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Radiographic Abnormalities in Barrel Racing Horses with Lameness Referable to the Metacarpophalangeal Joint

Bruno Carvalho Menarim DVM, MS [a], Vânia Maria Vasconcelos Machado DVM, MS, PhD [b], Luís Emiliano Cisneros Alvarez DVM, MS, PhD [b], Rodrigo Carneiro DVM [b], Leandro Busch DVM [b], Luiz Carlos Vulcano DVM, MSc, PhD [b]

[a] *Equine Surgery Section, Department of Clinical Sciences, College of Veterinary Sciences, Austral University of Chile, Valdivia, Chile*
[b] *Veterinary Diagnostic Imaging Section, Department of Animal Reproduction and Veterinary Radiology, College of Veterinary Medicine and Animal Sciences of the São Paulo State University-Unesp, Botucatu, São Paulo, Brazil*

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ABSTRACT

Barrel racing is one of the most popular uses of the American Quarter horse in North and South America. Although injury to the metacarpophalangeal joint frequently occurs in this sport, there is limited information describing the nature of these injuries. The aim of this study was to determine the most common radiographic abnormalities in barrel racing horses with lameness referable to the metacarpophalangeal joint. Lameness examinations were performed on 63 barrel racing horses. Those found to be lame were subjected to radiographic examination. Lameness at trot was scored on a scale of 0-5 (0 = sound; 5 = inability to move). Data were analyzed using descriptive statistical analysis. Of horses examined, 30 (47.6%) were lame with scores ranging from 1 to 4. Half of the lame horses (15 of 30) had grade 2 lameness of the right forelimb. Abnormal radiographic findings were more often present on the left forelimb and included signs of sesamoiditis (70%), villonodular synovitis (56.6%), osteoarthritis (36.6%), osteochondritis dissecans (13.3%), capsulitis (13.3%), and soft-tissue swelling (6.6%). Radiographic abnormalities indicated that sesamoiditis, villonodular synovitis, and osteoarthritis may be associated to mild-to-moderate lameness in barrel racing horses. Complementary sonographic evaluation is recommended to better characterize soft-tissue abnormalities.

1. Introduction

Sporting events and particular training programs subject horses to stresses that generate injuries of the musculoskeletal system [1-3]. Repetitive movements of horses performing certain events may cause predictable injuries, such as palmar heel pain and distal hock lameness in cutting and reining horses [4] and foot-, fetlock-, and carpus-related problems in Thoroughbred race horses [5,6]. Early detection of musculoskeletal disease is a key factor for prevention of further injuries and to increase the likelihood of successful treatment of equine athletes. Therefore, determination of the prevalence of injuries causing lameness associated with specific sports is useful because such injuries can affect the intended use of the horse [3,7]. Although there is a large number of studies describing the prevalence of various musculoskeletal injuries in Thoroughbred [8-10] and Standardbred horses [11-13], similar information on Quarter Horses is sparse [14,15]. Barrel racing is popular throughout North and South America, and is currently one of the highest paying sports in which Quarter Horses are involved [14]. The metacarpophalangeal (MCP) joint has been identified as the most frequent site of injury in barrel race horses [16] (Garcia, personal communication, 2006; Graf, personal communication, 2007; M.J. Moreira, personal

Corresponding author at: Bruno Carvalho Menarim, DVM, MS, Department of Clinical Sciences, Fundo Teja Norte, Universidad Austral de Chile, Hospital Veterinario, Campus Isla Teja, Valdivia, Chile.
E-mail address: brunomenarim@uach.cl (B.C. Menarim).

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communication, 2005; M.D. Pyles, personal communication, 2007). However, specific radiographic abnormalities associated with MCP joint lameness in barrel racing horses have not been previously described. The purpose of this study was to identify, using radiography, the types and distribution of musculoskeletal injuries in barrel racing horses with lameness referable to the MCP joint.

2. Materials and Methods

2.1. Horses

Sixty-three Quarter Horses currently under intensive training and performing barrel racing competitions were subjected to clinical examination. In order to be part of this study, the horses were selected according to the following criteria: (1) to be >3 years of age; (2) to be lame at walk or trot before or after flexion test of the MCP joint; (3) to be submitted to a detailed lameness examination; and (4) to have a complete radiographic evaluation of the MCP joint. According to these criteria, 30 horses were included.

