horses had grade 2 damage, 6 (24%) horses had grade 3 damage, and 6 (24%) horses had grade 4 damage. There was no association between fragment number or size and the degree of articular damage recorded ($P = 0.239$ and 0.574 , respectively). Information regarding the status of the medial palmar intercarpal ligament was available for 16 of 26 (61.5%) horses with palmar osteochondral fragments in the MCJ. In the other 10 cases, the horse either did not have surgery on the affected joint, the videotape of the surgery was unavailable, or the ligament was not observed during the recorded portion of the surgery. Of the 16 cases in which the medial palmar intercarpal ligament was observed, most (13 [81.3%]) had some degree of damage; only 3 (18.8%) horses had no visible damage. Of the 13 damaged ligaments, 5 (38.5%) had grade 1 damage, 2 (15.4%) had grade 2 damage, 4 (30.8%) had grade 3 damage, and 2 (15.4%) had grade 4 damage. There was no association between fragment number or size and medial palmar intercarpal ligament damage ($P = 0.489$ and 0.607 , respectively).

Several associations were detected between the type of primary lesion and fragment characteristics. Horses with primary lesions on the distodorsal aspect of the RCB or dorsal aspect of C3 were more likely to have multiple palmar fragments than 1 or 2 palmar fragments ($P = 0.015$ and 0.012 , respectively). Conversely, horses with primary lesions of the distal portion of the radius were more likely ($P = 0.028$) to have 1 or 2 palmar fragments than multiple palmar fragments. Although the differences were not significant, all horses with slab fractures of C3 had multiple palmar fragments ($P = 0.11$) and all had the smallest grade of palmar fragments (grade 1; $P = 0.102$). Size of the dorsal lesion or lesions and characteristics of the palmar lesion were significantly ($P = 0.033$) associated; horses with the largest dorsal lesions (ie, grades 2 and 3) were significantly more likely to have the smallest (grade 1) palmar fragments than horses with larger palmar fragments, and horses with 2 or 3 dorsal lesions were significantly ($P = 0.009$) more likely than horses with no dorsal lesions or 1 dorsal lesion to have the smallest (grade 1) palmar fragments.

Horses with primary lesions of only the proximal aspect of the RCB were significantly ($P = 0.001$) more likely to have 1 palmar fragment than 2 or multiple fragments; they were also more likely ($P = 0.014$) to have palmar fragments larger than 3 mm in diameter. These horses were also significantly ($P = 0.010$) more likely to have grade 1 articular cartilage damage than horses with other primary lesion types. Horses with only palmar primary lesions were more likely to have grade 1 articular cartilage damage than horses with dorsally located primary lesions, although the difference was not significant ($P = 0.078$).

Outcome—Evaluation of race records revealed that 16 (51.6%) horses with palmar carpal osteochondral fragments returned to racing (1 start) and 10 (32.3%) horses returned to race in 5 or more starts. Fifteen (48.4%) horses with palmar carpal osteochondral fragments returned to racing and earned money. Mean postoperative earnings of horses that returned to racing were \$21,431 (median, \$7,652; range, \$0 to \$125,328), and mean earnings per start after surgery were \$1,719 (median, \$1,026; range, \$0 to \$6,980). When a plot of the residuals versus predicted values for postoperative earnings and earnings per start was performed, the variances were unequal and the data were normalized via log transformation and reanalyzed. Therefore, comparisons of postoperative earnings and earnings per start for the independent variables were reported as the results of the analysis of the transformed data; however, values for mean and SE were calculated from raw data. Postoperative performance index calculations were possible for 13 horses that returned to racing in at least 3 starts; the mean performance index for those horses was 4.6 (median, 4.8; range, 2 to 7.2). When pre- and postoperative performance index values for those horses were compared, the mean change in performance index was -2.8 (median, -2.4 ; range, -8.2 to 2). The mean number of postoperative starts for horses that returned to racing was 9.1 (median, 5.5 starts; range, 1 to 29 starts). For horses that did return to racing, mean time before returning to race from the date of surgery was 7.6 months (median, 7.5 months; range, 3.75 to 11.75 months).

