http://dx.doi.org/10.1590/1678-4162-12343

***Arq. Bras. Med. Vet. Zootec.*, v.74, n.3, p.446-456, 2022**

Clinical and arthroscopic presentation of horses with osteochondral fragmentation at metacarpophalangeal and metatarsophalangeal joints: a 10-year study (2010–2019)

[*Caracterização clínica e artroscópica de equinos com fragmentação osteocondral em articulações metacarpofalangeana e metatarsofalangeana: estudo de 10 anos (2010-2019)*]

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ABSTRACT

This study aimed to characterize the clinical and arthroscopic presentations of horses with osteochondral fragmentation at the metacarpophalangeal and metatarsophalangeal joints at the Veterinary Hospital of the University of São Paulo in a 10-year period (2010–2019). The hind limbs were affected similarly to the plantar and dorsal fragments from the first phalanx, while the thoracic limbs had a more frequent occurrence on the dorsal aspect of the joint. The Brazilian Sport Horses were the most frequently observed breed. The degree of lameness was variable and might be related to fragment localization, animal age, and physical activity. There was a significant statistical difference between the joint effusion and degree of lameness; therefore, it can be considered that the joint effusion is related to degenerative joint processes and might be triggered by the presence of the osteochondral fragment. Surgical correction, especially when performed in young animals using an arthroscopic procedure is probably the best treatment option for most cases, possibly acting as a minimizer of the occurrence of secondary joint degeneration. Prospective studies of specific breeds with a larger number of animals can expand this clinical characterization and enable a better understanding of the animal's recovery after surgical or conservative management.

Keyword: arthroscopy, fetlock, horse, osteochondritis dissecans

RESUMO

O objetivo deste estudo foi caracterizar a apresentação clínica e artroscópica de equinos com fragmentação osteocondral em articulação metacarpo/metatarsofalangeana atendidos no Hospital Veterinário da Universidade de São Paulo, no período de 10 anos (2010-2019). Os membros pélvicos são mais acometidos com fragmentos plantaromediais da primeira falange, enquanto os membros torácicos apresentam uma caracterização de ocorrência de fragmentação dorsal da primeira falange, sendo o Brasileiro de Hipismo a raça de maior ocorrência nesta casuística. O grau de claudicação foi variável e pode relacionar-se com a localização do fragmento, a idade e o nível de atividade atlética desenvolvida. Houve relação estatística significativa entre a presença de efusão articular e o grau de claudicação, por isso suscita-se sobre a efusão relacionar-se com processos degenerativos articulares que podem ser desencadeados pela presença do fragmento osteocondral. A correção cirúrgica por meio de procedimento artroscópico provavelmente consiste na melhor opção de tratamento para a maioria dos casos, principalmente quando realizada em animais jovens, possivelmente atuando como minimizador da ocorrência de degeneração articular secundária. Estudos prospectivos de raças específicas e com um número maior de animais podem ampliar essa caracterização clínica e possibilitar um entendimento sobre a evolução após a opção ou não pelo tratamento cirúrgico.

Palavras-chave: artroscopia, boleto, cavalos, osteocondrite dissecante

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Submitted: March 11, 2021. Accepted: April 2, 2022.

INTRODUCTION

Orthopedic diseases represent the main causes of horses' exclusion from their athletic activities. It is well known that the metacarpophalangeal and metatarsophalangeal joints are the most important joints for horses in all sports modalities because of their great abilities to move, receive intense load, and stabilize hind limbs (Bramlage, 2009).

The osteochondral fragments are commonly identified on radiographic evaluation, being classified as absent or high risk, during the clinical presentation of the horse at the time of the examination. These variations are related to the fragments' location and origin, age, and physical activity level. Depending on the location of the fragment, clinical signs can vary significantly (Declercq, 2011).

At the metacarpophalangeal and metatarsophalangeal joints, these fragments are identified close to the dorsoproximal and proximal palmar/plantar aspects of the first phalanx (P1), a sagittal ridge of the third metacarpal and metatarsal bones, and proximal sesamoid, or incorporated into the synovial membrane. They can be identified as a fracture or can even be associated with the development of an orthopedic disease, known as osteochondritis dissecans (OCD). All cases can be considered osteochondral fragments to avoid inappropriate characterization (Kyla and Ortved, 2017).

