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Impact of periarticular osteophytes of the distal tarsus diagnosed in nonlame yearling Standardbred horses on racing performance

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Abstract

Objective: The aim of this study was to identify the radiographic prevalence of periarticular osteophytes of the distal tarsus in nonlame yearling Standardbred horses, and to evaluate its potential impact on race performance.

Study design: Cross-sectional cohort study.

Animals: Client-owned yearling Standardbred horses ($n = 416$).

Methods: Bilateral tarsal radiographs were available from all horses for review. Osteophytes were measured on radiographs using clinical visualization software and categorized by size. Racing records were obtained from the United States Trotting Association. Regression analysis was used to determine associations between presence or size of periarticular osteophytes and performance parameters with sex and gait covariates.

Results: Of 416 Standardbred yearlings without clinical lameness, 113 (27.1%) had distal tarsal periarticular osteophytes. Regression analyses revealed few associations between the presence of periarticular osteophytes and performance parameters. Affected horses had fewer starts at 4 years of age (incident rate ratio [IRR] 0.92, $p = .01$) and fewer lifetime starts (IRR 0.95, $p = .003$), but the effect size was small. Within the affected group, osteophyte size was only associated with number of starts at 3 (IRR 0.67, $p < .0001$). Sex and gait affected many performance parameters.

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AUTHOR CONTRIBUTIONS
McCoy AM, DVM, MS, PhD, DACVS-LA: Contributed to conception and design, data acquisition, analysis and interpretation, manuscript preparation, and approved the final version of the manuscript. Scolman KN, MS: Contributed to analysis and interpretation and manuscript preparation, and approved the final version of the manuscript.

CONFLICT OF INTEREST STATEMENT
The authors declare no conflict of interest related to this report.

SUPPORTING INFORMATION
Additional supporting information can be found online in the Supporting Information section at the end of this article.

Results presented in part as a research abstract at the American College of Veterinary Surgeons Surgical Summit, Portland, Oregon, October 12–14, 2022.

Conclusion: The prevalence of distal tarsal periarticular osteophytes was similar to that in other breeds. Periarticular osteophytes of the distal tarsus appeared to be a largely incidental finding in nonlame yearling Standardbreds intended for harness racing.

Clinical significance: Distal tarsal periarticular osteophytes in young, nonlame Standardbred horses should affect racing potential only minimally. This is in contrast to reports from other disciplines.

1 | INTRODUCTION

Periarticular osteophytes are widely recognized as a radiographic hallmark of degenerative joint disease (DJD). However, in the distal tarsus, the presence of periarticular osteophytes is not strongly correlated with clinical signs of lameness.[1] Further, periarticular osteophytes of the distal tarsus have been reported in nonlame yearling horses on routine presale radiographs. Indeed, in two separate surveys of Thoroughbred yearlings, 16–31% of horses were found to have distal tarsal periarticular osteophytes on repository films prior to sale.[2,3] Similarly, 31% of yearling Quarter Horses intended for cutting were reportedly affected in another study.[4]

Little is known about the etiology or clinical significance of distal tarsal osteophytes in young horses. In the study in Quarter Horses, periarticular osteophytes of the distal intertarsal (DIT) and tarsometatarsal (TMT) joints identified on yearling films were linked to a decrease in performance at 3 and 4 years of age.[4] In Thoroughbreds, Kane et al.[2] reported that yearlings with distal tarsal osteophytes were less likely to start a race, but among starters there was no difference in performance. Association of repository film findings with performance can influence buyers’ decisions and therefore may have economic implications. However, it is unlikely that findings from the limited number of previous studies can be extrapolated across breeds and disciplines. Thus, the purpose of the present study was to identify the radiographic prevalence of periarticular osteophytes of the distal tarsus in nonlame yearling Standardbred horses intended for harness racing and to evaluate its potential impact on race performance. We hypothesized that periarticular osteophytes of the distal tarsus would negatively impact race performance and that larger osteophytes would have a more negative impact on performance than smaller osteophytes.

