Racing performance of juvenile Thoroughbreds with femoropatellar osteochondrosis at auction: A retrospective case-control study

by

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Abstract

Background: Osteochondrosis (OCD) is common in the femoropatellar joint in Thoroughbred yearlings for sale at auction and there is no consensus on the effect on racing outcomes.

Objectives: Describe femoropatellar OCD in juvenile Thoroughbreds and compare the racing performance of affected Thoroughbred horses to siblings and unaffected horses from the same sale.

Study design: Retrospective case-control study of juvenile horses born between 2010 and 2016.

Methods: Radiographic reports from 27 Thoroughbred auctions of weanling (5-11 months of age) and yearling (12-22 months of age) horses were reviewed to identify femoropatellar OCD. Age and sex of cases and controls were obtained from the sales catalog. Subject racing performance was obtained from an online database and compared to sibling controls and age- and sex-matched hip controls from the same sale using the Kruskal-Wallis test.

Results: Femoropatellar OCD was identified in 429 horses with North American race records. OCD was present on 519 lateral trochlear ridge (LTR) and 54 on medial trochlear ridge (MTR). The length and depth of OCD lesions was similar for LTR and MTR lesions. There were more males in the subject group (70%) than in sibling controls (47%). Subject racing performance was compared to 1,042 sibling and 757 hip controls. There was no significant difference between cases and both control groups for ever starting, years raced, total starts, starts for 2-5 years of age, total placings or placings at 2-5 years of age. Analysis of specific lesion metrics revealed weak correlations for some performance outcomes (both positive and negative) resulting in an inability to draw firm conclusions.

Main limitations: Retrospective observational study where management techniques were unknown, and buyer directed case selection may introduce bias.

Conclusions: Femoropatellar OCD in Juvenile Thoroughbred horses offered for sale at auction has a limited effect on racing performance.

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Chapter 1 - Introduction

Osteochondritis dissecans (OCD) affects articular cartilage and subchondral bone and can cause cartilage and bone to detach.[1] OCD is very common in Thoroughbred yearlings as 23% of horses have a lesion in at least one joint.[2] Equine juvenile OCD is most common in the femoropatellar joint[2] and appears radiographically as subchondral sclerosis and lucencies often accompanied by bone fragmentation. The lateral trochlear ridge (LTR) is the most frequently affected location followed by the medial trochlear ridge (MTR) and patella.[2–8] Clinical signs of femoropatellar OCD vary from nothing to effusion and lameness that rarely is severe enough to preclude athletic activity.[1] Radiographic surveys of young horses with femoropatellar OCD indicate that as many as 90% of lesions heal with conservative treatment,[9–11] however a small percentage do not and require surgery.

Surgical treatment of femoropatellar OCD has traditionally consisted of debridement of poorly attached cartilage and bone,[9,10] although a small number of horses have had the loose fragments reattached with polydioxanone pins.[12] Performance data on racehorses with femoropatellar OCD are scant and sometimes contradictory. A small study of Thoroughbred horses with femoropatellar OCD debrided arthroscopically concluded affected horses raced less successfully than unaffected controls and increased age at surgery was associated with better racing performance.[13] Another study examining performance after surgery on a mixed breed group of horses revealed that longer lesions were correlated with reduced success.[14] Larger surveys of radiographs of Thoroughbred sales horses with unknown treatment either could not correlate femoropatellar OCD with performance[15] or found smaller lesions associated with

poorer racing performance.[5] Due to these discrepancies, further investigation of the impact of OCD on racing performance is warranted.

The objective of the current study was to describe femoropatellar OCD in juvenile Thoroughbreds <650 days of age (before yearling sale age) and compare the racing performance of affected Thoroughbred horses with siblings and unaffected horses from the same sale. Racing performance metrics include the numbers of starts and places at two to five years of age as well as total starts, placings, and years raced. The null hypothesis for this analysis was that there would be no significant difference in racing outcome between affected horses and either control group.