It is important to reinforce that regardless of the classification, the presence of this fragment can trigger the process of secondary progressive joint degeneration due to the release of mechanical cellular debris (cartilage particles) and biological factors (cytokines and inflammatory mediators) (Bramlage, 2009).

Intraarticular therapy with hyaluronic acid may reduce the clinical signs related to the associated joint diseases. However, depending on the use of the animal and intensity of the athletic performance, surgical intervention is required for most osteochondral fragments and must always be considered based on the career and performance level of the horse in the long term. In many cases, early surgical removal of the fragments eliminates the triggering cause of the joint disease; hence, the degenerative process can be reduced and/or interrupted (Kyla and Ortved, 2017).

This observational retrospective study aimed to characterize the clinical and arthroscopic presentation of horses with osteochondral fragmentation at the metacarpophalangeal and metatarsophalangeal joints admitted at the Veterinary Hospital of the School of Veterinary Medicine and Animal Science of the University of São Paulo (HOVET/FMVZ/USP) over a period of 10 years between 2010 and 2019.

MATERIALS AND METHODS

A total of 105 horses were selected among those admitted by the Equine Internal Medicine and Large Animal Surgery Services of the HOVET, over 10 years (2010–2019), presenting osteochondral fragments at the metacarpophalangeal and metatarsophalangeal joints, which were submitted for clinical examinations and arthroscopic assessments.

This study included patients without clinical signs of joint disease on the same joint, which was evaluated using radiographic and ultrasound examinations. Anamneses were documented, recording whether the fragments were identified by the pre-purchase examination or a clinical examination due to complaining of lameness. The breed and sex of the animals were categorized. The age at which the animals were subjected to clinical evaluations and surgical treatments was classified into four different groups: A: 1–3 years, B: 3–6 years, C: 6–9 years, and D: > 9 years.

All 105 horses underwent a specific locomotor system clinical examination. A total of 144 affected limbs were identified in this study. The degree of lameness was determined from absent (0) to critical (5) using stride evaluation in a straight line, according to the American Association of Equine Practitioners (AAEP) classification method. Synovial effusion and fetlock joint responses were classified as absent or present.

Radiographic projections were performed in all animals to define the location of the fragments (dorsal or palmar/plantar eminence of the P1, sesamoids, condyle, or sagittal ridge of the third metacarpal and metatarsal in the medial or lateral aspects). Four projections: lateromedial, dorsopalmar/plantar, medial dorsolateral palmar/plantar, and lateral dorsomedial palmar/plantar oblique views were used. Additionally, the flexed lateromedial view was also used for fragments originating from the sagittal ridge, as well as for palmar/plantar fragments. Furthermore, oblique projections with proximodistal angulation (around 10° to 20°) were added.

In 40% of the horses, an ultrasound was performed at the metacarpophalangeal and metatarsophalangeal joints using the MyLab30 Vet Esaote (Italy), 6 to 18 MHz linear transducer, in B mode. The ultrasonographic parameters assessed were classified according to a score of 0/34 (Table 1) and were converted to an ordinal variable with three different levels: low (0.016–5.33), average (5.33–10.7), and high (10.7–16.0).

All horses underwent general anesthesia for arthroscopy. Before the procedure, arthrocentesis was performed, and a macroscopic evaluation of synovial fluid was performed. For arthroscopic extraction of fragments and cartilage debridement, the standard dorsal or palmar/plantar approach was used, with two portals, lateral and medial, according to McIlwraith *et al*. (2015). The joint was assessed for synovial fluid parameters: quantity (unique or multiple), fragment mobility, presence of synovitis (proliferation and vascularization of the synovial membrane), and cartilage lesion (erosion, exposition of subchondral bone, and fibrillation of joint cartilage).