Results concerning outcome and horse variables were summarized (Table 1). Significant associations were observed between sex and outcome, with geldings more likely ($P < 0.001$) to return to racing (≥ 5 starts) after surgery, compared with males or females. Geldings also had a significantly ($P < 0.001$) greater number of starts after surgery than females or males. Earnings after surgery were significantly ($P < 0.001$) higher for geldings than for males or females, as were earnings per start ($P = 0.001$). Of the primary lesion sites examined, only slab fractures of C3 were significantly associated with outcome. Of the 6 horses with slab fractures of C3, none returned to racing; therefore, horses with lesions at that site were significantly ($P = 0.003$) less likely to return to racing than horses with lesions at other sites.

Number of palmar osteochondral fragments and outcome were significantly associated. When compared with horses with 1 palmar fragment, horses with

Table 1—Outcome values (mean \pm SE) for horses with palmar carpal osteochondral fragments.

Variable	No. of horses	No. RTR-5	No. of starts	Total earnings after surgery (\$)	Earnings/start (\$)	PI
Sex						
Male	10	2 ^a	2.0 \pm 0.9 ^a	4,008 \pm 2,700 ^a	716 \pm 448 ^a	5.9 \pm 0.8 ^a
Female	17	4 ^a	3.4 \pm 1.8 ^a	2,607 \pm 1,085 ^a	470 \pm 170 ^a	3.5 \pm 1.5 ^a
Gelding	4	4 ^b	18.8 \pm 2.5 ^b	67,278 \pm 29,751 ^b	3,564 \pm 1,509 ^b	5.4 \pm 0.9 ^b
No. of palmar fragments						
1	11	5 ^a	8.7 \pm 3.2 ^a	32,549 \pm 16,525 ^a	2,223 \pm 849 ^a	5.7 \pm 0.6 ^a
2	2	1 ^a	6.0 \pm 0 ^a	8,229 \pm 0 ^{a,b}	1,372 \pm 0 ^{a,b}	6.2 \pm 0 ^{a,b}
Multiple	18	4 ^a	3.4 \pm 1.7 ^a	2,318 \pm 982 ^b	340 \pm 109 ^b	3.2 \pm 0.5 ^b
Palmar fragment size (grade)						
1	16	2 ^b	1.3 \pm 0.5 ^b	994 \pm 501 ^b	245 \pm 111 ^b	3.3 \pm 0.6 ^a
2	5	3 ^a	7.8 \pm 4.3 ^{a,b}	13,409 \pm 4,939 ^{a,b}	1,760 \pm 783 ^{a,b}	5.5 \pm 1.0 ^a
3	7	3 ^a	13.8 \pm 5.6 ^a	30,690 \pm 23,798 ^a	1,638 \pm 900 ^a	4.5 \pm 1.1 ^a
4	3	2 ^a	8.3 \pm 5.6 ^{a,b}	39,968 \pm 35,932 ^{a,b}	2,784 \pm 2,135 ^{a,b}	6.3 \pm 0.1 ^a
MPICL damage						
Yes	13	1 ^a	2.9 \pm 2.4 ^a	1,195 \pm 1,082 ^b	111 \pm 69 ^b	2.1 \pm 0.1 ^a
No	3	2 ^a	4.7 \pm 0.9 ^a	7,613 \pm 2,387 ^a	1,612 \pm 394 ^a	3.9 \pm 0.9 ^a
Palmar fragments removed						
Yes	13	5 ^a	7.5 \pm 2.9 ^b	26,491 \pm 13,971 ^b	1,690 \pm 739 ^a	5.7 \pm 0.8 ^a
No	18	5 ^a	3.8 \pm 1.7 ^a	3,029 \pm 1,064 ^a	524 \pm 168 ^a	3.9 \pm 0.6 ^a

RTR-5 = Returned to racing and had 5 or more starts. PI = Performance index.¹⁶ MPICL = Medial palmar intercarpal ligament.
^{a,b}Superscript letters represent values that were significantly ($P < 0.05$) different within a variable category.

multiple fragments had lower total earnings ($P = 0.047$) and earnings per start ($P = 0.017$) after surgery. Horses with multiple fragments also had significantly ($P = 0.019$) lower postoperative performance index values than those with 1 fragment. A significant association was also found between fragment size and outcome. Horses with smaller fragments (grade 1) were less likely to return to racing (≥ 5 starts; $P = 0.014$) or to earn money after surgery ($P = 0.010$), compared with horses with larger palmar fragments (ie, grades 2, 3, and 4). Those horses were less likely to return to racing (1 start), but the difference was not significant ($P = 0.060$). The number of starts after surgery for horses with grade 1 fragments was significantly ($P = 0.009$) less than that for horses with grade 3 fragments. Horses with grade 1 fragments also earned significantly less total money ($P = 0.010$) and money per start ($P = 0.016$) after surgery than those with grade 3 fragments.