Chapter 2 - Materials and Methods

2.1 Cases

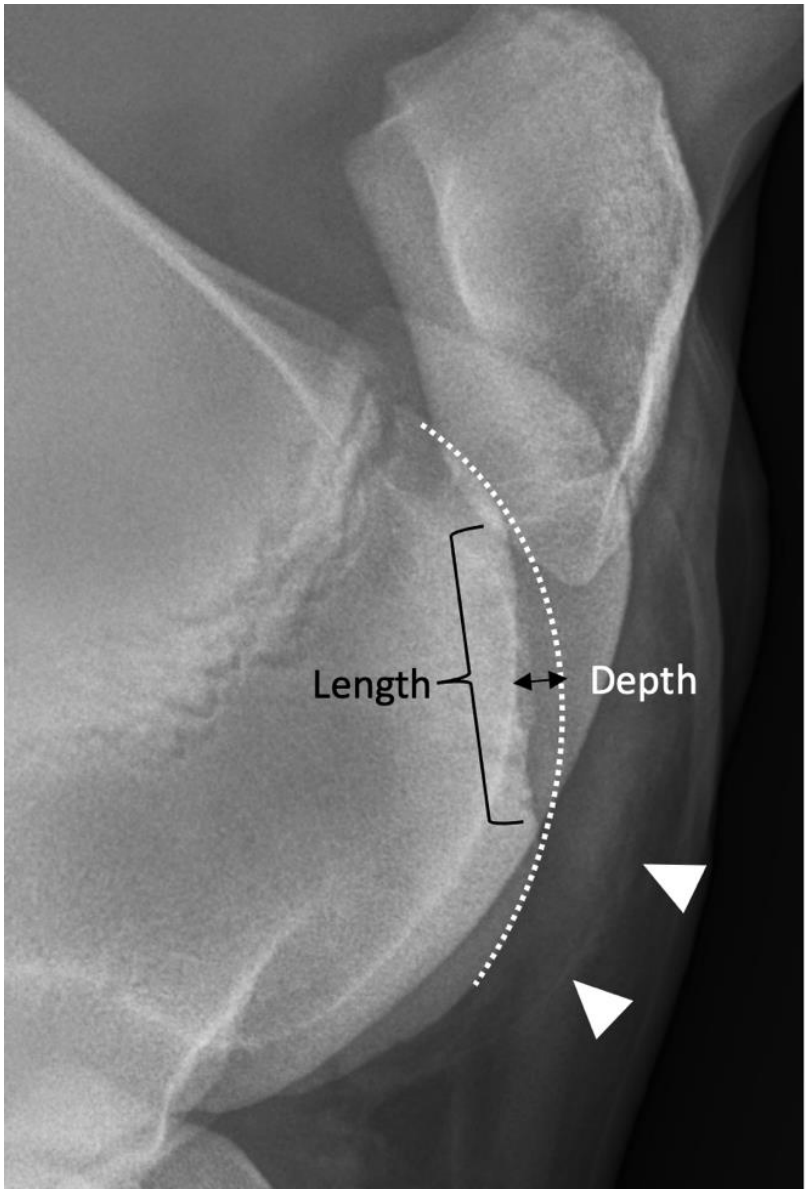
Cases were identified from all radiographic reports from one practice written in 2010-2016 of weanling (5-11 months of age) and yearling (12-22 months of age) Thoroughbred horses for sale at auction (supplement 1). Horses were identified by their sale number and selected for evaluation by prospective buyers. Radiograph reports are summaries of the evaluation of 36 digital radiographic images of all 4 fetlocks, both carpi, hocks and stifles (details at www.keeneland.com) by 5 experienced equine practitioners. Three projections of each stifle were included: lateral–medial, caudolateral 30°- craniomedial oblique and caudoproximal 15°-craniodistal. Radiographic reports were entered into FileMaker Pro (Filemaker Inc, Santa Clara, CA) and cases were identified by searching the left and right stifle fields for the keyword "OCD". Subject date of birth, sex and dam name were located through sales records (www.fasigtipton.com and www.keeneland.com).

Horses were included as cases with femoropatellar OCD if the cranial surface of the LTR or MTR on the lateral to medial projection had a depression of at least 2mm in depth and subchondral sclerosis (figure 1). Many lesions also had patchy lucencies within the sclerotic area and some had osseous fragments. Horses that raced outside of North America were excluded from all descriptive statistics. Descriptive data of stifle OCD recorded included structure affected: LTR, MTR or patella, region (proximal, central, distal), proximal to distal length and cranial to caudal depth (Figure 1). Radiographic abnormalities were measured using the digital image viewing software (Keystone, Asteris Inc, Monument, Co, USA) on the lateral to medial stifle projection. No attempt was made to adjust for magnification. When included in the report, further descriptors recorded included the presence of fragments (0, 1, >1), subchondral sclerosis

(increase in bone density), or an appearance of lesion healing (minimal subchondral sclerosis, smooth margins, or woven bone in the margins of a lucency). Lesions were recorded as surgical if there was a stifle surgery report included with the radiographs or if recommended after purchase. The concern for racing was summarized as none, mild, moderate, or severe based on the report summary (supplement table 1). Radiograph reviewer and date of review were recorded. Horses with radiographic abnormalities outside the stifle believed to impact racing performance were excluded as cases. Due to small number of affected cases, patellar lesions were not analyzed.