The statistical prevalence was expressed as a percentage of all data mentioned in this study. The R 3.6.3 software (enabled with “mlogit” library) was used “to conduct statistical analyses of the above-mentioned studies (Croissant, 2020). The results are presented in two sections: descriptive statistics and statistical inferences. In the first section, the presence of lameness was evaluated in terms of the number and frequency of observations and potential predictors (fragment localization, joint effusion, and ultrasonographic score). The association of the variables was tested using analyses of the logistic regression models. The *p-value* associated with the calculated chi-square test and the models’ number of degrees of freedom was obtained. The coefficients (B) of the logistical model parameters, including odds ratio (OR), and the OR confidence intervals (CIs) of each predictor were analyzed. The setting of the model was assessed using the R^2 coefficient, according to the methodology proposed by Hosmer-Lemeshow (Croissant, 2020). The significance level was set at 5%.

RESULTS

Out of 105 animals (64.8% male and 35.2% female) assessed, 139 metacarpophalangeal and metatarsophalangeal joints were analyzed. In 96.6% of the horses, the disorders were identified during the pre-purchase examination. The five breeds identified among the horses were Brazilian Sport Horse (56.4%), Lusitano (27.6%), American Quarter Horse (10.4%), Thoroughbred (2.8%), and American Trotter (2.8%).

The distribution of age groups between 1–3 years, 3–6 years, 6–9 years, and > 9 years were 26.6%, 48.8%, 18%, and 6.6%, respectively with an average age of 4.41 ± 2.54 years.

Regarding the stride evaluation, 62.9% of the animals did not present lameness; the degree of lameness was 1, 2, and 3 in 21.9%, 13.3%, and 1.9%, respectively. In the trot evaluation, 41.9% did not exhibit lameness; the degree of lameness was 1, 2, 3, and 4 in 23.9%, 20%, 13.3%, and 0.9%, respectively. After the digit flexion test, 45.7% of the horses were positive for trot evaluation.

Joint effusion was present in 40.9% of animals. Other orthopedic illnesses on the same limb, but not on the same joint, were observed in 7.6% of these patients, while presented with, lameness on the contralateral limb with no clear reason was noted in 4.7% of the animals. In 10.4% of the horses, the fragments were also present on other joints and were not assessed in this study.

Table 1. Ultrasound parameters evaluated

Synovial fluid appearance	
Normal	0
Anechoic synovial effusion	1
Heterogeneous, mostly anechoic fluid	2
Predominance of heterogeneous amorphous material and anechoic fluid	3
Heterogeneous amorphous material and/or fluid containing dense material and suspended hyper reflective foci	4
Synovial fluid volume	
Unchanged	0
Increased - up to half the physiologic volume	1
Increased - up to twice the physiologic volume	2
Increased - more than twice the physiologic volume	3
Increased - more than three times the physiologic volume	4
Joint capsule thickness	
Unchanged	0
Mild localized thickening	1
Generalized thickening	2
Generalized thickening greater than	3
Joint capsule attachment	
Smooth	0
Mild irregularity	1
Evident irregularity	2
Marked irregularity with increased blood vessel flow/width	3
Joint capsule appearance	
Homogeneous echogenicity	0
Localized hypoechoic areas	1
Hypoechoic areas containing hyperechoic foci	2
Periarticular ligament appearance	
Unchanged	0
Heterogeneous with hypoechoic areas Heterogeneous with hyperechoic areas	1
Massive damage and tear	2
Unchanged	3
Periarticular ligament origin/attachment	
Unchanged—smooth	0
Presence of irregularities	1
Bone proliferation	2
Marked bone proliferation	3
Marked bone proliferation and fragments	4
Joint capsule and synovial membrane vascularity	
No detectable blood flow	0
Visible vascularity/small numbers of scattered color dots	1
Increased vascularity	2
Articular cartilage thickness	
Well-defined articular cartilage. Continuous, smooth, easily recognizable	0
Articular cartilage difficult to distinguish; smooth, continuous portions detected in more than 50% of scanned surface	1
Articular cartilage difficult to distinguish; rough, discontinuous portions detected	2
Undistinguishable articular cartilage; fragments in the synovial fluid	3
Undistinguishable articular cartilage and diffuse subchondral bone surface changes	4
Subchondral bone surface	
Smooth surface	0
Irregular surface	1
Areas of flattening	2
Subchondral bone osteophytosis	
Smooth surface	0
Irregular surface	1
Areas of flattening	2
Subchondral bone osteophytosis	
Smooth articular margin	0
Rough articular margin	1
Osteophytosis	2
Large and/or fragmented osteophytes	3
Total	34