A significant association between grade of articular cartilage damage and return to racing (1 start) was observed. More (6/6) horses with grade 3 damage returned to racing than did horses with grades 1, 2, and 4 articular cartilage damage (0/1, 4/10, and 2/5, respectively; $P = 0.037$). An association between medial palmar intercarpal ligament damage and outcome was also observed; horses with ligament damage were significantly ($P = 0.044$) less likely to earn money after return to racing than horses without damage to that ligament. Horses with medial palmar intercarpal ligament damage were less likely to return to racing, but the differences were not significant (1 start, $P = 0.077$; ≥ 5 starts, $P = 0.081$). Horses with medial palmar intercarpal ligament damage had significantly less total earnings and earnings ($P = 0.005$) per start ($P = 0.003$) after surgery than those without damage to the liga-

ment. Only 1 horse with medial palmar intercarpal ligament damage (any grade) returned to racing (≥ 5 starts), and none of the horses with grade 4 ligament damage returned to racing (1 start). All horses with no medial palmar intercarpal ligament damage returned to racing (1 start).

Horses in which the palmar osteochondral fragments were removed had a significantly ($P = 0.019$) greater number of starts after surgery than those that did not undergo surgery; they also had significantly ($P = 0.046$) higher earnings after surgery than those that did not. However, when palmar osteochondral fragment size was further consolidated into categories of < 3 mm or ≥ 3 mm, significantly more horses with fragments ≥ 3 mm had surgery to remove the fragments ($P = 0.032$), and horses with palmar fragments ≥ 3 mm were significantly more likely to return to racing (1 start, $P = 0.024$; ≥ 5 starts, $P = 0.005$) and to earn money after returning to racing ($P = 0.009$).

Discussion

Results support the hypothesis that horses with palmar carpal osteochondral fragments in addition to osteochondral fragments in the dorsal aspect of the carpus have a poorer prognosis for returning to racing and racing successfully than horses with only dorsally located fragments. Previous studies^{6,7,12,17} have revealed that 74% to 88% of horses undergoing carpal arthroscopic surgery for removal of dorsal osteochondral fragments will return to racing, with approximately 68% of those horses performing successfully (ie, at or above their previous level of performance) after surgery.⁶ Although primary lesions involving the dorsal aspect of the carpus were evaluated in those studies, to the authors' knowledge, the effects of palmar carpal

osteocondral fragments have not been evaluated. Overall, 51.6% of the horses in the present study returned to racing (1 start), and 48% earned money after surgery. Additionally, only 32% of the horses in this study went on to start in 5 starts after surgery, with a mean change in performance index of -2.8 .

The most likely reason why horses in the present study had a poor prognosis for return to racing, compared with horses with only dorsal carpal osteochondral fragments, is that fragments in the palmar aspect of the joint are indicators of chronic, diffuse articular damage. The prognosis for horses with carpal osteochondral fragments is dependent on the extent of articular damage at the time of surgery. In a previous report⁶ in which investigators used the same grading scale as was used in the present study, 74% of horses undergoing carpal arthroscopic surgery had mild to moderate (ie, grade 1 or 2) articular damage, whereas only 26% of horses had moderate to severe damage (grade 3 or 4). In that study, 72% to 75% of horses with grade 1 or 2 damage successfully returned to racing, whereas only 53% to 54% of those with grade 3 or 4 damage raced successfully. Horses in the present study had proportionately greater articular damage than has been previously reported, with 52% having grade 1 or 2 damage and 48% having grade 3 or 4 damage. This suggests that horses with palmar carpal fragments have more severe articular damage than horses with other types of carpal osteochondral fractures, a finding that could explain their poorer prognosis for successfully returning to racing.

Another possible reason for the poor prognosis in horses in the present study is that the palmar osteochondral fragments were removed in only 42% of the cases. Although there was no significant difference in the grade of articular cartilage damage between horses that had the fragments removed and those that did not have fragments removed at the time of surgery, the continued presence of the fragments in the latter group could have increased the inflammation and cartilage damage in the palmar aspect of those joints. The decision to remove the fragments was made largely on the basis of the size of the fragment, and there was a positive association between having the fragment removed and large fragment size. Surgeon preference also played a role in the decision, with some clinicians opting to not remove smaller fragments because of their uncertain clinical significance and the supposition that small fragments would be hard to find and remove. Horses in which palmar fragments were removed had more starts and higher earnings after surgery than those in which fragments were not removed. However, it is difficult to determine whether removal of the fragment was the cause of the more successful outcome in those horses or whether fragment size was a more important factor. Arthroscopic approaches to the palmar aspect of the carpus have been described,^{9c} and further discussion of the surgical technique is beyond the scope of this report; however, the greater success of horses that underwent surgical removal of the fragments suggests that palmar carpal fragments should be removed when possible.