Figure 1. Radiographic measurement of osteochondrosis.

An example of proximal lateral trochlear ridge osteochondrosis on a lateral to medial radiographic projection with the location of measurements. The white dotted line estimates the location of the cranial margin of an unaffected ridge. Lesion length and depth are determined as indicated. The arrowheads indicate the margin of femoropatellar joint effusion.



2.2 Controls

This study was designed as a retrospective case-control study to ascertain racing performance outcomes with two control groups.

2.2.1 Control set 1: Horses from the same sale (hip controls)

Horses from the same sale and of the same sex as cases that did not have femoropatellar joint abnormalities or serious concerns for racing in other locations were used as control set 1 (hip controls). These horses were also selected by potential buyers. The date of birth and sex were located through sales records.

2.2.2 Control Set 2: Siblings

Maternal siblings born in 2010-2015 were identified from produce records obtained from an online database (www.equineline.com). Date of birth and sex were recorded.

2.3 Racing Performance

Produce records including lifetime racing performance data were obtained in January 2021 from the same online resource as sibling information. Variables retrieved included total years raced, starts, and placings (finish order of 1, 2 or 3). Racing results by age (2-5 years old) for starts and placings were also recorded. Due to the potential for incomplete racing records, horses were excluded if racing occurred outside of North America.

2.4 Data analysis

Data were analyzed with a statistical software (SAS v.9.4, SAS Institute Inc., Cary, NC). Summary and descriptive statistics were produced, with proportions and 95% Clopper-Pearson confidence intervals (95% CI) calculated for categorical data and median and range for continuous data. Sex was dichotomized as male (stallions and geldings) or female. The normality in the racing performance (years raced, total starts, total placings, 2 y/o starts, 3 y/o starts, 4 y/o

starts, 5 y/o starts, 2 y/o placings, 3 y/o placings, 4 y/o placings, 5 y/o placings) was assessed using a Shapiro-Wilk test in the univariate procedure of SAS v 9.4 and was determined to be non-parametric. Descriptive statistics of the mean, standard deviation, median, and range were calculated, given the distribution of the data, using the means procedure of SAS v 9.4. Proportions were calculated using Excel. Correlation between lesion location, length, and depth, joint sclerosis, fragments present, surgical intervention, and racing performance were assessed using the correlation procedure of SAS v 9.4. Correlation between racing concern and performance was assessed. Continuous variables were evaluated with a Pearson correlation. Ordinal and categorical variables were evaluated using a Spearman correlation. Racing performance between horses with OCD lesions and horses matched by either sale hip number or a sibling of a case horse and sex was assessed using the Kruskal-Wallis test in the NPAR1WAY procedure with a significance level of alpha = 0.05.

Chapter 3 - Results

3.1 Descriptive results

There were 40,440 Thoroughbred weanlings and yearlings offered for sale (withdrawn horses not included) in the 37 sales of Thoroughbred weanlings and yearlings born in 2010-2015 included (supplement 2). Of this total, 20,906 were male (52%) and 19,534 were female (48%). There were 12,759 radiographic reports read (31.5% of all) revealing femoropatellar OCD in 474 horses (3.7%). Forty-five horses raced outside of North America and were excluded from all analysis. Three hundred and two horses were male (70.4%; 95% CI: 65.8-74.7%), and 127 were female (29.6%; 95% CI: 25.3-34.2%). Subject median age was 250 days (range 145-638 days). OCD affected both stifles in 129 horses (30%) and one stifle in 300 (70%), resulting in 558 stifle joints with femoropatellar OCD. Unilateral OCD was present in the left stifle in 155 (52%), and in the right stifle in 145 (48%).