In 67.7% of the horses, the fragments were presented unilaterally; however, in 21.9%, they were bilateral in both thoracic and hind limbs; in 8.5% cases, the fragments were observed in at least one thoracic and one hind limb, while in 1.9% cases they were in all limbs. Overall, 34.7% of the thoracic limbs and 65.3% of the hind limbs were implicated. Of these, 18.4% were from the right thoracic limb (89.6% of dorsal and 10.4% of palmar fragments), 16.3% were from the left thoracic limb (90% dorsal and 10% palmar), 37% from the right hind limb (56% dorsal and 44% plantar), and 28% from the left hind limb (52.3% dorsal and 47.7% plantar) (Table 2).

Table 2. Distribution of the fragments' location at the affected limb

Limb		Fragment Location			
Thoracic	34.7%	Right	18.4%	Dorsal	89.6%
				Palmar	10.4%
		Left	16.3%	Dorsal	90.0%
				Palmar	10.0%
Hind limb	65.3%	Right	37.0%	Dorsal	56.0%
				Plantar	44.0%
		Left	28.3%	Dorsal	52.3%
				Plantar	47.7%

The location of the fragments in this study corresponded to 87.7% from the P1, where 63.7% were in the dorsal aspect and 36% were in the palmar/plantar aspect. Further, fragments found in the dorsomedial, dorsolateral, palmaromedial, plantaromedial, and plantarolateral (P1) aspects were 39.3%, 14.8%, 4.2%, 21.9%, and 7.8%, respectively. Fragments in the sagittal ridge, lateral sesamoid apex, medial sesamoid apex, and lateral condyle accounted for 9.2% 1.4%, 0.7%, and 0.7%, respectively.

Regarding the location of the fragments in the right thoracic limb, the incidence in the dorsomedial, dorsolateral, palmaromedial in the proximal portion of P1, third metacarpal sagittal ridge, and medial sesamoid apex was 58.6%, 20.6%, 6.9%, 10.4%, and 3.5%, respectively. Similarly, on the left thoracic limb, the incidences were 45%, 35%, 10%, and 10%, respectively. In the right hind limb, the numbers in the dorsomedial, dorsolateral, plantaromedial, plantarolateral in the proximal portion of P1 aspects were 38%, 8%, 30%, and 12%, respectively.

Table 3. Location of the fragments in each limb

Location	RTL (%)	LTL (%)	RHL (%)	LHL (%)
Dorsomedial P1	58.6	45.0	38.0	33.3
Dorsolateral P1	20.6	35.0	8.0	12.0
Sagittal ridge	10.4	10.0	10.0	7.1
Palmaro/plantaromedial P1	6.9	10.0	30.0	38.1
Palmaro/plantatolateral P1	0	0	12.0	7.2
Lateral sesamoid	0	0	2.0	0
Medial sesamoid	3.5	0	0	0
Lateral condyle	0	0	0	2.3

RTL: right thoracic limb, LTL: left thoracic limb, RHL: right hind limb, LHL: left hind limb, P1: first phalanx.

Further, 10% fragments were observed in the third metacarpal sagittal ridge and 2% were observed in the medial sesamoid apex. In the left hind limb, the occurrence of the fragments in the dorsomedial, dorsolateral, plantarolateral, plantarolateral in the proximal portion of P1, third metacarpal sagittal ridge, and lateral condyle aspects were 33.3%, 12%, 38.1%, 7.2%, 7.1%, and 2.3%, respectively (Table 3).