Most horses in this study were 2 to 3 years old, and the most common lesion sites were the distal and dor-

sal aspects of the RCB and proximal and dorsal aspect of C3. That signalment and distribution of primary lesion sites were similar to those reported in other studies^{3-6,10,12} of horses with carpal osteochondral fragments; it is therefore unlikely that those factors contributed to the poorer outcome in the present study. Another possibility for the less favorable outcome in the present study is that fragments in the MCJ are reportedly associated with a poorer prognosis for successful return to racing than those in the ACJ^{1,10,12} and 81% of the horses in the present study had fragments in the MCJ. However, fragments in the MCJ were more common than those in the ACJ in all previous studies^{3-6,10,12} of carpal osteochondral fragments, and there was no significant difference between horses with lesions in the ACJ versus MCJ in any of the outcome variables analyzed in our study.

Slab fractures of C3 have been associated with the worst prognosis of all common carpal osteochondral fractures in racehorses,^{6,10,12} and 6 (19%) horses in the present study had C3 slab fractures, which may have contributed to the poor outcome. However, in 2 retrospective studies^{14,18} in which C3 slab fractures were investigated, 65% to 77% of those horses resumed racing, whereas none of the horses with C3 slab fractures in the present study returned to racing. This finding may have resulted from the sex distribution of the horses with slab fractures of C3 in the present study. Although no significant association between sex and C3 slab fracture was observed, 4 of the 6 horses with slab fractures were females and the other 2 horses were sexually intact males. Females were less likely to return to racing than males or geldings in other studies^{14,18} of C3 slab fractures, and information in the records of 2 of the females in the present study indicated that they were intended to become broodmares after surgery. The other 2 females were 4 years old at the time of surgery, and it is likely that they were also retired for breeding purposes. Females and sexually intact males are less likely to return to racing than geldings after undergoing orthopedic surgery,^{19,20} and because there were no geldings with slab fractures of C3 in the present study, it is likely that sex influenced outcome results. It is also possible that the horses with slab fractures of C3 in this study had more severe fractures than what has previously been described; 4 of the 6 horses with C3 slab fractures in the present study had a fracture of both the radial and intermediate facet, and the other 2 horses had fractures of the radial facet only. Other studies^{13,14} of C3 slab fractures have revealed that fractures of the radial facet are the most common fracture type. Additionally, size of the fracture fragment and degree of displacement at the fracture site were larger in horses in the present study than those that have been described previously and may have contributed to the poorer outcome. Horses in the present study had a mean fracture depth of 15 mm, a mean fracture width of 81% of the total width of C3, and a mean fracture gap of 1.9 mm, compared with values of 8 mm, 45%, and 1.7 mm, respectively, reported in an earlier study.¹⁴ In another study,¹⁸ horses with larger slab fractures were found to be less likely to return to racing; therefore, the size of fractures in horses of the present study may have influenced outcome.

In horses in which the medial palmar intercarpal ligament was evaluated in the present study, 81% had damage to the ligament and damage involving that ligament was associated with a poor outcome. Injury of the medial palmar intercarpal ligament as a cause of lameness has been described,^{15,21-23} and it has been suggested that horses with grade 3 or 4 damage have a decreased chance for successful return to racing.^{15,21-23} It is possible that proportionately more horses in the present study had damage to the ligament, contributing to the overall poor prognosis for these horses, compared with horses in other studies. However, the reported incidence of medial palmar intercarpal ligament damage in racehorses is variable, with some degree of damage detected in 9% to 70% of horses undergoing carpal arthroscopic surgery,^{15,21,23,24} making it difficult to draw conclusions about the actual contribution of ligament damage to outcome in this study.