2.2. Lameness Examination

To determine whether horses were lame, they were initially evaluated at walk and trot in a straight line on a 50-m flat, solid surface. Lameness at the trot was scored on a scale of 0-5 (0 = sound; 5 = inability to move [American Association of Equine Practitioners (AAEP) scale]). Further physical evaluation included inspection and palpation of the anatomic structures of the forelimbs, application of hoof testers, passive and forced flexion, and rotation of the joints of the distal limb for evidence of pain. A MCP joint flexion test was performed by placing a hand on the dorsal aspect of the pastern, and flexing the MCP joint for 45 seconds; the horse was then trotted for detection of lameness. Care was taken to flex only the MCP joint and not the entire distal limb. Horses with forelimb lameness in one or both forelimbs, referable to the MCP joint based on positive results of the MCP joint flexion test were then submitted for radiographic evaluation. Diagnostic anesthesia was performed by localizing lameness to the MCP joint after a negative response to palmar digital and abaxial sesamoid perineural nerve blocks and a positive response to low palmar analgesia. In this study, 3 mL of 2% lidocaine solution was injected subcutaneously at each point.

2.3. Radiographic Examination

To identify abnormalities of the MCP joint, the following radiographic views of both forelimbs of each horse were obtained: weight-bearing lateromedial, flexed lateromedial, dorsopalmar, and 45° oblique views. For this, a 24 cm × 30 cm chassis, X-ray screen (Kodak-Medical X-ray Film General Purpose Green—MXG, Sao Paulo, Brazil), and a portable X-ray machine (FNX-90 Jockey-Electra, Rio de Janeiro, Brazil) of 100-mA power were used. Kilo voltage (kVp) technique was standardized to 65 kVp, 5 mA to extended lateromedial, flexed lateromedial, and dorsopalmar projections; for the oblique views, settings used were 60 kVp, 5 mA. The distance from the X-ray machine to the screen was 70 cm. Radiographs were analyzed by both B.C.M. and a blinded specialist radiologist (L.C.V.).

2.4. Follow-up of Barrel Racing Performance

The performance of 27 of the 30 lame horses was followed for 12 months. Retirements and rankings in the National Barrel Racing Championship of the following year were recorded.

2.5. Data Analysis

Findings of lameness and radiographic examinations, including limb, lameness score before and after MCP joint flexion, and site of radiographic abnormality were tabulated. Descriptive statistics (mean ± SD) were then performed.

3. Results and Discussion

3.1. Lameness Examination

Thirty horses (47.6%), ranging in age from 3 to 19 years (mean ± SD, 6.8 ± 3.8) were identified as having gait abnormality during lameness evaluation. Throughout examination, 4 of 63 horses (6.3%) were spontaneously lame, and 26 of 63 horses (38%) were lame only after forced flexion of the MCP joint. Although MCP joint flexion can induce lameness in sound horses with no radiographic evidence of disease at the MCP joint when excessive force (250 N) is applied for an extended period (60-90 seconds) [17,18], in this study, time of flexion was less than that recommended by Keg et al. (60-90 seconds) [17], and Ramey (60 seconds) [19]. Because the force applied by the majority of practitioners is around 150 N [20], we believe that lameness caused by pain induced by MCP joint flexion in this study was likely a reflection of pain originating from the joint. In addition, radiographic evidence of disease of the MCP joint was detected in 29 of 30 horses (96.8%) radiographed in this study.

In contrast to the findings described by Ramey (1997) who observed that 98% of horses became lame after firm MCP joint flexion, we found that firm MCP joint flexion caused lameness in only 47% of the horses we subjected to this test [19]. In Ramey's study, flexion was performed by holding the toe, whereas in the present study, force was applied directly to the pastern.

Because of restrictions imposed by some owners, it was not possible to perform diagnostic anesthesia in all horses (22 of 30). Lameness localization was therefore subjective in 8 of 30 horses; nonetheless, abnormal radiographic findings were identified. Kearney et al. reported that the anatomical structures located distal to the MCP joint appear to contribute only minimally to the outcome of a positive flexion test of the distal aspect of a forelimb in a clinically nonlame horse [18]. However, flexing the distal limb by applying pressure on the dorsal hoof wall can exacerbate pain from other parts of the distal limb besides the MCP joint, such as the interphalangeal joints [19,21]. Because we made an effort to flex only the MCP joint, we consider lameness caused by forced flexion was likely caused by disease of this joint even though this was not confirmed by diagnostic anesthesia in 8 of 30 horses.