Considering the predominant breed (Brazilian Sport Horse), fragments localized in the right and left thoracic limbs and right and left hind limbs were 18.7%, 10%, 38.8%, and 32.5% respectively. In the right thoracic limb, the percentage of localizations in dorsomedial, dorsolateral to the proximal portion of P1, and third metacarpal sagittal ridge were 53.4%, 33.3%, and 13.3%, respectively. In the left thoracic limb, these values were 25%, 50%, and 25%, respectively. In the right hind limb, 29.1%, 9.6%, 38.8%, and 6.4% of fragments were noted in dorsomedial, dorsolateral, plantaromedial, and plantarolateral in the proximal portion of P1, respectively. Further, 12.9% and 3.2% fragments were observed in the third metacarpal sagittal ridge and lateral sesamoid apex, respectively. In the left hind limb, 34.6%, 3.8%, 38.5%, and 7.8% fragments were in dorsomedial, dorsolateral, plantaromedial, and plantarolateral of the proximal portion of P1, respectively, while 11.5% and 3.8% were in the third metacarpal sagittal ridge and lateral condyle region, respectively (Table 4).

Table 4. Location of the fragments in the limbs of the breed Brazilian Sport Horse

Location	RTL (%)	LTL (%)	RHL (%)	LHL (%)
Dorsomedial P1	53.4	25.0	291	34.6
Dorsolateral P1	33.3	50.0	9.6	3.8
Sagittal Ridge	13.3	25.0	12.9	11.5
Palmaro/plantaromedial P1	0	0	38.8	38.5
Palmaro/plantatolateral P1	0	0	6.4	7.8
Lateral Sesamoid	0	0	3.2	0
Lateral Condyle	0	0	0	3.8

RTL: right thoracic limb, LTL: left thoracic limb, RHL: right hind limb, LHL: left hind limb, P1: first phalanx.

During the ultrasound examinations, 59.5% of the joints were found to present cartilage irregularities: 7.1% were disorders in cartilage thickness, 33.3% were subchondral disorders, and 16.6% had fibrin. Osteophytes and enthesophytes were identified in 9.6% and 2.3% of the joints, respectively. During the synovial liquid assessment, 78.5% of the joints showed an increased amount of fluid, and 69% of them had modifications in their aspects. The joint capsule presented thickness modifications in 23.8% of the joints; among them, 52.3% presented heterogeneities in this structure and 33.3% presented disorders in its insertions. Changes in synovial membrane aspects were observed in 14.2% of the cases and vascularization was enhanced in 11.9%. Synovial plicae evaluation revealed size disorders in 26.1% of the joints, aspect disorders in 16.6%, and vascularization disorders in 2.3% cases. The articular and periarticular joint evaluation showed heterogeneities in the fetlock suspensory ligament, medial collateral ligament (deep and/or superficial), lateral collateral ligament (deep and/or superficial), and oblique sesamoidean ligament in 21.4%, 42.8%, 21.6%, and 7.1%, cases respectively. The osteochondral fragment was identified using ultrasound in 76.1% of the joints.

In ultrasonographic score assessment, 28.57% of the animals were classified as low, 44.64% as average, and 28.78% as high. Class 10 was the most frequent type (7/56).

When the joints in this study were individualized, lameness represented 44.60% (62/139) and 37.09% of osteochondral fragments were identified in the dorsomedial portion of the proximal portion of P1. Joint effusion was observed in 48.38% of the animals, which presented lameness and 12.98% of those without lameness. Among the animals exhibiting high classification in the ultrasonographic score, 22.85% presented lameness, while 33.33% were (Table 5, 6, 7).

Table 5. Contingency table assessing lameness versus localization of fragment, joint effusion, and ultrasonographic score

Parameters		Lameness			
		Absent		Present	
		N	%	N	%
Fragment location	Sagittal ridge	5	6.49	5	8.06
	Dorsolateral P1	10	12.98	9	14.51
	Dorsomedial P1	35	45.45	23	37.09
	Palmaromedial P1	4	5.19	7	11.29
	Plantaromedial P1	16	20.77	10	16.12
	Other localizations	7	9.09	8	12.90
Effusion	Present	10	12.98	30	48.38
	Absent	67	87.01	32	51.61
Ultrasonographic score	Low [-0.016, 5.33]	6	28.57	10	28.57
	Average [5.33, 10.7]	8	38.09	17	48.57
	High [10.7, 16]	7	33.33	8	22.85

Table 6. Contingency table assessing joint effusion versus ultrasonographic score

		Effusion			
		Absent		Present	
		N	%	N	%
Ultrasonographic score	Baixo [–0.016, 5.33]	9	25.71	7	33.33
	Médio [5.33, 10.7]	15	42.85	10	47.61
	Alto [10.7, 16]	11	31.42	4	19.04

