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Ultrasonographic measurements on normal tarsocrural articular recesses in the Standardbred Trotter horse

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ABSTRACT
The aim of this study was to provide reference measurements from the three tibiotarsal synovial recesses (plantarolateral, plantaromedial, and dorsomedial) from both right and left sound equine hock joints. For this study, proximodistal and plantarodorsal (PLD) diameters were ultrasonographically obtained from the synovial recesses of 24 sound Standardbred Trotter horses. A comparison between right and left limb measurements was also made. The dorsomedial recess has shown a variable PLD diameter (0.11–0.90 cm), although the plantarolateral recess has shown the most variable dimensions (0.3–1.5 cm). In many cases, great differences have been found between two tarsi within the same horse; in contrast, the plantaromedial recess of the tarsocrural joint has a more homogeneous PLD diameter (0.6–0.9 cm). Ultimately, the assessed echographic limits for the studied tarsal structures could serve to accurately evaluate the pathological variations for this breed.

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KEYWORDS
Horse; ultrasonography; tarsus; measurement; joint recess

1. Introduction

The usefulness of the ultrasonographic technique in diagnosing soft tissue injuries of the locomotor system in horses has been widely demonstrated, becoming an integral part of evaluating horses with soft tissue injuries, such as ligaments and/or tendons (El-Shafaey et al. 2016), along with articular and periarticular diseases (Reef 1998; Redding 2001). Along this line, some studies have been published concerning the normal and pathological ultrasonographic images of some tarsal components (Dik 1993; Leveille et al. 1993; Ruohoniemi 1993; Denoix 1996).

Additionally, the indications for ultrasonographic examination of equine joints include synovial fluid distention, given that could be a sign of early osteoarthritis (Olive et al. 2014), local swelling, pain on passive manipulation of the joint, improvement in lameness after intra-articular or regional analgesia, and positive radiographic or scintigraphic findings (Denoix 2003).

The hock joint consists of numerous articulations, among which the tibiotarsal is particularly complex. This joint is a ginglymus based on the shape of deep grooves on the cochlear articular surface of the distal end of the tibia, with extensive surface of the trochlea on the astragalus. The tibiotarsal synovial compartment is composed of three main recesses: the dorsomedial, plantaromedial, and plantarolateral (Dabareiner et al. (2003)) (Figure 1). The knowledge of normal echogenicity and dimensions of these articular recesses takes an important role when evaluating them for clinical purposes; for this reason, this study aims to establish the normal dimensions of those articular components, using ultrasonographic examination of both hock joints of 24 healthy, adult Standardbred Trotter horse (STH).

2. Materials and methods

2.1. Animals

Twenty-four STH (age range from 5 to 15 years) were employed in our study: 14 males and 10 females. A complete lameness examination including inspection, palpation, and static and dynamic flexion tests of each tarsus was performed on each horse in order to select animals with no tarsal disorders.

2.2. Ultrasonographic exploration

Following the routine preparations, that is, clipping of the hair, soaking of the skin, and application of acoustic gel, each examination was performed using a real-time ultrasound machine (ALOKA, Assago, Italy) with a 7 MHz sector probe. Echographs from both right and left joints of each horse were obtained via the weight bearing of standing animals.

Proximodistal (PD) and plantarodorsal (PLD) diameters were obtained from each synovial recess of the tibiotarsal joint, using two different cursors manipulated through the ultrasound machine.

The probe was positioned transversally as described in Vilar et al. 2008. To illustrate briefly, the probe was placed dorsally in position DT1 approximately at the level of the most plantar aspect of the calcaneal tuberosity; in this way,

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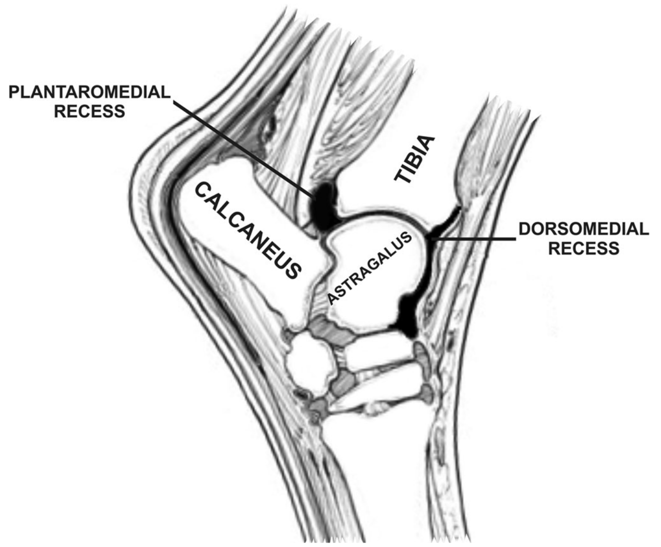

Figure 1. Sagital schematic representation of tarsal region. The plantarolateral recess (not shown here) is located laterally to the plantaromedial recess.