Table 1
Summary of distribution and grade of spontaneous lameness (SL) (n = 4) and lameness after forced flexion (LAFF) (n = 30) in the right forelimb (RF) and left forelimb (LF) in 30 lame Barrel Racing Quarter Horses (– = 0)

Lameness score	SL (n = 30)				LAFF (n = 30)			
	Unilateral (n = 3)		Bilateral (n = 1)		Unilateral (n = 10)		Bilateral (n = 20)	
	RFL	LFL	RFL	LFL	RFL	LFL	RFL	LFL
1	1	2	1	1	–	–	5	8
2	–	–	–	–	6	3	9	6
3	–	–	–	–	1	–	4	4
4	–	–	–	–	–	–	2	2
5	–	–	–	–	–	–	–	–

Owing to the fact that some diseases of the MCP joint such as sesamoiditis do not have lameness abolished with intra-articular anesthesia [13,22], and the proximal sesamoid bones are part of the MCP joint [23], we decided to perform perineural diagnostic anesthesia. Analgesia of the MCP joint region and distal limb can be induced using the low palmar analgesic technique injecting 1-5 mL of anesthetic solution [24]. In this study, 3 mL per injection point was used; therefore, excessive diffusion of anesthetic solution and misinterpretation of the results of diagnostic analgesia are unlikely.

In the present study, the percentage of horses exhibiting lameness before or after forced flexion (n = 30; 47.6%) and radiographic abnormalities (n = 29; 46%) indicate that a considerable number of barrel racing horses perform while tolerating some degree of musculoskeletal pain. Similar findings have been previously reported [15,25] with affected horses showing a decrease in performance [14].

Only one of 63 horses exhibited spontaneous bilateral lameness. Based on response of MCP joint flexion, 20 of 63 horses (31.7%) in this study appeared to have bilateral MCP joint pain. Of the 30 lame horses, right forelimb (RFL) lameness was predominant (n = 27) and more severe than left forelimb (LFL) lameness (n = 23) (Table 1). After forced flexion, 80% (24 of 30) of horses had a 2/5 lameness.

Although the suspensory apparatuses of both forelimbs are stressed during barrel racing, it seems that the RFL bears a greater load. The disproportion between RFL verses LFL load-bearing is theorized to occur because the first barrel is positioned on the horse's right side, and the horse goes at maximum speed to this barrel before rapidly decelerating to turn around the barrel [14,26] (Fig. 1). Despite reports of injuries in flat racehorses from the United Kingdom, in which left and right limbs were equally affected by lameness in both forelimbs and hindlimbs [27,28], biomechanics of barrel racing is unlikely to be comparable with flat racehorses [14].

3.2. Radiographic Examination

Radiographs revealed that 96.8% (n = 29) of lame horses exhibited some type of MCP joint abnormality. Although it is likely that the radiographic abnormality was the cause of the lameness, abnormal findings during diagnostic imaging can be found during lameness examinations without being strictly related to lameness [3,29]. Many horses in speed training develop structural changes of tissues leading to

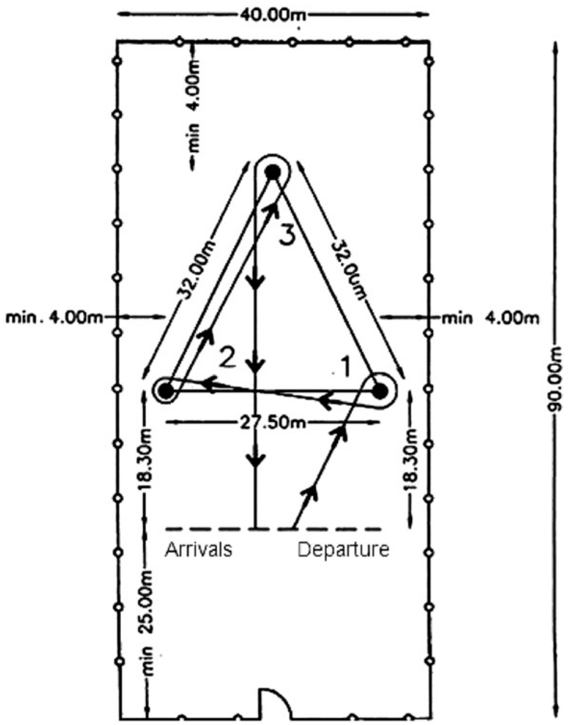

Fig. 1. Pattern and distances performed by barrel racing horses in Brazil. The arrows denote the direction the horse travels.

stress-related injuries such as signs of inflammation [30] and bone remodeling [29].