Table 7. Contingency table assessing ultrasonographic score versus the location of fragments in the joint

		Ultrasonographic score					
		Low		Average		High	
		N	%	N	%	N	%
Fragment location	Sagittal ridge	3	18.75	1	4.00	2	13.33
	Dorsolateral P1	1	6.25	3	12.00	3	20.00
	Dorsomedial P1	5	31.25	11	44.00	6	40.00
	Palmaromedial P1	1	6.25	4	16.00	2	13.33
	Plantaromedial P1	4	25.00	5	20.00	0	0.00
	Other localizations	2	12.50	1	4.00	2	13.33

Logistic regression analysis showed an association between the incidence of joint effusion and the presence of lameness ($p = .000003$). In this sample, the incidence of joint effusion was 6.28 times more than the incidence of lameness (Table 8).

Table 8. Association between the incidence of joint effusion and lameness using logistic regression model analysis

	B	OR confidence intervals 95%		
		Lowest limit	OR	Highest limit
Presence of joint effusion	1.83**	2.81	6.28	15.01

$R^2 = 0.11$ (Hosmer–Lemeshow). $\chi^2(1) = 21.48$. ** $p < .01$. * $p < .05$. B: coefficient, OR: odds ratio.

There was no association of the presence of lameness with either the location of the fragment ($p = .66$) or the ultrasonographic score ($p = .65$). Similarly, no association of ultrasonographic score with the presence of joint effusion ($\chi^2(2) = 1.11$; $p = .57$) or fragment localization ($\chi^2(10) = 9.13$; $p= .51$) was observed.

The arthroscopic assessment revealed that 95.3% of the joints presented a single fragment, while only 4.7% had multiple fragmentations. It was identified that in 19% of the joints, the viscosity of the fluid was reduced. In 43% of cases, joint disorders other than fragmentation were observed. Concerning synovitis, 10.4% presented synovial proliferation and 8.5% exhibited enhanced synovial membrane vascularization. Cartilage lesions were observed in 9.5% of joints, where 7.6% presented cartilage erosion, 0.9% showed exposition of the subchondral bone, and 0.9% displayed fibrillation of the articular cartilage. In 2.8% of the cases, the osteochondral fragment was free, while in 7.5% of the horses, it was attached to the oblique sesamoidean ligament, and in 89.7% of cases, it was connected to the fibrous or fibrocartilage tissue in its original place.

DISCUSSION

The etiology of osteochondrosis is related to failure in the endochondral ossification process; the suggested triggers include ischemic chondronecrosis (which can be inherited or associated with infectious injuries), exercise level, genetics, dietetics, endocrine, biomechanical, toxic, and gender-related factors (Rodgerson, 2008; Adams and Stashak's, 2011; Kyla and Ortved, 2017; Naccache *et al*., 2018; Hendrickson *et al.*, 2018). Although the etiology has not been completely clarified, body weight and growth rate emphasize a positive correlation with osteochondrosis development, very similar to our observation in this study that showed a predisposition in young horses, mainly the Brazilian Sport Horse and Lusitano breeds with this characteristic development. These breeds are also destined for riding, which is why the animals undergo a pre-purchase examination. The reason why the Thoroughbred or American Quarter Horse did not present a representative sample in this study was probably related to the fact that these breeds are usually examined in different veterinary centers, such as hippodromes.

Based on literature reports, the presence of osteochondral fragments is referred to as fractures or primarily associated with the development of orthopedic diseases. Such origin characterization is linked to histologic evidence, which in many cases does not maintain any kind of classification (Declercq *et al*., 2009). However, this study aimed to relate cases that are not related to an isolated traumatic origin.

Although a male predominance was observed, it is emphasized that in many different breeds, there is a higher evaluation incidence of males due to commercialization preference.

In terms of age, clinical evidence of osteochondral fragments is often observed in horses between 4 months and 2 years of age (Rodgerson, 2008). In this study, the horses that were sent to the hospital were mainly between 3 and 6 years old. It is important to reinforce that in most animals, this fragment had been previously identified in medical care through pre-purchase examination, demonstrating that there is a correlation between the identification of the injury time and the patient’s referral for surgical treatment. Consolidated information about age and the fragment location is as follows: when surgical indication and surgery in young animals are correctly performed with the disappearance of the signs of joint diseases, the prognosis for future athletic performance is better (Bramlage, 2009).