2 | MATERIALS AND METHODS

2.1 | Study cohort and radiographs

The study cohort included 416 Standardbred yearlings, without signs of clinical lameness, born at a single farm in the eastern USA in 2016 (n = 257) or 2017 (n = 159). Radiographs were obtained on the farm under IACUC approval (protocol #18055) and with informed owner consent during the course of an unrelated project that was focused on osteochondrosis dissecans of the tarsus. Four standard radiographic views were taken of each tarsus—dorsal-plantar, lateral, dorsomedial-plantarolateral oblique (DMPLO), and dorsolateral-plantaromedial oblique (DLPMO)—under routine physical restraint (halter, lead rope, +/− lip twitch) by trained farm personnel. Sedation (xylazine 0.3 mg/kg ± butorphanol 0.01 mg/kg IV) was administered as needed for safety at the discretion of the farm manager and attending veterinarian. Digital images were stored in the hospital repository at the University of Illinois Veterinary Teaching Hospital, where they were accessible to study personnel via commercial visualization software (Carestream solutions version 12.1.0.1059: Carestream Health, Rochester, NY, USA).

2.2 | Osteophyte measurement

Radiographs were reviewed by a board-certified large-animal surgeon (AMM) for the presence or absence of periarticular osteophytes associated with the DIT and/or TMT. When one or more osteophytes was present, they were measured by a single individual (KNS) using built-in tools within the visualization software (Carestream solutions version 12.1.0.1059: Carestream Health, Rochester, NY). The average of three measurements was used to determine osteophyte size in millimeters on each radiographic view in which an osteophyte could be distinguished. When more than one osteophyte was present, or when the osteophyte was visualized on multiple radiographic projections, the largest measurement was used for the purposes of categorization (Table 1, Figure 1) and subsequent analysis.

2.3 | Performance records

Racing records were collected from the United States Trotting Association public database and included: sire; gait; number of races started as a 2 year old, 3 year old, and 4 year old; races won and earnings at 2, 3, and 4 years of age; total seasons raced; cumulative lifetime starts, lifetime wins, and lifetime earnings; earnings per start; and fastest time recorded. Horses that started a race but did not earn any money were assigned nominal earnings of $1 to distinguish them from those that never started a race.

2.4 | Statistical analysis

Statistical analyses were performed in the R computing environment[5] using the basic “stats” package as well as the “plyr,”[6] “janitor,”[7] and “MASS”[8] packages. Descriptive performance data are reported as median (interquartile range [IQR]) and [range]. Multiple regression analyses were performed for all performance outcome variables. As there is debate regarding the “best” measure of performance in racehorses, we chose to report a variety of performance outcomes, all of which have been reported in the literature. For all models, periarticular osteophyte status was the primary predictor variable of interest but this was considered as a dichotomous (yes/no) or categorical (size category) variable depending on the individual analysis. Association with performance parameters was assessed with either linear regression (for continuous outcomes) or negative binomial regression (for count outcomes) in the entire study cohort or in only the affected individuals. Earnings ($) were log-transformed for analyses due to their strongly skewed distribution. Sex and gait were included as covariates for all analyses. Additional predictor variables were added to the models as appropriate (e.g., number of lifetime starts for the outcome variable lifetime earnings). Proportions (i.e., proportion of horses starting a race) between affected and unaffected groups were compared using a two-sample test for equality of proportions with a continuity correction. Significance was set at $p < .05$ for all analyses.

3 | RESULTS

3.1 | Prevalence of periarticular osteophytes

Of the 416 yearlings, 113 (27.1%) had periarticular osteophytes of the distal tarsus, nearly always affecting the TMT joint. Individual osteophytes ranged in size from 0.7 to 8.9 mm (mean 3.3 mm, median 3.0 mm). Distribution of osteophyte size by category among the affected individuals is shown in Table 1; individuals were categorized according to the size of the largest osteophyte measured in either tarsus. The lateral and DMPLO views were most useful for visualizing and measuring osteophytes. Among the affected individuals, 63/113 (55.8%) had periarticular osteophytes bilaterally. There was no difference in sex distribution between affected and unaffected groups, with 64/212 (30.2%) males affected and 49/204 (24.0%) females affected ($p = .19$). There were 296 pacers and 120 trotters in the study cohort. Pacers had a higher proportion of affected individuals (90/296, 30.4%) than trotters (23/120, 19.2%) ($p = .03$). When considered in multivariate logistic regression analysis, the presence of periarticular osteophytes was associated with gait but not sex (trotter odds ratio 0.53 [95% CI 0.31–0.88], $p = .02$).