Among horses that exhibited radiographic abnormalities in this study, the prevalence of radiographic signs of the following diseases was observed: sesamoiditis (70%), more frequent in the lateral sesamoid bone of the LFL; villonodular synovitis (56.6%), more often at the dorsal surface of the distal portion of the third metacarpal bone, equally distributed between both forelimbs; osteoarthritis (OA) in the form of osteophyte formation (36.6%), most prevalent on the medial proximal surface of the proximal phalanx of either forelimb; osteochondral fragments (13.3%) observed on the dorsal proximal surface of the sagittal ridge of the third metacarpal bone in both forelimbs; capsulitis (13.3%), most frequently observed in the LFL as capsule entesophyte formation; and general soft-tissue swelling (STS) (6.6%), equally distributed in both forelimbs (Table 2).

According to Bertone (2004), the majority of these radiographic abnormalities suggest injury caused by MCP joint hyperextension [22]. The radiographic findings in the MCP joint of barrel racing horses were similar to those in the MCP joint of various breeds of horses that reacted to forced flexion [19].

3.2.1. Sesamoiditis

Radiographic signs of sesamoiditis, such as marginal enthesophytes, focal radiolucent defects, and most commonly enlarged vascular channels, similar to those described by Richardson and Dyson (2011) [23] were frequently observed in our study. In a study associating radiographic abnormalities of Thoroughbred yearlings with racing performance at 2 or 3 years of age, irregular vascular

Table 2
Radiographic abnormalities observed at right forelimb (RF), left forelimb (LF), and both forelimbs (RF/LF) in 30 Barrel Racing Horses

	RF	LF	RF/LF	Total
S	2 (6.6%)	7 (23.3%)	12 (40%)	21 (70%)
VS	1 (3.3%)	1 (3.3%)	15 (50%)	17 (56.6%)
OA	2 (6.6%)	6 (20%)	3 (10%)	11 (36.6%)
OCD	1 (3.3%)	1 (3.3%)	2 (6.6%)	4 (13.3%)
C	1 (3.3%)	2 (6.6%)	1 (6.6%)	4 (13.3%)
STS	1 (3.3%)	1 (3.3%)	–	2 (6.6%)

S, sesamoiditis; VS, villonodular synovitis; OA, osteoarthritis; OCD, osteochondral fragments; C, capsulitis; STS, soft-tissue swelling (– = 0).

channels were observed in 79% of horses [31], although their presence was not associated with decreased performance. Enlarged vascular channels in the proximal sesamoid bones are believed to be a normal adaptation to exercise [22]. We strongly believe that the high incidence of sesamoiditis in our horses could represent a pathological condition and not just an adaptation to exercise, as most of the horses in this study were >4 years of age, and the observed lesions generally consisted of more than two vascular channels of ≥2-mm in width and/or intense bone remodeling, which have been reported to affect performance [32]. Moreover, radiographic changes associated with chronic sesamoiditis can become persistent and present in sound performing horses [22]. In flat racing Thoroughbreds, the medial sesamoid bones are more often inflamed than the lateral sesamoid bones because joint hyperextension is concentrated on the medial portion of the limb (H.C. Hagen, personal communication, 2009). Although weight distribution is concentrated on the medial aspect of the limb straight movement, the sharp turn around the barrel places a counterforce on the lateral aspect of the limb [33]. We suggest that this factor places an increased force on the lateral aspect of the suspensory apparatus, which could increase the strain in the lateral sesamoid bone and related ligaments, which underlies the etiology of sesamoiditis [34] (Fig. 2).

3.2.2. *Villonodular Synovitis*

Villonodular synovitis is commonly observed in Thoroughbred horses [22] at the palmar and especially the dorsal region of the proximal aspect of the MCP joint [23,36]. Similar findings were observed in this study. This is caused by persistent compression of the synovial pad by the dorsal rim of the proximal phalanx during excessive dorsiflexion of the MCP joint [23,37]. The incidence of radiographic abnormalities associated with villonodular synovitis was 56.6% in our study. The prevalence of villonodular synovitis in 4.8% Thoroughbred yearlings has been reported, with the odds for racing as a 2-year old reduced by three times for yearlings with marked supracondylar lysis [38]. Menarim et al. described villonodular synovitis in

Fig. 2. Diagram of proposed effects of dynamic equilibrium and centrifugal forces exerted on the metacarpophalangeal joint of a horse turning a barrel. Picture C adapted from Riegel and Hakola (2001) [35].

lame urban draught horses (33.3%) examined by radiography [39]. Differences of presentation and level of decreased performance in each type of equine sporting event may be because of different degrees of impact on the MCP joint and muscle fatigue, which exacerbate MCP joint hyperextension [22]. Villonodular synovitis is considered to be an early indicator of OA and is generally associated with an absence of, or only mild lameness [36], which is in agreement with our findings.

