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Advances in Equine Nutrition

Volume III

Edited by

J.D. Pagan

THE PREVALENCE OF RADIOGRAPHIC CHANGES IN THOROUGHBRED YEARLINGS AND THE EFFECT OF THOSE CHANGES ON FUTURE RACING PERFORMANCE

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Introduction

Radiographic examination of Thoroughbreds at the time of the yearling sales is common practice in the U.S. Although it is generally accepted that most yearlings have some radiographic changes (judged as normal variation or otherwise), there are few data to estimate the prevalence of these changes in Thoroughbred yearlings at the time of the sales. Howard et al. reported on the occurrence of radiographic abnormalities in 582 yearlings offered for sale during a six-year period (1992). They reported that fore and hind fetlocks were most commonly affected followed by the tarsi, stifles, feet, and carpi. McIntosh et al. followed the development of over 300 yearlings and documented the occurrence of femoropatellar osteochondrosis (1993). The occurrence of selected radiographic changes in clinically normal young horses of other breeds has been investigated in several studies (Sandgren, 1988; Hardy et al., 1991; Carlsten et al., 1993; Sandgren et al., 1993; Grondahl et al., 1994; Grondahl and Engeland, 1995; Jorgensen et al., 1997; Valentino et al., 1999). A better understanding of the prevalence of radiographic changes in Thoroughbred yearlings at the time of sales will help practitioners and researchers focus their work on the most commonly affected sites. These data will also help practitioners that may need further investigation for the complete evaluation of a sale yearling.

The objective of this portion of the Yearling Radiographic Study was to describe the distribution of radiographic changes in yearlings sold at Keeneland and Fasig-Tipton July and September sales from 1993-1996. Changes that tend to be bilateral or biaxial are noted.

Materials and Methods

Radiographs from 1162 pre- and post-sale purchase examinations conducted at the 1993-1996 Keeneland and Fasig-Tipton yearling sales were obtained from a private practice (Morehead) serving buyers and consignors at these sales. Joint examinations included fore fetlocks (DP, flexed LM, DLPMO, and DMPLO views), hind fetlocks (DP, LM, DLPMO, and DMPLO views), carpi (LM, DLPMO, and

DMPLO views), tarsi (DP, DLPMO, and DMPLO views), stifles (LM view), and forefeet (DP and LM views). Joint series with missing or non-diagnostic films for any view of a left and right pair were not included in the analysis.

All of the films were evaluated independently by two authors (Kane and Rantanen) and radiographic changes present were categorized by location and type of lesion (e.g., flattening, lucency, fragment, etc.). Discrepancies between these two interpretations were resolved using a third assessment (Park) and the consensus opinion to decide the final categorization of changes. Yearlings were then classified as having a radiographic change if they were present in either the left or right limb. If both limbs were affected, the higher (more severe) category was used to classify the horse.

Fore fetlocks and proximal sesamoid bones were analyzed separately from hind fetlocks and sesamoid bones. Linear defects in the proximal sesamoid bones, discussed here as vascular channels, were categorized as regular (≤ 2 mm in width with parallel sides) or irregular (> 2 mm in width or having nonparallel sides) based on their size and shape. Often a vascular channel ≤ 2 mm in width had parallel sides until it widened into a "V" shape 3-4 mm from the abaxial surface. These were categorized as irregular. Radiopaque "flakes" < 1 mm in size with no corresponding defect associated in a joint margin were not categorized as fragments in any joint. Articular fragments must have had a visible defect in the corresponding joint margin or joint surface. The diameter of subchondral cysts was recorded. Cysts were defined as any lucent areas that extended through the subchondral bone. Flat regions were recorded on several joint surfaces (e.g., condyles or sagittal ridge of the distal third metacarpus, lateral and medial trochlea of the talus, etc.). These areas had to have good radiographic alignment to be categorized as flat because obliquity often makes two partially superimposed curved surfaces seem flattened. Osteophytes in the carpus were measured; in other joints their presence was simply recorded as yes/no. Unless otherwise indicated, percentages reported here are the number of affected yearlings/number of yearlings examined.