In the left stifle OCD was present on the LTR in 265 horses, on the MTR in 30, and on the patella in 3. In 11 of the 265 horses (4%), OCD was present on both trochlear ridges, in 2 on the LTR and patella, and in 1 on the MTR, LTR, and patella. The location of LTR OCD in the left stifle was recorded for 126/265 (47.5%) horses and was proximal in 114 (90.5%), central in 5, distal in 5 and in two locations in 2. The location of MTR OCD in the left stifle was recorded in 16/30 (53%) horses and was central in 13 (81%), proximal in 2 and in 2 locations in 1. In the right stifle OCD was present on the LTR in 254 horses, on the MTR in 24 and on the patella in 1. In 4 of the 254 horses (1.6%), OCD was present on both trochlear ridges and in one subject on the LTR and patella. The locations of LTR OCD in the right stifle was recorded for 129/254 horses (50.8%), and was proximal in 118 (91.5%), central in 5, distal in 4 and in two locations in

5. The locations of MTR OCD in the right stifle were recorded in 11/24 (45.8%) horses and was central in 10 (91%) and proximal in 1. Additional lesion metrics are listed in table 1.

Femoropatellar Trochlear Ridge Lesion Metrics (429 cases)				
	Left LTR	Left MTR	Right LTR	Right MTR
Total lesions	265	30	254	24
Lesion length (mm)	23.0 (16.0 – 30.0)	24.2 (14.6 – 33.8)	24.0 (16.0 – 30.5)	22.5 (9.2 – 35.8)
Lesion depth (mm)	5.0 (3.0 – 7.0)	5.0 (4.0 – 7.0)	5.0 (3.0 – 7.0)	5.0 (3.0 – 8.0)
Subchondral sclerosis (% of that lesion)	72 (27.2%)	9 (30%)	67 (26.4%)	9 (37.5%)
(% of that lesion)	59 (22.2%)	3 (10.0%)	68 (26.8%)	0
One fragment (% of that lesion)	28 (10.6%)	1 (0.3%)	36 (14.2%)	0
Multiple fragments (% of that lesion)	31 (11.7%)	2 (0.7%)	32 (12.6%)	0

Table 1. Femoropatellar trochlear ridge OCD lesion metrics.
LTR=lateral trochlear ridge, MTR= medial trochlear ridge. LTR length and depth metrics are presented as median and interquartile range due to non-normality. MTR length and depth metrics were normally distributed and displayed as mean and standard deviation.

Surgical treatment of LTR OCD was recommended for 43 cases (21 left and 22 right), and 12 had previously had surgery (9 left and 3 right). Forty-seven horses were recorded as being "healed" or "healing" at the time of sale (15 left LTR, 3 left MTR, 29 right LTR).

3.2 Control groups

In the hip control group, two controls were available for 331 horses, one for 95 horses, and 3 horses had no controls due to a small number of reports available for that sale. A total of 757 hip controls were available resulting in a mean of 1.76 controls for each subject. There were 526 males (69.5%; 95% CI: 66.1-72.7%) and 231 females (30.5%; 95% CI: 27.3-33.9%) ranging in age from 151 to 650 days (mean 334.5 days and median of 265 days). In the maternal sibling control group 421 of 429 horses (98%) had siblings resulting in a total of 1,042 sibling controls (mean of 2.4 for each subject). In this control group, there were 494 males (169 colts and 325 geldings, 47.4%; 95% CI: 44.3-50.5%) and 548 females (52.6%; 95% CI: 49.5-55.7%). In sibling controls, females were more likely to be a control (548 females) than a case (127 females) ($p<0.0001$), but males had an even distribution between cases (302 males) and controls (494 males).

3.3 Racing performance

There were no significant differences in the binary outcome of ever starting a race between cases and either control group. There was no significant difference between cases and both control groups for years raced; total starts; starts for 2-5 years of age; total placings; or placings at 2-5 years of age (Table 2).

Outcome	Cases (429)	Sibling Control (1042)	Hip Control (757)
Total starts	13 (6-23)	13 (6-23) 0.4593	14 (6-27) 0.4063
2-year-old starts	1 (0-3)	1 (0-3) 0.2032	1 (0-3) 0.1839
3-year-old starts	5 (2-8)	5 (2-8) 0.5654	5 (2-8) 0.7717
4-year-old starts	4 (0-8)	4 (0-8) 0.6899	4 (0-8) 0.9746
5-year-old starts	0 (0-5)	0 (0-5) 0.4730	0 (0-6) 0.2472
Total placements	5 (2-10)	5 (2-10) 0.9211	6 (2-12) 0.2860
2-year-old placements	0 (0-1)	0 (0-1) 0.6789	0 (0-1) 0.1418
3-year-old placements	2 (0-4)	2 (0-4) 0.7437	2 (0-4) 0.9992
4-year-old placements	1 (0-3)	1 (0-3) 0.4517	1 (0-4) 0.6217
5-year-old placements	0 (0-2)	0 (0-2) 0.7773	0 (0-2) 0.2545
Total years raced	2 (1-3)	2 (1-3) 0.3480	2 (1-4) 0.1495

Table 2. Career racing outcomes for femoropatellar OCD cases compared to sibling or hip controls.