In most horses, osteochondral fragments were detected on radiographs of the limbs taken during the pre-purchase examination, because many animals demonstrate lameness < 2/5 (AAEP) or do not show any clinical sign until subjected to intense training (Rodgerson, 2008; Adams and Stashak's, 2011; Kyla and Ortved, 2017). This reinforces the findings of this study that 60% or more of the assessed animals did not present lameness on the stride evaluation.

Joint effusion was present in 40.9% of the animals, which implies that it is the most common clinical sign observed in patients with osteochondral fragments during limb inspection. In our observational study, a significant correlation between the incidence of joint effusion and lameness was observed. In addition, joint effusion is also observed in animals that do not present lameness, representing one of the first symptoms of with the presence of osteochondral fragments. Pain after joint flexion has also been recognized, especially in horses with fragments at the palmar/plantar eminence of the P1, precisely because of the pressure on these eminence areas (Adams and Stashak, 2011; Kyla and Ortved, 2017).

Oblique radiographs are primordial for determining the location of most fragments, and when performed in a proximodistal angulation, they can improve such evidence, especially in plantar/palmar fragments (Wright and Minshall, 2014; Walsh *et al*., 2018), as was observed in this study. Despite the predictive values of the radiographic findings being controversial, it is well known that horses can present one or more fragments at the same time when no locomotor alteration was identified (Stock *et al*., 2005; Declercq *et al*., 2009, 2011).

Ultrasound is useful for identifying the fragments and contributing to the identification of the disorders associated with the joint degenerative processes, which leads to case severity and impair the prognosis, especially the athletic one. Injuries frequently associated with the fragments in the dorsoproximal of the P1 include proliferative synovitis and cartilage erosions of the metacarpal/metatarsal condyles (Declercq *et al*., 2009). In 64.4% of the assessed horses, disorders of the collateral ligaments were identified, which were higher than the injuries in the medial aspect. Such evaluation is important to assess the stability of the joints and identify if injuries in structural joints have occurred, indicating that its association with other joint disorders might affect the animal's athletic ability. Other factors that might also influence the diagnosis are linked to the age of the animal, fragment size and number, synovitis severity, and the presence of osteoarthritis (Adams and Stashak, 2011). A study with ultrasonographic evaluation in a higher number of animals would bring us more enriching information.

The thoracic limb collateral ligaments are located more to the dorsal portion, maintaining the joint surfaces in apposition and avoiding the dorsal joint border separation during the hyperextension. This justifies an increase in occasional injury to the dorsal medial and lateral eminence because of the trauma but a low palmar lesion aspect incidence (Bramlage, 2009). Similar observations were noted in this study and were explicitly observed in Brazilian Sport Horse animals.

The joint support in the hind limbs is located more in the lateral and medial plantar portion, which allows an opening of the dorsal joint border, leading to a greater flexion angle that proceeds until the support resists. As far as it goes, there is a higher tension in bone connection sites with collateral and distal sesamoids joints, resulting in a significant occurrence of plantar fragments in hind limbs (Bramlage, 2009), precisely as observed in this study.

There was a predominance of fragments in the medial aspect of the dorsoproximal and palmar/plantar eminence of the P1 in this study. Though the reason could not be completely elucidated, a close relationship with an anatomic feature might be a possibility, where the medial eminence of the dorsoproximal border of the P1 might be more prominent and might propagate abaxially compared to the lateral one. This could explain the incidence of medial injuries because, during joint hyperextension, there is pressure on the dorsal aspect of the P1 edge in the third metacarpal/metatarsal joints. In contrast, such fragmentation has also been observed in 1-year-old animals that have never been trained or used for the race before (Adams and Stashak's, 2011; Declercq *et al*., 2011; Walsh *et al*., 2018).