Results

The 1162 yearlings included in the study represented 7% of all yearlings sold at the same sales during this time. Six hundred seventy-three (58%) were colts and 489 (42%) were fillies. Most (1074, 92%) of the yearlings were actually sold with only 80 (7%) not reaching their reserve price and eight (1%) being withdrawn prior to entering the sale ring. The typical price of yearlings included in this study (median $40,000; mean $70,474 ± 2584 SEM) was higher than for all other yearlings sold at the same sales but not included in the study (median $20,000; mean $45,596 ± 676).

There were 1127 fore fetlock, 1102 hind fetlock, 1130 carpal, 1101 tarsal, 660 stifle, and 300 forefeet series that were complete and included in the analyses.

FORE FETLOCKS AND PROXIMAL SESAMOID BONES

Proximal dorsal P1 fragments were present in 18 (1.6%) yearlings and were usually unilateral. Unilateral proximal palmar P1 fragments were found in five (0.5%) yearlings (1 articular, 4 non-articular). Distal third metacarpal or proximal P1 cysts were found in eight (0.7%) yearlings, one of which had bilateral cysts. Three of the cysts recorded were 5 mm in diameter; the others were 2, 6, 7, 10, and 11 mm in diameter. Changes were recorded in the distal dorsal region of the third metacarpus (includes proximal third of the dorsal sagittal ridge) in 380 (33.8%) yearlings. Most of these were a semicircular notch with a well-defined border at the proximal aspect of the dorsal sagittal ridge. Often bilateral, these are usually about 3 mm across (this is often regarded as a "normal" change). However, 22 yearlings (2.0%) had an irregularly shaped lucency (Type I lesion) in this location that was often bilateral (McIlwraith and Vorhees, 1991). Eight horses (0.7%) had fragments (Type II lesion) and one horse (0.1%) had a loose body (Type III lesion) in this location (McIlwraith and Vorhees, 1991). These lesions were all unilateral. Flattening of the distal sagittal ridge of the third metacarpus was noted in 110 (9.8%) yearlings and a lucency was recorded in this location on 196 (17.4%). The lucencies were visible on the DP and/or LM views and were most often bilateral. Flattening of the distal palmar third metacarpus condyles was present in 461 (40.9%) yearlings, but lucencies in this location (often referred to as palmar metacarpal disease or traumatic osteochondrosis) (Pool and Meagher, 1990) were only found in four horses (0.4%). Palmar supracondylar lysis (Pool and Meagher, 1990) of the third metacarpus was present in 54 (4.8%) yearlings with 30 (2.7%) classified as slight and 24 (2.1%) as moderate or extreme. These changes were also usually bilateral. All of the radiographic changes that tended to be unilateral in the fore fetlocks seemed equally distributed between left and right limbs.

Twenty-nine (2.6%) yearlings had elongated proximal sesamoid bones on the forelimbs. Elongation was defined as a greater than 2 mm difference in length between biaxial sesamoids in an attempt to account for the lateral sesamoid which tends to be slightly longer than the medial. Still, elongation of the lateral sesamoid was recorded slightly more frequently than elongation of the medial sesamoid. Independent of sesamoid length, abnormally shaped (proximal, distal, abaxial, or overall enlargement) fore sesamoids were recorded for 34 (3.0%) yearlings and were found almost twice as often on the medial sesamoid compared with the lateral. Forelimb sesamoid fractures (apical, abaxial, basal) were found in 11 (1.0%) yearlings. Only one fracture was of a lateral sesamoid, and two yearlings had bilateral medial sesamoid fractures. Osteophytes were not recorded on any fore sesamoids; however, enthesophytes at the attachments of the suspensory or distal sesamoidean ligaments to the proximal sesamoid bones were recorded on 14 (1.2%) yearlings. Circular lucencies in the sesamoids were found in 164 (14.6%)

yearlings. These were usually only found in one fore sesamoid per animal and were almost twice as common on the medial sesamoid compared with the lateral.