Racing performance between controls and respective matches was assessed with the Kruskal-Wallis test. Placements refers to finishing race in first through third order. The data was not normally distributed and was presented as median, interquartile range, and p-value.

Left medial trochlear ridge depth was moderately correlated with an increase in 3-year-old placements ($r = 0.41$; $p=0.046$). Right lateral trochlear ridge fragmentation was weakly correlated with a decrease in 2-year-old starts ($r = -0.20$; $p=0.004$). Surgical debridement of the left LTR was weakly correlated with an increase in total years raced ($r= 0.14$; $p=0.023$), total starts ($r = 0.16$; $p=0.014$), and 3-year-old placements ($r = 0.14$; $p=0.033$). Left lateral trochlear ridge sclerosis was weakly correlated with a decrease in total years raced ($r = -0.14$; $p=0.02$). Sclerosis in any location was also weakly correlated with a decrease in total years raced ($r = -0.097$; $p = 0.04$). No other lesion metrics were significantly correlated with racing performance.

Chapter 4 - Discussion

The prevalence of radiographic femoropatellar osteochondrosis (OCD) in Thoroughbred sales young stock in this study is similar or lower to previous descriptions[2–8], however racing performance associated with OCD reported are scant and often contradictory. Associations between radiographic appearance and future performance would be beneficial to inform reader evaluation at sales and direct therapy for horses with femoropatellar OCD. This study provides an analysis of performance outcomes for horses with femoropatellar OCD and sibling controls, as well as a comparison with an unexposed group (hip controls).

There was no age difference between cases and both control groups. There was an increase in males in the subject group (70%), and in the sex-matched hip controls, as compared to the total sale (53%) and sibling (47%) groups. This was unexpected and may reflect buyer preference for males as racing and future sales prospects. An association with sex and stifle OCD was not examined in large radiographic survey[2,4–112,4–11], however in two smaller reports of surgical therapy, males comprised 60 and 67% of treated juveniles.[13,14] Similar to the present study, these were not random populations, but the possibility that male sex is a risk factor for femoropatellar OCD should be further investigated.

Left and right stifle joints were equally affected with all femoropatellar OCD. LTR lesions occurred more commonly than MTR lesions. LTR lesions occurred more frequently (91-92%) on the proximal aspect and MTR lesions occurred more frequently (81-91%) on the central aspect as previously reported.[9] The etiology of OCD is incompletely understood[16,17], however biomechanical loading is believed to play a role[17], and the location of OCD lesions in the femoropatellar joint may provide insight into the geometry and local femoropatellar joint forces in young Thoroughbreds.

Two control groups were used to account for variable factors. Hip controls were incorporated to compare horses identified with femoropatellar OCD to horses known to be unexposed and without any lesion that would be considered a concern for racing. The effect of pedigree is a possible confounding variable, so sibling controls were also analyzed. There is only mild evidence of the heritability of femoropatellar OCD,[2,3] but the sibling controls in this study were not known to be free from femoropatellar OCD.

Young Thoroughbred horses offered at auction are selected as potential purchases based on pedigree, conformation, and a lack of undesirable factors such as radiographic and airway abnormalities. Radiographic abnormalities cause concern because of a possible impact on for resellers, an impact on sale price. There was no difference in any racing outcome for cases and either control group indicating that femoropatellar OCD lesions at sales do not have a substantial impact on racing performance. Analysis of specific lesion metrics revealed weak correlations for some performance outcomes (both positive and negative), resulting in an inability to draw firm conclusions. Performance outcomes of Thoroughbred sales horses with stifle OCD should be applied with caution to all young horses with OCD as there are more severe lesions that would preclude sale at an auction that could have a negative impact on performance.