3.2 | Racing performance

Three hundred seventeen of 416 horses (76.2%) started at least one race. Performance outcomes for the study cohort are summarized in Table 2. There was no difference in the proportion of horses that never started a race between the affected (24/113, 21.2%) and unaffected (75/303, 24.8%) groups ($p = .54$). The number of seasons raced ranged from 0 to 5 at the time of data collection (Table S1); some horses were still actively racing at that time. There was no effect on the number of seasons raced when periarticular osteophytes were considered as a dichotomous variable (present/absent; $p = .67$) or as a categorical variable (size category; $p > .43$) (Table S2). In both models, males raced more seasons than females (incidence rate ratio [IRR] 1.23 [95% CI 1.06–1.42], $p = .006$) and trotters raced fewer seasons than pacers (IRR 0.66 [95% CI 0.56–0.78], $p < .0001$).

Performance outcomes in the entire cohort were considered using the presence or absence of periarticular osteophytes as the primary predictor variable of interest (Table S3). The only performance outcomes for which periarticular osteophytes were associated were the number of starts at 4 years of age (IRR = 0.92 [95% CI 0.86–0.98], $p = .01$) and the number of lifetime starts (IRR = 0.95 [95% CI 0.91–0.98], $p = .003$); in both cases, the effect size was small. Gait and sex were associated with many outcome parameters. Trotters had fewer lifetime starts than pacers (IRR 0.55 [95% CI 0.53–0.58], $p < .0001$); this was driven by fewer starts at 3 (IRR 0.67 [95% CI 0.63–0.72], $p < .0001$) and 4 (IRR 0.44 [95% CI 0.40–0.47], $p < .0001$) years of age. Trotters also had fewer lifetime wins at 4 years of age than pacers (IRR 0.65 [95% CI 0.46–0.92], $p = .02$), even after accounting for number of starts. Although absolute lifetime earnings for trotters were lower than pacers (median log [earnings] = 4.40 vs. 4.52, respectively), when the number of starts was accounted for in multivariate regression, trotter lifetime earnings were slightly higher than pacers (0.23 [95% CI 0.007–0.46], $p = .04$). Trotters were slower than pacers (4.03 [95% CI 2.92–5.15], $p < .0001$). Males had more starts at 3 (IRR 1.05 [95% CI 0.99–1.11], $p = .003$) and 4 (IRR 1.52 [95% CI 1.43–1.62], $p < .0001$) years of age and more lifetime starts (IRR 1.33 [95% CI

1.28–1.37], $p < .0001$) than females. Males also had more wins than females only at 4 years of age (IRR 1.54 [95% CI 1.17–2.02], $p = .002$), when number of starts was accounted for. Males were faster than females (1.88 [95% CI 2.83 to 0.94], $p = .0001$).

When only the affected individuals were considered ($n = 113$), the size category of osteophytes was associated with a single performance outcome. In comparison with horses with Category 1 osteophytes, horses with Category 4 osteophytes had fewer starts at 3 years of age (IRR 0.67 [95% CI 0.57–0.80], $p < .0001$). As in the whole cohort, gait or sex were associated with several performance outcomes, including starts at 3 and 4 years of age, earnings per start, and fastest recorded time (Table S4).

4 | DISCUSSION

In this study cohort there were few associations between the presence of periarticular osteophytes of the distal tarsus and racing performance. The incident rate ratio for horses with periarticular osteophytes was just below 1 for number of starts at 4 years of age and number of lifetime starts (IRR 0.92 and 0.95, respectively), reflecting a small effect size of questionable clinical significance. For all other performance parameters there was no association with tarsal periarticular osteophytes. These data largely refute our hypothesis that periarticular osteophytes of the distal tarsus would negatively impact race performance. Further, among affected individuals, larger osteophyte size category was only associated with a single performance outcome. Horses in the largest osteophyte size category had fewer starts at 3 years of age relative to those with the smallest size category (IRR 0.67). This result was contrary to our expectation that larger osteophytes would have a more negative impact on performance than smaller osteophytes. Performance effects of sex and gait have been previously reported in North American Standardbreds[9] and were not a surprising finding in this cohort.