Less than half of all the fore proximal sesamoid bones examined had regular vascular channels and less than 10% had more than three. Regular vascular channels were evenly distributed between limbs and between biaxial pairs of sesamoids. More than half of the fore proximal sesamoid bones examined had irregular vascular channels. (Note that regular and irregular here refers to size and shape, not how frequently the changes occur.) Irregular vascular channels were more common in the medial sesamoid bone. Overall, 26 (2.3%) yearlings were categorized as not having vascular channels in a fore sesamoid, because most had at least one vascular channel in at least one sesamoid.

HIND FETLOCKS AND PROXIMAL SESAMOID BONES

Proximal dorsal P1 fragments were most common on the hind limbs compared with the forelimbs. Thirty-six (3.3%) yearlings had these fragments, and one yearling had bilateral fragments in this location. Proximal plantar fragments were also more common on the hind limbs. Sixty-five yearlings (5.9%) were affected; 20 (1.8%) had non-articular fragments and 45 (4.1%) had articular fragments. Four yearlings had bilateral proximal plantar P1 fragments (2 non-articular and 2 articular). Only two (0.2%) yearlings had distal third metatarsal or proximal P1 cysts in the hind fetlocks. Three hundred thirty-four (30%) yearlings had some changes in the distal dorsal region of the third metatarsus (includes proximal third of the dorsal sagittal ridge). A semicircular notch was noted in 299 (27.1%) yearlings and was often bilateral. Nineteen (1.7%) yearlings had an irregularly shaped lucency (Type I lesion) in this location which was bilateral in four individuals. Twelve (1.1%) yearlings had fragments (2 bilateral, Type II lesion) and four (0.4%) had a loose body (all unilateral, Type III lesion) in this location. In contrast to the third metacarpus, only 20 (1.8%) yearlings had changes in the sagittal ridge of the distal third metatarsus. Two (0.2%) had flattening and 18 (1.6%) had a lucency at this location. Most of these changes were unilateral. Flattening on the distal palmar third metatarsus was found on 71 (6.4%) yearlings examined and one had a lucency in this location. Palmar supracondylar lysis of the distal third metatarsus was not found in any of the yearlings examined.

Elongation of a hind proximal sesamoid was found in eight (0.7%) yearlings and abnormally shaped hind sesamoids were present in 23 yearlings (2.1%). Elongated sesamoids were evenly distributed between left/right and lateral/medial pairs, but medial sesamoids were abnormally shaped more often than lateral sesamoids. Thirty-two (2.9%) yearlings had hind proximal sesamoid fractures. There were 16 fractures of a lateral sesamoid (15 apical and 1 basal) and 24 fractures of a medial sesamoid. In the medial sesamoid 18 apical fractures were recorded with three basal, one abaxial, and two comminuted fractures also recorded. Osteophytes on a hind sesamoid were only found in three (0.3%) yearlings and

usually affected more than one hind sesamoid. Enthesophytes were found at the attachments of the suspensory or distal sesamoidean ligaments in 14 (1.3%) yearlings. Circular lucencies in a hind sesamoid were found in 172 (15.6%) yearlings and were more common on the medial sesamoid. Most of those affected had one circular lucency (149, 13.5%) but 21 yearlings (1.9%) had two and two (0.2%) yearlings had three.

Seventy-seven (7.0%) yearlings were categorized as not having any vascular channels in a hind sesamoid. Most had at least one vascular channel in at least one sesamoid. Less than 30% of all hind proximal sesamoid bones examined had regular vascular channels and less than 1% had more than three. Regular vascular channels were evenly distributed between limbs and between biaxial pairs of sesamoids. Irregular vascular channels were found on more than half of the hind proximal sesamoid bones examined. Irregular vascular channels were slightly less common in the medial sesamoid bone.

CARPI

Dorsal medial intercarpal joint disease (characterized by rounded appearance to the radial carpal bone and/or thickened dorsal cortex, proliferative change, enthesophyte, or fragment involving the radial carpal or third carpal bones) was found in 30 (2.7%) of the yearlings examined. These changes were most often unilateral and affected left and right limbs equally. Palmar lucencies in the ulnar carpal bone were detected in 227 (20.1%) yearlings, were usually unilateral, and affected left and right limbs equally. Nine (0.8%) yearlings had carpal fragments that ranged in size from 2 to 10 mm. Nineteen (1.7%) had carpal osteophytes ranging in size from 1 to 4 mm, and three (0.3%) had subchondral cysts in a carpal bone ranging in size from 4 to 10 mm. Carpal fragments, osteophytes, and subchondral bone cysts tended to be evenly distributed between left and right limbs. Accessory carpal fractures affected four (0.4%) yearlings.