Left lateral trochlear ridge OCD lesions that were surgically debrided or recommended for surgery were significantly but weakly correlated with an increase in total years raced, total starts, and 3-year-old placements. Our finding of no effect or an improved performance of cases with LTR OCD is at odds with reduced performance in another Thoroughbred auction survey[5] and two surgical retrospectives that found debridement of lesions >2 cm resulted in poorer performance.[13,14] This may be the result of longer lesions in the surgical cases; mean lengths were not reported, but there were cases with LTR OCD longer than 40 mm that were not present

in this study (max LTR length 30mm; table 1). Our results do agree with an earlier Thoroughbred auction study that determined that LTR OCD had no effect on racing performance.[15] It appears that trochlear ridge OCD in sales weanlings and yearlings is not likely to affect later racing performance if the length for LTR lesions is < 31 mm and for MTR lesions is < 36 mm.

A previous study evaluating the effect of arthroscopic removal of femoropatellar OCD in juvenile Thoroughbred determined that those horses had reduced performance for some metrics than controls, but older patients had improved outcomes over younger.[13] We were unable to determine when surgery was performed in cases but was probably after 12 months of age for yearlings. The impact of age at surgery on racing performance should be further investigated, especially because OCD lesions can heal over time[9,10] which could eliminate the need for surgery or reduce the size of debridement.

This study has several limitations include its retrospective nature and potential bias due to the report generation from requests from potential buyers. Because multiple buyers requested reports of multiple horses over several years, the authors consider the present group of horses to approximate juvenile sale Thoroughbred horses. Additionally, the inclusion of reports from multiple readers will lead to some variation in the lesion metrics recorded. This can be reader preference but can also be the results of time constraints inherent in radiograph evaluation at sales. A further limitation involves the lack of clinical information about treatments of stifle OCD before or after the sale.

Weanling and yearling Thoroughbred horses with femoropatellar OCD at public sales have similar racing performance to unaffected weanling and yearlings from the same sale and to their siblings.

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Appendix A - Grading scale for radiographic report "concern for racing".

Concern for Racing	
None	no comment, "okay", "some concern for resale but okay for race", "blemish for resale"
Mild	"some concern for race", "may require surgery", or "some risk"
Moderate	"concern for racing", "fair for racing"
Severe	"too risky", "NO", "significant risk", or "serious risk"

Supplemental Table 1. Grading scale for radiographic report "concern for racing".

Appendix B - **Thoroughbred weanlings and yearlings for sale.**

Sales	Total Sales Weanlings and Yearlings	Total Reports	Femoropatellar OCD
2010 Keeneland November	1343	468	22
2011 Keenland January	484	122	3
2011 Keeneland November	1214	486	48
2011 Keeneland September	3689	1136	13
2011 Fasig-Tipton Kentucky Fall	885	135	3
2012 Keenland January	472	147	6
2012 Keeneland November	1288	432	32
2012 Keeneland September	3114	1134	13
2012 Fasig-Tipton July	283	86	1
2012 Fasig-Tipton November	41	35	2
2012 Fasig-Tipton October	1094	221	10
2013 Keenland January	585	184	15
2013 Keeneland November	1048	520	40
2013 Keeneland September	3427	1181	22
2013 Fasig-Tipton Kentucky	69	39	2
2013 Fasig-Tipton November	48	36	3
2013 Fasig-Tipton October	976	243	8
2013 Fasig-Tipton NY August	400	177	3
2013 Fasig-Tipton July	222	137	1
2014 Keenland January	507	158	11
2014 Keeneland November	1244	444	37
2014 Keeneland September	3606	1023	8
2014 Fasig-Tipton November	57	50	3
2014 Fasig-Tipton October Sale	1056	240	5
2015 Keenland January	445	148	14
2015 Keeneland November	1281	457	43
2015 Keeneland September	3624	973	8

2015 Fasig-Tipton Kentucky	109	40	3
2015 Fasig-Tipton July	289	155	3
2015 Fasig-Tipton November	14	33	4
2015 Fasig-Tipton October	1234	258	11
2016 Keenland January	586	166	11
2016 Keeneland September	3798	1071	13
2016 Fasig-Tipton Kentucky	112	42	2
2016 Fasig-Tipton July	293	148	1
2016 Fasig-Tipton October	1037	235	4
2016 Fasig-Tipton NY Bred August	466	199	1
Totals	**40440**	**12759**	**429**

Supplemental Table 2. There were 40,440 Thoroughbred weanlings and yearlings offered for sale (withdrawn horses not included) in the 37 sales of Thoroughbred weanlings and yearlings born in 2010-2015 that were attended by veterinarians of this practice.