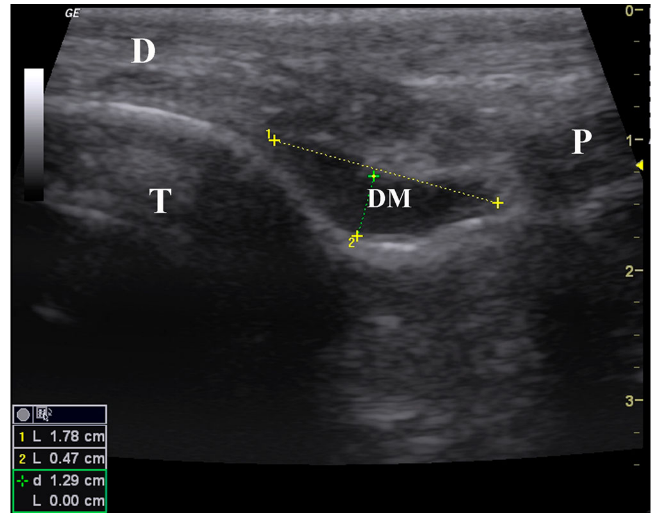

Figure 3. PLD measurement of the DM recess (1); depth measurements (2) were discarded in any recess because probe pressure can significantly alter its dimensions. T: tibia; D: dorsal; P: plantar; DM: dorsomedial recess.

the PLD dimension of dorsomedial recess was obtained. In the LT1 position, the probe was placed laterally over the tibiocalcaneal space, measuring the plantarolateral recess. Finally, the MT4 position was obtained in the same manner as the LT1 but was placed over the medial aspect, where the plantaromedial recess dimension was obtained (Figure 2). When possible, PD measurements were performed, turning the probe vertically.

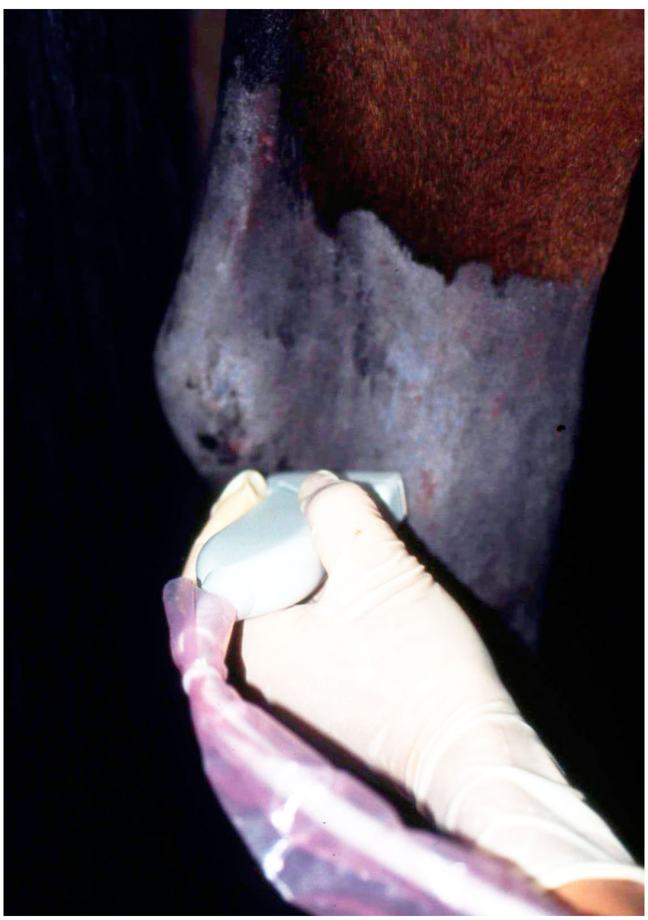

Figure 2. Positioning the probe over plantaromedial recess.

In order to obtain images of homogeneous echogenicity, the focus, contrast, and near-field gain controls were maintained in the middle of their range during the whole study.

Images were obtained by three faculty clinicians (JMV, LP, and MDB), experienced in equine musculoskeletal ultrasound. All of them were blinded to each other's measurements. Repeat measurements were taken if the variance among the three operators was >10%.

2.3. Statistical analysis

The mean, standard deviation (SD), median, minimum and maximum values, percentiles 5% and 95%, and standard error (SE) for all PD and PLD measurements were obtained.