Periarticular osteophytes are a radiographic hallmark of DJD. However, there is not a strong correlation between clinical lameness attributed to the tarsus and radiographic changes in that joint.[10,11] In a study of 614 mature Icelandic horses, radiographic signs of tarsal DJD were found in a third of the horses, but lameness was not predicted by radiographic findings.[1] In a study of 20 horses with lameness attributed to one tarsus, radiographs were unreliable at detecting pathology that was subsequently found on magnetic resonance imaging (MRI).[12] Murray et al. reported that lame horses with tarsal pain but no radiographic changes had significantly increased radiopharmaceutical uptake in the painful in comparison with the nonpainful limb, but less uptake than those with radiographic changes. These and similar studies lend credence to the philosophy that radiographic changes alone should not dictate treatment of tarsal pathology but that therapeutic decision making should be based on evaluating clinical signs in concert with diagnostic imaging. Certainly, the findings in our study cohort support the conclusion that the presence of periarticular osteophytes alone should not be considered sufficient for a clinical diagnosis of DJD. We did not attempt to assess additional radiographic features of DJD such as subchondral bone sclerosis, bone lysis, or joint space narrowing. The combination of these features would be more suggestive of clinically relevant DJD, although a previous attempt to develop a quantitative scoring system for distal hock DJD based on radiographic findings was unreliable.[13]

In our study cohort, the lateral and DMPLO views were most useful for assessing the presence and size of periarticular osteophytes of the distal tarsal joints. This is consistent with previously published work[14,15] and reflects the fact that the dorsal and lateral portions of the proximal metatarsal III (MTIII) bone are most prone to development of periarticular osteophytes.[11,14] While the etiology of distal tarsal osteophyte formation is not entirely understood, it is possible that anatomical and/or conformational factors may play a role.[16,17] The proximal MTIII is the attachment site for two important muscles in the equine crus, the dorsal tendon of the peroneus tertius muscle and the cranial tibial muscle, both of which are important tarsal flexors and key components of the reciprocal apparatus. Microtrauma at bone-soft tissue junctions from normal pasture movement and play could lead to periosteal proliferation and enthesiophyte formation. Similarly, suboptimal conformation could place abnormal forces on articular margins, promoting osteophyte formation. Conformation of the tarsus was not evaluated in our study cohort but its association with periarticular osteophyte formation in yearlings could be explored in future work.

Despite the uncertain clinical significance of radiographically evident tarsal osteophytes in the absence of lameness, they may still be of concern to owners and particularly prospective buyers. Barrett et al. reported that Quarter Horses intended for cutting that had distal tarsal osteophytes had increased odds of not earning money at 3 and 4 years of age in comparison with those without these lesions.[4] In Thoroughbreds, it was reported that yearlings with DIT or TMT osteophytes/enthesiophytes were less likely to start a race, though among starters there was no difference in performance.[2] However, a similar survey of 2-year-old Thoroughbreds being offered for sale found no association between tarsal osteophytes/enthesiophytes and subsequent performance.[18] Robert et al. reported that “mild” radiographic findings (including distal tarsal osteophytes/enthesiophytes) were not associated with nonqualification in young French Trotters.[19] In our study cohort of Standardbred pacers and trotters there were few associations between periarticular osteophytes and performance through at least 4 years of age. Some of the differences in performance impact may be explained by the physical requirements of various disciplines. Cutting Quarter Horses are required to crouch and spin on their hind limbs, placing more stress on their distal tarsal joints than racing Thoroughbreds or Standardbreds. This may explain the greater impact of periarticular osteophytes on cutting horse performance. It is also possible that these horses may develop clinical DJD in the distal tarsal joints as a result of their athletic use. Horses that are conformationally or genetically predisposed to the development of distal tarsal osteophytes may also be more likely to develop subsequent clinical DJD, although this would require longitudinal radiographic monitoring to confirm. One such study has previously been conducted in Standardbred trotters, and while the authors reported that the prevalence and severity of radiographic changes in the tarsus increased across the entire cohort with age, radiographic changes within the same animals were stable over time regardless of training intensity.[20]

The prevalence of periarticular osteophytes of the distal tarsus was variable across previous studies. In two studies, these lesions were relatively uncommon, only diagnosed in 4%

or 6% of horses (in 2-year-old Thoroughbreds and French Trotters, respectively).[18,19] In contrast, 31% of the Quarter Horse cohort[4] and 16–31% of yearling Thoroughbreds[2,3] were affected. The 27% prevalence in our study cohort is in line with these reports. Interestingly, a radiographic survey in 134 young German Standardbred trotters revealed that 49% had radiographic changes in the distal tarsus, although specific findings were not separated out, so this likely overestimates the prevalence of periarticular osteophytes in this cohort.[20] Some of these differences may be due to varying definitions of osteophytes/enthesiophytes across studies, although true biological variability across breeds and disciplines is likely.