HOCKS

Five (0.5%) yearlings had articular lucent areas in the medial malleolus. Fragments or concavities of the distal intermediate ridge of the tibia were found in 48 (4.4%) yearlings and were evenly distributed between left and right limbs. Most of the intermediate ridge lesions were unilateral. One yearling had a flattened lateral trochlear ridge of the talus and 14 (1.3%) had lucencies and/or fragmentation in this location. Flattening of the medial trochlear ridge was more common (12 yearlings, 1.1%), but only seven (0.6%) yearlings had lucencies or fragments on the medial trochlear ridge. “Dewdrop lesions” on the distal medial trochlear ridge were found on 39 (3.5%) of the yearlings examined, and fragments at this location were found in eight (0.7%) yearlings. Osteophytes or enthesophytes at the distal intertarsal or tarsal metatarsal joint margins were found in 80 (7.3%) yearlings.

Wedging or collapse of a distal tarsal bone was present in 13 (1.2%) of the yearlings examined and was usually unilateral.

STIFLES

Thirty-eight (5.8%) yearlings had changes on the lateral trochlear ridge of the femur. Flattening was present in four (0.6%) yearlings and lucencies and/or fragmentation were detected in 34 yearlings (5.1%). Two (0.3%) yearlings had a lucent area with or without a fragment on the medial trochlear ridge. These femoral trochlear ridge lesions tended to be unilateral but also occurred bilaterally. One (0.2%) yearling had a lucent area in the trochlear groove of the femoropatellar joint, two (0.3%) had lucencies in the patella, and one (0.2%) had fragmentation of the distal patella. The medial femoral condyle and proximal tibia could only be visualized in 170 yearlings. No subchondral cysts were detected in these animals.

FOREFEET

Signs of pedal osteitis (proliferation on the dorsal surface of P3, remodeling of the tip of P3) were detected in 33 (11%) of the yearlings with radiographs of the forefeet. Other changes in the forefeet were found in 45 (15%) yearlings. These included 18 (6%) animals with prominent synovial fossae in the navicular bone, 15 (5%) with palmar process fragments, two (0.6%) with spurs on the extensor process of P3, and one (0.3%) with an extensor process fragment.

Discussion

Most yearlings examined in this study had some radiographic changes noted in the fetlocks, proximal sesamoid bones, carpi, tarsi, stifles, or forefeet. Some of the changes recorded are commonly thought to be incidental findings. They were included in this survey for a complete and unbiased assessment of what a practitioner can expect to find when reviewing sale radiographs.

Comparison of the prevalence of changes found in this study with other published work is difficult. Most studies have grouped many specific changes under one broad diagnosis (e.g., OCD of the fetlock). In this study we have kept as much detail as possible in the classification system used to categorize each horse. Another survey of Thoroughbred yearlings in central Kentucky by Howard et al. (1992) used the number of joints examined as a denominator without accounting for the number of horses (e.g., number of fetlocks diagnosed with OCD/number of fore fetlocks examined). Because of this and the rarity of most specific changes, comparison between these studies should be interpreted with caution. Apical fractures of the fore proximal sesamoid (2/2254 joints examined in this study vs.

5/1018 in Howard et al.) seem less common in this study. Proximal dorsal P1 fractures in the hind fetlocks (37/2204 joints examined in this study vs. 24/700 in Howard et al.), and medial malleolus lesions in the tarsi (5/2202 joints examined in this study vs. 5/710 in Howard et al.) all seem to be less common in this study. On the other hand, osteophytes at the joint margins of the distal intertarsal and tarsometatarsal joints (263/2202 joints examined in this study vs. 16/710 in Howard et al.) seem more common in this study. It is unlikely that the differences noted above would be statistically significant if appropriate variance estimates could be included.

