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Short communication

High-field magnetic resonance imaging of a normal anatomy of the rabbit common calcanean tendon

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Abstract

The aim of the study was to evaluate the visualization of the rabbit common calcanean tendon and adjacent structures in the high-field magnetic resonance imaging (MRI) of 1.5 T field strength and to compare the results with those previously obtained for the low-field MRI (0.25 T). Eight New Zealand rabbits were used in the post-mortem study and the results indicate that the high-field MRI provides more detailed images only in transverse scans, where the outer outline of the tendon was visualized more accurately. Other analysed structures were imaged with a resolution comparable to the low-field MRI.

Key words: animal model, rabbit, anatomy, hf-MRI, common calcanean tendon

Introduction

Magnetic resonance imaging can contribute greatly to the evaluation of animal tendon models (Rodeo 2017). In tendinopathy research, laboratory animals are commonly utilized, but their relatively small sizes challenge technical capabilities of imaging equipment (Bottagisio and Lovati 2017). This study is a continuation of our previous research concerning the low-field magnetic resonance imaging (MRI) (Skalec et al. 2016). Generally, low-field MRI systems are characterized by the magnetic field strength of less than 0.5 T and high-field systems are recognized by some authors as more than 1 T (Hayashi et al. 2004). The objective of the present study was to investigate the utility of the high-field MRI in the evaluation of the common calcanean tendon (CCT) of the rabbit and to compare the visualization of the anatomical details with low-field MRI scans obtained and described previously (Skalec et al. 2016).

Materials and Methods

The study consisted in post-mortem, high-field MRI examination of 8 skeletally-mature female New Zealand rabbits of a mean body weight of 4.53 kg (4.32 kg – 4.75 kg). The animals were euthanized with overdose of pentobarbital (200 mg/kg intravenously) in the course of a different experiment, neither related to this study nor to pelvic limb pathologies (approval

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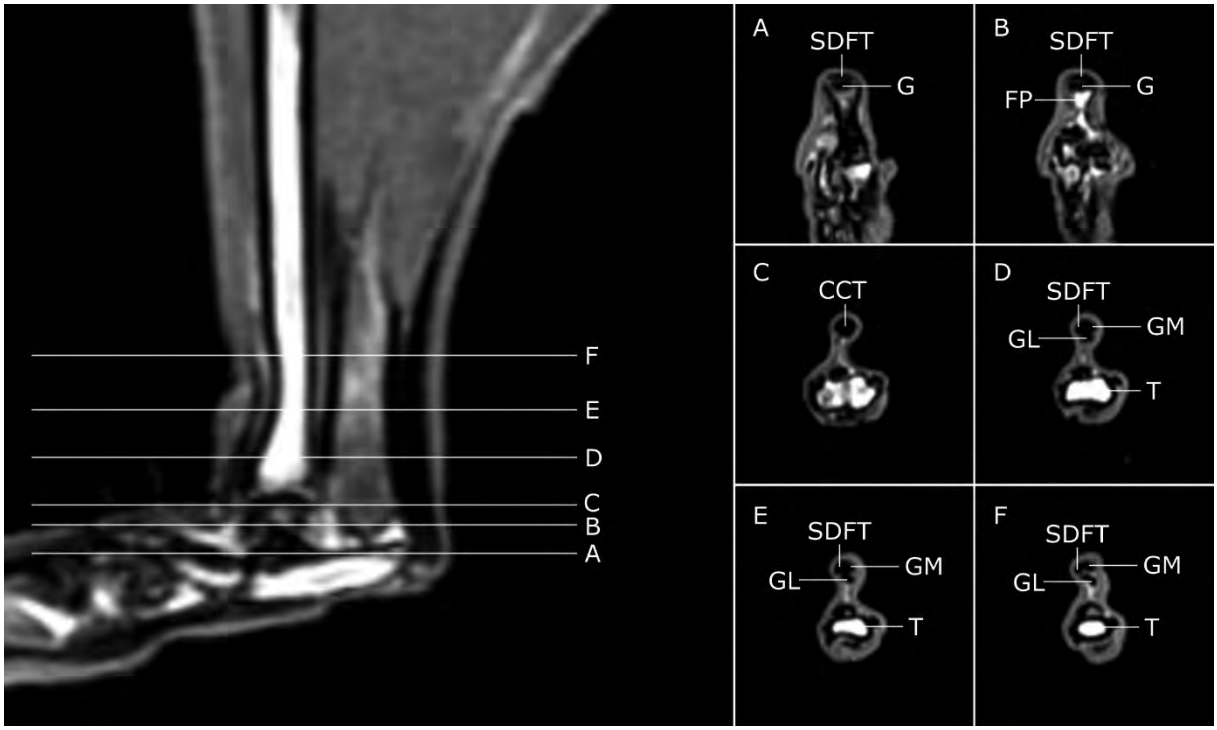