This study had several limitations, including the relatively small number of affected individuals in the cohort, which may have limited our power to detect true differences. In addition, testing for many different clinically relevant outcomes increases the risk of Type II error. As there were few significant associations found in this study, it is unlikely that this affected our conclusions. Finally, follow up was limited to publicly available data and it was not possible to account for other factors that might have played a role in performance.

Based on the findings in this study cohort, we conclude that in nonlame yearling Standardbreds, periarticular osteophytes of the distal tarsus are a largely incidental finding and should not adversely affect racing potential substantially. It would be interesting to continue to track the study cohort to see how their periarticular osteophytes change over time and if lameness or DJD develops in the future. There are ongoing opportunities to look at the impact periarticular osteophytes have on performance in other horse breeds/disciplines and to examine the potential role of conformation on the development and progression of osteophytes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations:

DIT	Distal intertarsal
DJD	Degenerative joint disease
DLPMO	Dorsolateral-plantaromedial oblique
DMPLO	Dorsomedial-plantarolateral oblique

IACUC	Institutional animal care and use committee
IQR	Interquartile range
IRR	Incidence rate ratio
MRI	Magnetic resonance imaging
MTIII	Third metatarsus
TMT	Tarsometatarsal

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FIGURE 1.

Representative dorsomedial-plantarolateral oblique (DMPLO) radiographic images of horses with periarticular osteophytes classified as (A) Category 0 (none); (B) Category 1; (C) Category 2; (D) Category 3; and (E) Category 4.

TABLE 1

Categorization of distal tarsal periarticular osteophytes based on size, and frequency of each category within the affected individuals in the study cohort ($n = 113$).

Category	Size (mm)	Frequency
1	<2.99	41
2	3.00–3.99	35
3	4.0–4.99	17
4	>5.00	20

TABLE 2

Summary of performance measures in the study cohort.

Performance outcome	Unaffected (n = 303)	Affected (n = 113)
Started a race	228 (75.2%)	89 (78.8%)
Seasons raced	2 (1–4) [0–5]	2 (1–4) [0–5]
Starts at 2	3 (0–8) [0–24]	6 (0–9) [0–21]
Starts at 3	12 (0–21) [0–37]	13 (0–22) [0–36]
Starts at 4	2 (0–20) [0–49]	4 (0–22) [0–43]
Wins at 2	0 (0–1) [0–11]	0 (0–1) [0–9]
Wins at 3	1 (0–3) [0–11]	1 (0–3) [0–8]
Wins at 4	0 (0–2) [0–10]	0 (0–1) [0–8]
Earnings at 2	$960 ($0–$10 466) [$0–$485 813]	$2694 ($0–$12 680) [$0–$267 135]
Earnings at 3	$7508 ($0–$26 711) [$0–$910 603]	$7301 ($0–$19 649) [$0–$1 028 171]
Earnings at 4	$1 ($0–$15 126) [$0–$381 800]	$504 ($0–$12 296) [$0–$118 426]
Lifetime starts	27 (1–57) [0–129]	28 (6–53) [0–131]
Lifetime wins	3 (0–7) [0–25]	2 (0–6) [0–20]
Lifetime earnings	$21 045 ($1–$65 519) [$0–$1 345 754]	$21 862 ($830–$53 546) [$0–$1 295 306]
Earnings per start	$600 ($1–$1271) [$0–$127 792]	$607 ($159–$1139) [$0–$49 819]
Fastest time (s)	115.4 (112.8–118.2) [107.2–114.8] (n = 192)	116.6 (114.0–118.7) [110.0–126.8] (n = 78)

Note: Data are reported as median (IQR) and [range].