An association was found between number of palmar osteochondral fragments and fragment size; when multiple fragments were detected, fragments were often < 3 mm in diameter. The prognosis for horses with these types of fragments was significantly worse than for horses with 1 or 2 large fragments. Horses with multiple small fragments had fewer starts, lower performance index values, less earnings, and less money earned per start after surgery than horses with 1 or 2 large fragments. One explanation for this finding is that smaller fragments could originate from larger fragments in the dorsal aspect of the joint that subsequently fragment into smaller pieces upon further training or racing, eventually migrating to the palmar aspect of the joint. This is supported by the fact that horses with the largest dorsal lesions in the present study were significantly more likely to have the smallest palmar fragments, whereas horses with lesions involving only the proximal aspect of the RCB were more likely to have large single palmar fragments. In horses with large dorsal lesions, cartilage and bone debris from breakdown of the fragments would cause release of inflammatory mediators, inducing synovitis and contributing to articular cartilage degeneration.²⁵ The small palmar fragments, therefore, are likely indicators of chronic ongoing damage to the dorsal aspect of the joint and may explain why horses with smaller palmar fragments had a poorer outcome than horses with larger palmar fragments. In contrast, the presence of 1 or 2 large palmar fragments may represent a more acute injury—horses with only proximal lesions of the RCB were more likely to have grade 1 articular cartilage damage than grades 2 to 4 cartilage damage. Although not significant, horses with only palmarly located primary lesions had less severe articular cartilage damage than horses with dorsally located lesions. This could also explain why horses with 1 or 2 larger palmar fragments had a better outcome than horses with multiple smaller palmar fragments.

One limitation of the present study was low statistical power, which may have accounted for some of the unexpected results obtained. Horses with grade 3 articular damage were more likely to return to racing (1 start) than those with other grades of damage; howev-

er, there were only 3 horses with grade 1 damage in the study, and information pertaining to articular damage grade was not available for 9 others. Therefore, most horses in this study had either moderate-to-severe articular damage or the grade of damage was unknown. It seems unlikely that horses with moderate articular damage would perform better than those with less damage, and it is possible that these results are the result of a type II statistical error. The same may be true for the finding that females were more likely to have multiple osteochondral fragments than sexually intact males or geldings. There were more females (17) than males (10) or geldings (4) in the present study, which may have contributed to this result. This may also have altered the sex-related outcome results, in which geldings were more likely to return to racing (≥ 5 starts), had a greater number of starts, and earned more money after surgery than males or females. However, it is known that sex can be a confounding factor when outcome variables such as ours are used, because many females and sexually intact males are retired for breeding purposes after an injury.^{19,20,26}

Outcome variables used in the present study were chosen on the basis that a successful outcome after surgery for a racehorse would include returning to racing at or above the previous performance level and earning money. However, because female and sexually intact male horses may be retired without an attempt to return them to racing because of their value as breeding animals, these methods of assessing outcome have limitations. It can also be difficult to determine if a horse has returned to racing at its previous performance level because horses often drop in class of race and have decreased earnings as they age, which can be a confounding factor for the outcome variables analyzed.²⁶ By examining the performance index of horses before and after surgery, more variables relating to horses' performance were incorporated into the determination of outcome, but because not all horses had started in 3 races before and after surgery, this information was not available in every case. Finally, there were limitations in comparing results from the present study with those derived from horses undergoing carpal arthroscopic surgery. Differences in variables such as populations of horses, trainers, and surgeons may have accounted for some of the differences in outcome in the present study. However, 2 of the studies^{7,14} with which we compared results were performed by investigators at our hospital, and results of studies from other hospitals were comparable to results of those 2 studies.

Results suggest that palmar carpal osteochondral fragments can be used as prognostic indicators in racehorses. Radiographs of the carpus should be evaluated carefully for multiple small (< 3 mm in diameter) palmar osteochondral fragments; horses with such fragments are less likely to successfully return to racing than horses with only dorsally located fragments or horses with 1 or 2 large palmar fragments. In addition, horses with small fragments are likely to have substantial pathologic changes in the dorsal aspect of the affected carpal joint. Palmar carpal osteochondral fragments should be removed when possible.

- a. Bloodstock Research Information Service Inc, Lexington, Ky.
- b. US Trotting Association, Columbus, Ohio.
- c. PROC FREQ, Statistical Analysis System, SAS Institute Inc, Cary, NC.
- d. PROC ANOVA, Statistical Analysis System, SAS Institute Inc, Cary, NC.
- e. Cheetham J, Nixon AJ. Arthroscopic approaches to the palmar aspects of the midcarpal and antebrachio-carpal joints of the horse (abstr), in *Proceedings. 14th Annu Meet Am College Vet Surg* 2004;E5.

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