Fig. 1. T1–weighted (T1-W) sagittal high-field magnetic resonance scan of the rabbit common calcanean tendon (CCT) (left side) with lines indicating the positions of transverse T1-W scans presented on the right, (A) at the level of the calcaneal tuber; (B) 3 mm proximal; (C) 5 mm; (D) 10 mm; (E) 15 mm and (F) 20 mm proximal, respectively. The transverse cross-section of the CCT at the insertional portion is almost flat (A) and ovoid (B) with a thin line separating two contributing tendons. Proximal, the shape of the CCT changes to round (C) and the distinction between individual tendons is not possible. More proximal the CCT presents a trefoil (D) and fungi-like shape (E). Then, the tendons are beginning to be separated by the muscle tissue at the level of musculotendinous junction (F). *G* – fused tendons of the garstrocnemius; *GL* – tendon of the lateral and *GM* – tendon of the medial head of the gastrocnemius; *SDFT* – superficial digital flexor tendon; *CCT* – common calcanean tendon; *FP* – pre-Achilles fat pad; *T* – tibia.

by II Local Ethics Committee of Wrocław University of Environmental and Life Sciences, Poland, decision No. 110/2015). The CCT of both pelvic limbs in each rabbit were imaged with the Philips Ingenia 1.5 T MRI Scanner® within 48 hours after euthanasia, using a dStream HeadSpine coil® (integrated coil solution type, maximum number of channels - 15). Obtained MRI scans included T1–W SE 3D sequence [repetition time (TR) 25 ms, echo time (TE) shortest 4.9 ms, field of view (FOV) 220*220*63 mm, matrix 292*293, number of excitations (NEX) 2, slice thickness (S) 0.375 mm, interslice gap (G) 0 mm, voxel 0.375*0.75*0.75, acquisition time (time) 14:05 min:s], transverse T2-W TSE (TR shortest 6027 ms, TE 100 ms, FOV 160*148*74 mm, matrix 356*255, NEX 6, S 2 mm, G 0.5 mm, voxel 0.45*0.65*2, time 10:21 min:s) and sagittal T2-W TSE sequence (TR shortest 6050 ms, TE 100 ms, FOV 218*203*66 mm, matrix 484*345, NEX 6, S 2 mm, G 0.22 mm, voxel 0.56*2*0.45, time 14:03 min:s). An analysis of all obtained scans was undertaken analogically to that applied in the previous study (Skalec et al. 2016), using qualitative description based on visualisation of particular components of the CCT, i.e., the medial and lateral gastrocnemius tendons and the superficial digital flexor tendon**.** Signal intensity of the tendons, their musculotendinous junctions, the region of calcaneal insertion, the paratenon, the pre-Achilles fat pad and the bursa of calcaneal tendon were also assessed (Harris and Peduto 2006). The anatomical details presented in T1-weighted sequence were compared and referred to the previously described T1-wieghted low-field MRI (0.25 T) scans of the rabbit CCT (Skalec et al. 2016).

Results and Discussion

The CCT presented a low signal intensity in all the sequences analysed. The same, as in the low-field MRI (Skalec et al. 2016), linear areas of higher signal intensity representing the epitenon were visible in T1-weighted sagittal scans, but still, individual components of the CCT could not be identified. Only at the level of the calcaneal tuber, the conjoined tendons of gastrocnemius were easily distinguishable from the superficial digital flexor tendon, separated by a thin line of higher signal intensity. In contrast to low-field MRI, this separation was also visible in transverse

T1-weighted scans at the level of the calcaneal tuber and up to 3 mm proximal. However, clear and definite distinction between the lateral and medial gastrocnemius tendons and the superficial digital flexor tendon was not possible at any other location. The high-field MRI provided better delineation of the outer outline of the CCT transverse cross-sections than the low-field MRI, but internal boundaries of the individual tendons were not visible. Therefore, it was only possible to indicate the position of particular tendons, but any attempts of morphometric measurements would not be reliable (Fig. 1). The rest of the analysed structures was imaged with a resolution comparable to low-field MRI (Skalec et al. 2016). Although Doherty et al. (2006) and Trudel et al. (2007) did perform the morphometric measurements of the individual components of the CCT in the rabbit using 1.5 Tesla scanner, our results do not allow us to do it accurately. Nevertheless, we consider high-field MRI to be a suitable technique for the assessment of the common calcanean tendon in rabbits giving more detailed transverse scans than the low-field magnetic resonance.

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