To compare the diameter of the recesses between left and right limbs, the Wilcoxon test for paired data was used because of the absence of normality.

3. Results

The mean age for the horses was (mean ± SD) 7.25 ± 2.84; no significant difference between males and females was found (Wilcoxon test p-value = .1156). The mean height at the withers was 159.8 ± 2.95 cm; the difference between males and females was again not significant (t-test p-value = .2133).

Synovial fluid and membrane were identified, and their ultrasonographic appearance is discussed below. No joint capsule distention was required to obtain the measurement of any recess.

Main results are summarized in Table 1.

The *dorsomedial recess* (Figure 3) has shown a highly variable PLD diameter (0.11–0.90 cm); unfortunately, its PD measurement was impossible to determine due to its wideness in respect to the transducer contact surface.

Although the main values were equal or similar, the *plantarolateral recess* denoted the most variable dimensions

Table 1. Number of samples, mean, SD, median, minimum and maximum values, percentile 5 and 95%, and SE for all measurements.

	RDMR-H	LDMR-H	RPLR-H	LPLR-H	RPLR-V	LPLR-V	RPMR-H	LPMR-H
N	24	24	24	24	24	24	24	24
Mean	0.72	0.72	1.5	1.5	1.05	1.04	0.78	0.78
SD	0.26	0.23	0.40	0.38	0.45	0.43	0.08	0.09
Median	0.8	0.8	1.5	1.6	1.1	1.1	0.8	0.8
Min	0.11	0.11	0.7	0.7	0.3	0.3	0.7	0.6
Max	0.9	0.9	1.9	1.9	1.5	1.5	0.9	0.9
Perc 5%	0.11	0.11	0.75	0.79	0.35	0.39	0.7	0.66
Perc 95%	0.9	0.9	1.9	1.9	1.5	1.5	0.9	0.9
SE	0.05	0.04	0.08	0.07	0.09	0.08	0.01	0.02

Note: RDMR: right dorsomedial recess; LDMR: left dorsomedial recess; RPMR: right plantaromedial recess; LPMR left plantaromedial recess; LPLR: left plantarolateral recess; RPLR: right plantarolateral recess; H: PLD measurement; V: PD measurement.

Table 2. Wilcoxon test for paired samples.

	DMR	PLR-H	PLR-V	PMR
p-Value	.672	.465	1.000	.951

The *p*-values for the comparisons between right and left recesses are shown. In all cases, the hypothesis can be accepted, proving no significant differences between both sides. DMR: dorsomedial recess; PLR: plantarolateral recess; H: PLD measurement; V: PD measurement. PMR: plantaromedial recess.

(0.3–1.5 cm). In some cases, great differences have been found between the two tarsi of the same horse, specifically in five horses where one recess almost doubles the dimensions of the contralateral one.

The *plantaromedial recess* of the tarsocrural joint has a more homogeneous PLD diameter (0.6–0.9 cm) with 0.7 cm as a mean value, with a wide variation between both hocks. In this case, its PD dimension was impossible to measure.

No significant differences were found in any of the joint recesses when right and left limb measurements were compared (Figure 4, Table 2).

4. Discussion

The tarsus represents a very complex region to be evaluated, and for a successful use of ultrasounds, it requires a basic knowledge of the anatomy in that area (Denoix 2003; Reef 2004).

In our study, the three recesses of the tarsocrural joint could be identified and ultrasonographically measured. Previous bibliographical references regarding its dimensions have not been found. However, we could not provide PD and PLD dimensions of all studied recesses. This limitation could be solved by using of probes of different frequencies and/or using standoff pads to cover a wider field.