Sagittal ridge fragments of the third metacarpal/metatarsal have been associated with the presence of joint effusion with variable lameness but are commonly evident after the fetlock flexion test. In our study, radiographs could underestimate the size of the fragments, because the cartilage fragments are only partially made of bone and such cartilaginous dimensions are usually bigger. It is worth considering that the size of the fragment relates to the adjacent resulting injury. The latest can be conservatively treated; however, the best results, especially in high-performance horses, come from arthroscopic correction (Declercq *et al*., 2011; Wright and Minshall, 2014).

Osteochondral fragmentation of the palmar/plantar proximal eminence of the P1 presented a moderate to high incidence. They can occur with variable clinical evidence depending on the exercise intensity and are commonly found in the medial aspect of the metatarsophalangeal joint, as identified in this study. Its clinical meaning has been questioned in the past few years. Some authors believe that these are unintentional findings with no clinical relevance, while others consider it as a cause of lameness, although in some breeds they are indeed considered a common cause of low degree lameness (Declercq *et al*., 2011).

Osteochondral fragmentation of the sesamoid bone apex related to the development, which also occurs in this portion, needs to be differentiated from fractures. Usually, it is not associated with lameness and presents low incidence, as observed in this study. Previous studies have reported the incidence of such fragments commonly in racehorses including the Brazilian Sport Horse and American Quarter Horse. It shows a good prognosis in young animals as well as when removed precociously (Declercq *et al*., 2011).

Not all osteochondral fragments can be categorized in the groups mentioned above. This study found a Brazilian Sport Horse with a fragment that originated on the lateral condyle. In such unusual cases of fragmentation, criticism about the clinical and treatment importance is not always obvious. It generally involves a debate and although experience will be acquired through previous cases, each new animal requires very careful attention (Declercq *et al*., 2011; Mcllwraith *et al*., 2015).

Many association analyses have reported that more than one joint is affected (Lykkjen *et al*., ., 2012), whereas, in this study, 21.9% of the fragments were found to be bilateral in both thoracic and hind limbs, 8.5% in at least one thoracic and one hind limb and 1.9% in all limbs.

The surgical treatment, which aims to remove the osteochondral fragment and debridement of the adjacent cartilage by arthroscopy, is commonly seen as the best option since for horses presenting lameness, the clinical treatment can aggravate the joint time-dependent inflammation process, intensify financial cost, and reduce the horse’s athletic career time (Bramlage, 2009; Declercq *et al*., 2011; Mcllwraith *et al*., 2015).

In our study, it was observed that more than 40% of animals had already exhibited degenerative joint diseases combined with the presence of the osteochondral fragment, detected using ultrasound and arthroscopic assessment. There is ambivalence regarding surgical correction and clinical importance in the short-and long-term of osteochondral fragments, especially in animals with no clinical evidence, depending on the location and intensity of the animal’s physical activity. It is implied that there is a release of mechanical and biological factors that promote secondary progressive joint degeneration in the presence of the fragments (Machado *et al*., 2012) and once the self-perpetuation point is established, fragment removal cannot undo the degenerative process (Declercq *et al*., 2011).

Declercq *et al*. have reported more than one fragment in 10% of joints (Declercq *et al*., 2011). We observed in our study that 4.7% of horses presented multiple fragmentations, which were associated with advanced age (≥7 years old), the lameness signs resulting from the osteoarthritis process might be more commonly found (Walsh *et al*., 2018).

Most cases of joint inflammations observed in young horses with osteochondral fragments are related to a reversible process when the inciting cause is eliminated (Bramlage, 2009) and the prognosis of the animals for surgery is better when no other lesion is involved in the joint (Mcllwraith, 2002). Such criteria led our case-by-case study, in which most animals until 6 years of age underwent arthroscopic correction. Our results emphasized that the surgical process performance might decrease the risk of athletic career shortening.

Prospective studies of specific breeds with a larger sample size could increase this clinical characterization and lead to a better understanding of the animal’s recovery after surgical treatment.

CONCLUSION

The hind limbs are most affected, and fragmentations are more common at the plantaromedial aspect of the proximal portion of the P1, whereas dorsal fragmentation is often found in the thoracic limbs. There was a statistically significant correlation between the presence of joint effusion and the degree of lameness. In our case, Brazilian Sport Horses were the most affected breed.

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