Most of the specific radiographic changes observed in this study are rare. This presents unique challenges to clinicians and researchers trying to identify changes that are clinically significant. With thousands of Thoroughbred yearlings sold at auction every year in this country alone, however, even rare changes can present a problem for the sale veterinarian. This study provides data that can be used by researchers and clinicians to help focus their efforts on the most common problem areas and identify yearlings with unusual radiographic changes that may need further investigation.

The Effect of Radiographic Changes in Thoroughbred Yearlings on Future Racing Performance

Radiographic changes found at the time of Thoroughbred yearling sales have a substantial impact on the sale process but can be difficult to interpret. Consignors want to sell their yearlings at a fair market price, and buyers want to identify yearlings with orthopedic problems that are likely to influence future racing performance so new purchases have every chance of reaching their full potential. The sale veterinarian is often asked to identify radiographic changes that could be a future problem without unjustifiably declaring a horse unsuitable for purchase.

There are several reports describing the influence of radiographic changes on future racing performance in Standardbreds. However, comparable information is limited in Thoroughbreds. Spike et al. reported significantly fewer starts and lower total earnings for horses with more than two abnormally shaped linear defects in a proximal sesamoid bone. Most of the interpretation of yearling sale films is still based on clinical experience of the practitioner with horses that have shown clinical signs or required surgery when in race training.

The objectives of this historical cohort study were to identify radiographic changes in the fetlocks, proximal sesamoid bones, carpi, stifles, tarsi, or forefeet of Thoroughbred sales yearlings that are associated with future racing performance; the occurrence of orthopedic problems; and the need for surgery. This abstract is focused on identifying the radiographic changes in Thoroughbred yearlings that are associated with the likelihood of starting at least one race during the two- or three-year-old years.

Materials and Methods

Radiographs from 1162 pre- and post-sale purchase examinations conducted at the 1993-1996 Keeneland and Fasig-Tipton yearling sales were obtained from a private practice (Morehead) serving buyers and consignors at these sales. Joint examinations included fore fetlocks (DP, flexed LM, DLPMO, and DMPLO views), hind fetlocks (DP, LM, DLPMO, and DMPLO views), carpi (LM, DLPMO, and DMPLO views), tarsi (DP, DLPMO, and DMPLO views), stifles (LM view), and forefeet (DP and LM views). Joint series with missing or non-diagnostic films for any view of a left and right pair were not included in the analysis.

All of the films were evaluated independently by two authors (Kane and Rantanen) in a blinded manner and radiographic changes present were categorized by location and type of lesion (e.g., flattening, lucency, fragment, etc.). Discrepancies between these two interpretations were resolved using a third assessment (Park) and the consensus opinion to decide the final categorization of changes. Yearlings were then classified as having a radiographic change if they were present in either the left or right limb. If both limbs were affected, the higher (more severe) category was used to classify the horse. For variables related to vascular channels in the proximal sesamoid bones, the sesamoid with the highest total number of vascular channels (the "worst" sesamoid) was used to classify the yearling. Fore fetlocks and proximal sesamoid bones were analyzed separately from the hind fetlocks and sesamoid bones.

Racing performance data for the two- and three-year old years were obtained from The Jockey Club Information Systems for each horse included in the study. Horses without an official race record were assigned a value of zero starts. The number of race starts during the two- and three-year-old years combined was categorized as YES, the horse started at least one race, or NO, the horse did not start a race during its two- or three-year-old years. Sale price was obtained from Keeneland and Fasig-Tipton sale companies. For yearlings that did not meet their reserve price, the amount of the final bid was used. Yearlings withdrawn from the sale prior to the bidding were assigned a sale price of zero dollars.

Contingency tables were used to crosstabulate horses by radiographic variables and whether the horses started a race during the two- or three-year-old years. Values reported here are the percent of horses that started at least one race and the number of horses that started (starters) divided by the total number of horses with the same radiographic classification. Separate logistic regression models for each variable were used to obtain likelihood ratio chi-square p-values adjusted for sale price to test for an association between the presence or grade of a radiographic change and starting a race while simultaneously controlling for the potential confounding effect of sale price.