3.2.3. Osteoarthritis

The prevalence of OA in horses varies with use and age [40]. We suspect the increased radiographic evidence of OA on the medial (7 of 11) opposed to the lateral (3 of 11) aspect of the MCP joint is due to weight loading [41], which is in contrast to our initial hypothesis. Although turning around barrels exacerbates extension forces on the lateral aspect of limbs, compression seems to still be higher medially because of dynamic equilibrium. A sharply turning horse is able to keep its balance because as its body falls to the center of gravity, a limb is placed on the ground to support the body and propel the horse forward (Fig. 2). The faster the horse is moving, the more it must rely on this dynamic equilibrium to stay upright, similar to dynamics affecting a turning motorcycle [33]. Also, ground friction is increased on curves because of centrifugal forces, mainly on the area of major compression.

3.2.4. Osteochondral Fragments

Osteochondral fragments at the MCP were observed in 4 of 30 horses (13.3%) in this study, with lesions on the proximal and dorsal aspect of the first phalanx and the sagittal ridge of the third metacarpal bone. Similar findings have been reported in other breeds, with a prevalence of 2.1% in the MCP joint in Thoroughbreds, 9.5 % in Warmbloods [42], and 5% in Standardbreds [22]. Fragments in the MCP may occur in one or both forelimbs, and usually occur at the same location as observed in this study, and are frequently not associated with clinical signs [43]. They can be a consequence of chronic trauma during hyperextension of the MCP joint, leading to generalized joint disease and should therefore be arthroscopically removed [22].

3.2.5. Capsulitis

Capsulitis and synovitis of the MCP joint are generally associated with repeated trauma [37]. Four of 30 horses (13.3%) in this study presented this abnormality. For this condition, careful evaluation should be performed to rule out concomitant osteochondral fragments. Sonographic evaluation of the joint should also be performed to rule out the presence of any soft-tissue injury [37].

3.2.6. Soft-tissue Swelling

We observed STS in only 2 of 30 horses (6.6%). Its presence can occur due to several causes and may be detected radiographically, either alone or with other radiographic abnormalities. Its specific cause cannot usually be determined. Although initial radiographs may show only STS, further images obtained 2-3 weeks later may demonstrate new bone at articular margins and soft-tissue attachments [43]; therefore, follow-up radiographic examination is advised.

Although we identified more horses with RFL than LFL lameness, there was a higher incidence of radiographic abnormalities observed in the left than right MCP joint. This suggests that soft-tissue injuries were responsible for some of the lameness observed. Even though there is a higher impact and hyperextension on the right suspensory apparatus while turning right around the first barrel [26], exercise repetition may come into play, as the horse must turn left on both the second and the third barrels [2]. These factors may explain the different distribution between lameness and radiographic abnormalities.

3.3. Performance Follow-Up

Of the 30 lame horses initially studied, follow-up was available on 27 horses, with 23 horses continuing to actively compete for at least 12 months after the initial examination. Despite being diagnosed with at least 2/5 lameness after forced flexion (LAFF), 10 of the horses were subsequently placed in the “top 10” of their respective classes, and six were class winners at the National Barrel Racing Championships held the following year. This indicates that in high-performing barrel racing horses, some degree of LAFF, even associated with radiographic abnormalities of the MCP joint, may not be completely detrimental to performance ability. The overall champion for that year was grade 4/5 MCP joint lame after forced flexion, a week before our examination. Eleven of 30 horses (36.6%) were treated by the authors, with 8 of 11 receiving medical treatments according to type of musculoskeletal injury, including stall rest (8 of 8); oral administration of nonsteroidal anti-inflammatory drugs (8 of 8); topical anti-inflammatory (7 of 8); intra-articular steroids (6 of 8); intra-articular administration of sodium hyaluronate (3 of 8); annular ligament desmotomy (1 of 8); and shoeing corrections (9 of 11). These horses included two of the class champions. In the 12-month follow-up period after the study, four horses were retired. One horse was retired because of forelimb MCP joint lameness, and the other three horses were retired because of stifle (1), hock (1), and navicular (1) lameness.

4. Conclusion

Mild-to-moderate LAFF of the MCP joint is observed in almost 50% of barrel racing horses. Although radiographic signs of sesamoiditis, villonodular synovitis, and mild OA can be associated with lameness and decreased performance, some of these horses continued as high-performance athletes despite these injuries when receiving veterinary care.

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