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Singularities of digital flexor tendons in the Catalan Pyrenean Horse

Singularidades dos tendões flexores digitais no Cavalo Pirineu Catalão

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ABSTRACT

The gross anatomy of the digital flexors tendons and the distal accessory ligament of the Catalan Pyrenean Horse, an equine trait breed from Catalonia (NE Spain), is presented here. Research has been based on the dissection of isolated 10 right forelimbs, 10 left forelimbs, six right hindlimbs and five left hindlimbs (total 31 distal limbs) from clinically normal yearlings, about 12 months of age. Tendons dimensions tended to be bigger than those reported in the literature, probably due to breed, age, bodyweight, withers height and exercise programme. Distal accessory ligament was sometimes absent. Data intend to serve as standard manual data for this breed but also for other trait breeds, being the present study the first one on the subject.

KEYWORDS: deep digital flexor tendon**,** distal accessory ligament, morphometry, superficial digital flexor tendon.

RESUMO

A anatomia dos tendões flexores digitais e o ligamento acessório distal do Cavalo Pirineu Catalão, uma raça de equinos de tração da Catalunha (NE Espanha) está apresentada aqui. A pesquisa se baseou na dissecação para isolamento de 10 membros anteriores direitos, 10 membros anteriores esquerdos, seis membros posteriores direitos e cinco membros posteriores esquerdos (total de 31 membros) de animais clinicamente normais, com cerca de 12 meses de idade. As dimensões dos tendões tendem a ser maiores do que as relatadas na literatura, provavelmente devido à raça, idade, peso corporal, altura de cernelha e programa de exercício. O ligamento acessório distal às vezes estava ausente. Os dados pretendem servir como padrões para essa raça, mas também para outras raças de tração, sendo o presente estudo o primeiro sobre o assunto.

PALAVRAS-CHAVE: tendão flexor digital profundo, ligamento distal acessório, morfometria, tendão flexor digital superficial.

The locomotor anatomy of the horse distal limb is almost entirely based on tendons, ligaments and bone (DENOIX 1994, BARONE 1999). The superficial digital flexor muscle of the forelimb (SDF, *flexor digitorum [digitalis] superficialis*) is located in the middle of the flexor groups of muscles between the flexor carpi ulnaris and the deep digital flexor. The tendon of the superficial digital flexor tendon (SDFT) becomes a thick to be inserted on the proximal eminencies of the middle phalanx, palmar to the collateral ligaments, and the distal aspect of the proximal phalanx (BARONE 2000). The deep digital flexor (DDF, *flexor digitorum [digitalis] profundus*) becomes a tendon (DDFT) just above the carpus (knee) and runs all the way down the limb to insert on the coffin bone (BARONE 2000). This tendon is very important in locomotion because it flexes the hoof as the horse moves. It also acts as part of the "suspensory apparatus" as part of the "sling". The distal accessory ligament of the deep digital flexor tendon (DAL, *lig. accessorium*, clinically termed "check ligament") is a small ligament that courses from below the fetlock to attach onto the deep digital flexor tendon (NAGY & DYSONM 2010, ICVGAN 2012). It courses from below the fetlock to attach onto the DDFT (BARONE 2000). It is weaker in hindlimbs than in forelimbs, sometimes being absent in hindlimbs (SISSON & GROSSMAN 1982).

Ecographical studies of the digital flexor tendons performed have reported morphometrical differences between breeds (VOSUGH et al. 2017) and between fore and hindlimbs (DENOIX & BUSONI 1999) so knowledge regarding the normal measurements of the flexor tendons for a specific breed had to be imperative before determining any pathological variations associated with the tendons (VOSUGH et al.

2017).

The purpose of this paper is to describe the gross anatomy of the digital flexor tendons of the Catalan Pyrenean Horse, an hypermetrical equine trait breed from Catalonia (NE Spain) (PARÉS-CASANOVA & OOSTERLINCK 2012). Until now, no study of the measurements and proportions of flexor tendons for this breed has been done, and studies on other trait horse are very scarce, so presented morphometric evaluation in the present study can give important information for trait breeds.

Isolated limbs of 10 right forelimbs, 10 left forelimbs, six right hindlimbs and five left hindlimbs (total 31 distal limbs) from yearlings belonging to Catalan Pyrenean breed, about 12 months of age, were obtained randomly from a commercial abattoir in Alt Urgell (Catalonia). The animals were sold from private farms to the slaughterhouse for commercial purposes (meat) and were apparently sound with no lameness. At the abattoir, the limbs were severed 15 cm proximal to the basipodial joint. Coat (black, chestnut and bay) and pigmentation of hooves (pigmented, non-pigmented and stripped) were registered, but gender and exact age was unknown.