Results

The 1162 yearlings included in the study represent 7% of all yearlings sold at the same sales during this time. Six hundred seventy-three (58%) were colts and 489 (42%) were fillies. Most (1074, 92%) of the yearlings were actually sold with only 80 (7%) not reaching their reserve price and eight (1%) being withdrawn prior to entering the sale ring. The typical price of yearlings included in this study (median $40,000; mean $70,474 ± 2584 SEM) was higher than for all other yearlings sold at the same sales but not included in the study (median $20,000; mean $45,596 ± 676).

There were 1127 fore fetlock, 1102 hind fetlock, 1130 carpal, 1101 tarsal, 660 stifle, and 300 forefeet series that were complete and included in the analyses. Overall, approximately 82% of horses without radiographic changes started at least one race during their two- and three-year-old years. (This number provides a convenient reference for comparison with most of the percentages of starters among those yearlings with radiographic changes.)

FORE FETLOCKS AND PROXIMAL SESAMOID BONES

Among radiographic changes observed in the fore fetlock joints, only moderate or extreme palmar supracondylar lysis of the distal palmar third metacarpal had a significant ($p = 0.02$) effect on the likelihood of starting a race. While 878/1073 (82%) yearlings with no supracondylar lysis and 26/30 (87%) yearlings with slight supracondylar lysis started, only 14/24 (58%) with moderate or severe lesions started a race. Fourteen of 18 (78%) yearlings with proximal dorsal P1 fragments started, and all of the five yearlings with proximal palmar P1 fragments started. More than half of the yearlings with subchondral cysts (5/8, 62%) in the distal third metacarpus or proximal first phalanx started, but with this few cases this was not significantly ($p = 0.13$) different from the 913/1119 (82%) that started without cysts in this location. Size of the cysts did not appear to affect the likelihood of starting as three of the five cysts in starters were greater than 5 mm in diameter. Radiographic changes of the distal dorsal third metacarpus (includes proximal ridge of the dorsal sagittal ridge) did not have a significant effect on starting ($p = 0.28$). Compared to the percent (606/749, 81%) of yearlings with no changes at this location that started, 209/347 (84%) yearlings with a “normal” semicircular notch at the most proximal aspect of the dorsal sagittal ridge started, 15/22 (68%) of those with a lucency (Type I lesion) started, and 7/9 (78%) of those with a defect and a fragment or loose body (Type II or III lesion) started (McIlwraith and Vorhees, 1991). Changes recorded on the distal two-thirds of the dorsal sagittal ridge or metacarpal condyles or on the distal palmar sagittal ridge or condyles had little effect on the likelihood of starting a race.

Enthesophytes at the attachments of the suspensory or distal sesamoidean ligaments to the proximal sesamoid bones had a significant ($p = 0.04$) effect on the likelihood of starting a race. Only 8/14 (57%) yearlings with enthesophytes on the proximal sesamoid bones started compared with 910/1113 (82%) that started without this change. One of two yearlings (50%) with an apical fracture of a proximal sesamoid bone started while 2/3 (67%) with abaxial fractures and 5/6 (83%) with basal fractures started; however, these percentages were not significantly ($p = 0.73$) different from the percentage of starters among those without sesamoid fractures. There was no significant difference ($p > 0.4$) in the percentage of yearlings that started with elongated or abnormally shaped proximal sesamoid bones or circular lucencies in the proximal sesamoids compared with yearlings without these changes. Most yearlings in this study had two or three vascular channels (range 0-9) in the "worst" proximal sesamoid bone. No significant ($p > 0.40$) association was detected between the number of regular (≤ 2 mm and parallel sides) or irregular (> 2 mm or nonparallel sides) vascular channels or the total number of vascular channels and the likelihood of starting a race.