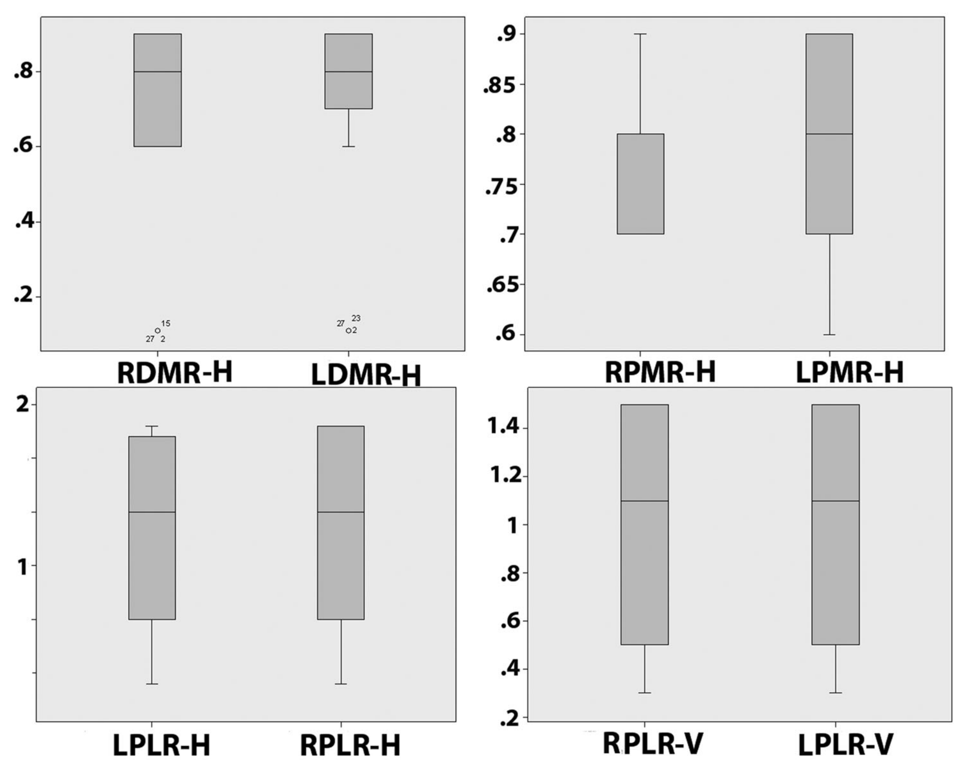

Figure 4. Boxplots corresponding to the considered variables in the left and right limb of the horse. A certain degree of asymmetry is present in all of the limbs and some outliers in RDMR-H and LDMR-R, but differences between left and right side were not significant. Unit: cm; RDMR: right dorsomedial recess; LDMR: left dorsomedial recess; RPLR: right plantarolateral recess; LPLR: left plantarolateral recess; RPMR: right plantaromedial recess; LPMR left plantaromedial recess; H: PLD measurement; V: PD measurement.

The depth of recesses was not measured, as its value highly depends on the pressure the probe applies.

We have found a large variation between the measures obtained from each articular recess in the different horses, finding the bigger range of oscillation (1.20 cm.) between the right and left plantarolateral recesses of some horses in their two diameters. This finding could have two explanations. First, some studies have reported that many horses have functional (directional) asymmetry (Lesniak 2013), which could have repercussions in the dimensions of some articular structures, such as the recesses. Second, some animals had previously competed in different racecourses, and the stress of racing, specifically in regards to left-leaning track turns, could explain these lateral differences. The most constant parameters have been in the horizontal diameter of the plantaromedial recess (0.20 cm of range), obtaining the maximum range (0.79 cm) for the transversal diameter of the dorsomedial recess.

Regarding measurements, different authors (Viitanen et al. 2003; Olive et al. 2014) noted that intra-articular pressure increases in horses in a standing, weight-bearing position; thus, this circumstance should be taken into account in order to obtain echographs in the same position so that it can be used accurately as reference data.

Several authors have determined that the normal synovial fluid is totally anechoic (Dik 1993; Chhem et al. 1994; Denoix et al. 1994; Smith and Webbon 1994), and the proliferation of the synovial villi must be considered like a particular condition of the synovial membrane, not necessarily associated to pathological conditions (Denoix 1996). In any case, it is believed that these structures can be identified by means of ultrasounds in the dorsomedial recess of the tarsocrural joint, like hypoechoic images floating in an anecogenic synovial fluid. However, on the 48 hocks examined in our study, we have found the synovial fluid anechoic, although differences in ultrasound machine, probe characteristics, and the setting of exploration parameters could explain this fact.

Diagnostic methods as contrast radiography and arthroscopy are considered invasive; however, ultrasound, as MRI, (Maher et al. 2011) allows non-invasive, non-irritating imaging of joint capsular abnormalities if distended. However, in non-distended joints, detailed ultrasonographic assessment of the joint capsule requires intra-articular injection of physiologic saline, thus making it an invasive imaging procedure (Dik 1993). This procedure obviously alters physiologic dimensions; for that reason, all our evaluated horses were animals that did not need such recess expansion in order to be measured.

5. Conclusion

The study of the articular recesses of the tarsocrural joint of the STH allowed us to establish that the greater variations are in plantarolateral recess of both right and left rear limbs, whereas the plantaromedial and dorsomedial recesses offered similar measurements when comparing both extremities of the same animal. In addition, the established echographic limits for the studied tarsal structures could serve as reference data for the accurate evaluation and comparison of pathological alterations of tarsus in STH horses; in this sense, any measurement outside these limits will be an indication of modifying changes of these structures.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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