At our laboratory, limbs were carefully dissected and cleaned to expose the tendons. This was done by second author (EB). The following parameters were measured for each tendon using a digital calliper, always at the same level (most proximal part of metapodium): thickness (palmaro-dorsal distance; PD) and width (latero-medial distance), following standard procedures (ÇELIMLI et al. 2010). The measurements were then statistically analysed. First, a NPMANOVA ("Non Parametric Multivariate ANalysis Of VAriance") was performed using Euclidean distances. Mann-Whitney *U* test was used for comparison of the parameters between fore and hindlimbs. Finally, Analysis were done with PAST v. 2.17c software (HAMMER et al. 2001). *P* values less than 0.05 were considered as statistically significant.

NPMANOVA showed no influence of coat, hoof pigmentation and laterality on tendons measurement ($p>0.1$), but it appeared between fore and hindlimbs ($p=0.0001$). In two hindlimbs (6.5% of the total sample) the distal accessory ligament was absent. For fore and hindlimbs, differences were focused on superficial tendon width ($U=16$), deep tendon thickness ($U=46$), and accessory width ($U=2$) and thickness ($U=7$). Main values of morphometric parameters of tendons in fore and hindlimbs are shown in Table 1.

Table 1. Descriptive statistical values for superficial digital flexor (SDFT), deep digital flexor (DDFT) and distal accessory ligament (DAL) for forelimbs (n=20) and hindlimbs (n=11). Measurements in mm.

	SDFT width	SDFT thickness	DDFT width	DDFT thickness	DAL width	DAL thickness
Forelimb						
Min	11.2	5.8	11.4	5.5	2.8	2.8
Max	18.1	10.3	29.0	15.1	12.3	12.3
Mean	13.3	8.2	20.8	11.2	6.5	6.6
Standard deviation	1.7	1.2	5.0	2.1	1.9	2.0
Hindlimb						
Min	14.1	5.6	14.9	9.1	3.4	2.2
Max	20.5	9.1	20.8	15.8	6.6	3.9
Mean	17.5	7.8	18.1	13.2	5.2	3.0
Standard deviation	2.0	1.0	1.7	1.9	0.9	0.6

Digital tendons in horse are easily accessible by palpation and image techniques, transferring the force of muscles to the phalanges. Their thickness greatly varies based on anatomical and breed but also between fore and hindlimbs, so a detailed anatomic description is desirable for each breed. Many studies of morphometric evaluation of digital flexor tendons based on diagnostic procedures are available (MARTÍNEZ MARTÍNEZ 2005, PLAZA ILIANES 2006) but researches on cadaveric tendons are very less. SEYREK-INTAS et al. (1998) determined *ante mortem* thickness of the SDFT, DDFT, AL and SL in Turkish native horses and compared this with *post mortem* measurements. María de los Llanos Martínez (MARTÍNEZ MARTÍNEZ 2005) found the limb had an effect on cross-sectional area of each tendon, being higher among right limbs, although other researchers have found no significant difference between left and right pairs (VOSUGH et al. 2017). In horses, morphological differences between the left and right limbs have been reported in bone size, muscular development and hoof dimensions (HOBBS et al. 2018) but this does not seem the case in Pyrenean Horse.

The comparison of the tendon measures revealed that they were bigger than those reported for

Arabian horses (VOSUGH et al. 2017) and Thoroughbreds (ÇELIMLI et al. 2010), except for SDFT width which appeared similar to those described for these breeds. Differences in tendon dimensions reported in the literature are thought to be due to breed, age, bodyweight (average 215.9 kg carcass weight) (PARÉS-CASANOVA 2014), height and height (average 154.27 withers height for males) (INFANTE 2011) and exercise programme. Bigger ligament measurements in the Pyrenean horses in this study could be explained by the fact that they are higher at the withers, have a bigger bodyweight and are less slim and fine-built than other breeds. The fact that CPC are never trained (it is a meat purpose breed) is also a factor that has to be considered because training affects the cross-sectional area of the tendons (VOSUGH et al. 2017) must also explain a part of these differences. No side differences appeared, this symmetry being similar to that reported by other authors (ARISTIZÁBAL et al. 2005).

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