HIND FETLOCKS AND PROXIMAL SESAMOID BONES

Only 25/36 (69%) yearlings with proximal P1 fragments in a hind fetlock started at least one race compared with 874/1066 (82%) that started without these fragments ($p = 0.08$). Proximal plantar P1 fragments did not appear to have a significant association with starting ($p = 0.37$), with 18/20 (90%) yearlings with non-articular fragments and 34/45 (76%) yearlings with articular fragments starting. Only two horses had subchondral cysts in the distal third metatarsus or proximal first phalanx, and both started. Similar to the forelimbs, changes of the distal dorsal third metatarsus (includes proximal third of the dorsal sagittal ridge) did not have a significant ($p = 0.24$) association with starting. Compared to the 619/768 (81%) yearlings with no changes at this location that started, 254/300 (85%) of the yearlings with a "normal" semicircular notch at the most proximal aspect of the dorsal sagittal ridge started, 15/18 (83%) of those with a lucency (Type I lesion) started, and only 11/16 (69%) of those with a defect and a fragment or loose body (Type II or III lesion) started. Both of the horses with a flattened distal sagittal ridge of the third metatarsus and 13/18 (72%) horses with lucency at this location started. Changes found on the distal plantar aspect of the third metatarsus were not associated with starting. Unlike the forelimbs, supracondylar lysis of the plantar distal metatarsus was not observed on the hind limbs.

Similar to the results from the fore proximal sesamoids, a smaller percentage (9/14, 64%) of yearlings with enthesophytes on the hind sesamoid bones started compared with yearlings without this change (890/1088, 82%); however, this difference was not significant ($p = 0.13$). Yearlings with elongated or abnormally

shaped hind proximal sesamoid bones as well as those with osteophytes or circular lucencies in these bones were just as likely ($p > 0.47$) to start as those without these changes. Fracture of the hind proximal sesamoid bones did not appear to affect the likelihood of starting. Twenty-two of 26 (85%) with apical fractures started and three of four (75%) of those with basal fractures started. Abaxial and comminuted fractures were found in two horses (1 each) and both started. The number of regular and irregular vascular channels as well as the total number of vascular channels in the "worst" hind proximal sesamoid bone were not significantly ($p > 0.50$) associated with starting. In fact, 87/102 (85%) yearlings with more than four irregular vascular channels in the "worst" sesamoid started.

CARPI

Yearlings with dorsal medial intercarpal joint changes were less likely to start (19/30, 63% started, $p = 0.20$) compared with those without these changes. A smaller percentage (13/19, 68%) of yearlings with osteophytosis in the carpal joints started compared with the percentage of starters for yearlings without this change (909/1111, 82%); however, this effect was not significant ($p = 0.17$). The percentage (183/227, 81%) of yearlings starting with circular lucencies in the palmar ulnar carpal bone was nearly identical to that for horses without these lucencies (739/903, 82%, $p = 0.68$). Seven of nine (78%) of the horses with carpal fragments started; this is similar to the percent (915/1121, 82%) of starters among those without fragments. Two horses with subchondral cysts ≥ 9 mm in diameter in a carpal bone started, and one horse with a 4-mm cyst did not start. Accessory carpal bone fractures were detected in four horses, all of which started at least one race.

TARSI

Yearlings with osteophyte or enthesophyte formation at the distal intertarsal or tarsometatarsal joint margins were significantly ($p = 0.03$) less likely to start a race (147/193, 76%) compared with those without this lesion (753/908, 83%). Similarly, 61/80 (76%) yearlings with subchondral lucency in these joints started compared with 839/1021 (82%) that started without this change. The effect of subchondral lucency, however, was not significant ($p = 0.19$). Only 9/13 (69%) yearlings with wedging of the distal tarsal bones started compared with 891/1088 (82%) that started without this lesion ($p = 0.25$). Most of the tarsal wedging or collapse that was seen in these sales yearlings was slight. There were no significant ($p > 0.26$) differences in the percentage of starters for yearlings with changes of the medial malleolus, intermediate ridge of the distal tibia, or lateral or medial trochlear ridges of the talus.

STIFLES

All four yearlings with flattening of the lateral trochlear ridge of the distal femur started. However, only 24/34 (71%) with lucency, subchondral defects, and/or fragments at this location started compared with 330/387 (85%) that started without any changes in this location ($p = 0.10$). Two horses with lucency, subchondral defects, and/or fragments on the medial trochlear ridge started. One of two horses with lucency of the patella and one horse with fragmentation of the distal patella started. Subchondral cysts on the medial femoral condyle or proximal tibia were not found among the 178 yearlings where these locations could be visualized clearly on the LM view.

FOREFEET

There was no significant ($p = 0.41$) association detected between radiographic changes in the feet and the likelihood of starting a race.

Discussion

This study identified several radiographic changes in the joints of Thoroughbred yearlings that are associated with the probability of starting at least one race during the two- or three-year-old years. It should not be surprising that supracondylar lysis of the distal palmar third metacarpus was associated with decreased probability of starting a race. This lesion is recognized as a sign of chronic inflammation of the fetlock joint (Pool and Meagher, 1990) and has been associated with decreased likelihood of returning to function among a group of older horses examined at a veterinary referral center (Haynes et al., 1983). Enthesophytes are also recognized as an early manifestation of osteoarthritis (Pool, 1996). This is consistent with the results reported here, that yearlings with this lesion are less likely to start a race during their two- and three-year-old years. It is surprising that the number of vascular channels (regular, irregular, or both combined) was not associated with failure to start. A lower average number of starts has been reported for yearlings with more than two abnormal linear defects in a proximal sesamoid bone (Spike et al., 1997). There were, however, only 10 yearlings (2%) in that study that had more than two abnormally shaped linear defects compared with 366/1127 (32%) yearlings in this study. This indicates a substantial difference between the studies in how these criteria were applied. Many of the vascular channels classified as irregular in this study were 2 mm wide with parallel sides for most of their length but widened into a "V" shape 3-4 mm from the abaxial border.

A large effect on the probability of starting a race was seen with dorsal medial intercarpal joint disease (only 63% started with this lesion). These changes were characterized by a rounded appearance to the radial carpal bone and/or a thickened dorsal cortex, proliferative change, enthesophyte or fragment involving the radial

carpal or third carpal bones. All of these changes are characteristic of early osteoarthritis, so it should not be surprising that they affect the probability of starting a race. It is somewhat alarming that a radiographic change as common as osteophytosis/enthesopathy of the distal intertarsal and tarsometatarsal joint margins (affected 193/1101 [18%] yearlings overall) was significantly associated with failure to start. The magnitude of the difference in the percent of starters between those with lesions (76%) and without lesions (83%), however, was small.

A significant effect on the ability to start a race was not detected for many radiographic changes that one might expect to influence the future potential of a yearling (e.g., fore fetlock fragments and cysts, sesamoid fractures, OCD lesions of the tarsi or stifles). The reader should recognize, however, that many of these lesions are rare and affected only a few horses in the study. As a result, the ability to detect a significant effect if one truly exists (power of the study) is likely to be low for many of these comparisons.

Results of this study should be used in parallel with a clinical impression based on one's personal experience to best evaluate yearling films. As future studies confirm or refute areas of concern brought to light with this study, a greater foundation of hard evidence on which to base purchase decisions will be built. Further analysis of these and additional data on the development of orthopedic problems and the need for surgery is planned, and a clearer picture of lesions that can be considered significant in the Thoroughbred yearling will develop.

The Yearling Radiographic Study was supported by the American Association of Equine Practitioners (AAEP) with funds provided by the Keeneland Association, the Fasig-Tipton Sales Company, the Ocala Breeders Sales Company, the AAEP Foundation, Barretts Equine Limited, Blood Horse Publications, and The Jockey Club. The authors thank Fred Arnold, Gary Lavin, Jim Becht, Noah Cohen, the AAEP Research Committee, Gary Carpenter, Clay Murray, Mark Adkinson, Bruce Irwin, Donald Butte, Mike King, and the staff of Equine Medical Associates for guidance and technical support.

This paper was first published as Kane, A.J., C.W. McIlwraith, R.D. Park, N.W. Rantanen, J.P. Morehead, and L.R. Bramlage. 2000. The prevalence of radiographic changes in Thoroughbred yearlings. In: Proc. Amer. Assoc. Equine Practnr. 46:365-369, and Kane, A.J., C.W. McIlwraith, R.D. Park, N.W. Rantanen, J.P. Morehead, and L.R. Bramlage. 2000. The effect of radiographic changes in Thoroughbred yearlings on future racing performance. In: Proc. Amer. Assoc. Equine Practnr. 46:370-374.

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