

## MORPHOLOGICAL ASPECTS OF FLEXOR FACE OF DIGITS OF CROSSBRED NELORE HEIFERS

### ASPECTOS MORFOLÓGICOS DA FACE FLEXORA DOS DÍGITOS DE NOVILHAS MISTIÇAS DA RAÇA NELORE

M. A. BERLINGIERI<sup>1</sup>; J. W. CATTELAN<sup>2</sup>; S. M. BARALDI ARTONI<sup>2\*</sup>

#### SUMMARY

In this research anatomical aspects from the flexor face of the digits of 20 crossbred Nelore heifers, aged between 24 and 36 months and bred in extensive system, have been investigated. The anatomical parts supplied by a slaughterhouse under supervision by the Official Inspection Service were kept frozen at -18°C until dissection. After shaving and cleaning the distal regions to the metacarpal and metatarsal, the palmar and plantar surfaces of the digits were dissected at room temperature, with the aid of intrasynovial injection in the digital flexor tendon sheath with 7,5mL of saturated solution of acid picric for each studied digit. The anatomical structures identified and described using this technique included accessory ligaments of the distal paracarpal, plantar and palmar annular ligaments, digital flexor tendon sheath, proximal and distal annular ligaments, distal interdigital ligaments, *manica flexoria* and superficial and deep digital flexor tendons as well. The dissection technique proposed in this research was considered useful for performing anatomical studies on the flexor face of the digits. It is also suggested for other members where tendon and respective tendon sheath and annular ligaments exist for a detailed description of the observed anatomical findings.

**KEY-WORDS:** Cattle. Tendon digital sheath. Flexor tendons. Digit. Morphology.

#### RESUMO

Nesta pesquisa foram investigados aspectos anatômicos da face flexora dos dígitos de 20 novilhas mestiças da raça Nelore, com idades entre 24 e 36 meses, criadas em sistema extensivo. O material foi proveniente de frigorífico sob Fiscalização do Serviço de Inspeção Oficial e mantido sob congelamento a -18°C até o momento da dissecação. Após tricotomia e limpeza das regiões distais ao metacarpo e metatarso, as faces palmar e plantar dos dígitos foram dissecadas à temperatura ambiente e com o auxílio de injeção intrassinovial da bainha digital tendínea com 7,5mL de solução saturada de ácido pícrico para cada dígito estudado. Com o uso desta técnica, as estruturas anatômicas identificadas e descritas incluíram os ligamentos acessórios distais dos paracarpais, os ligamentos anulares palmares e plantares, a bainha digital tendínea, os ligamentos anulares proximais e distais, os ligamentos interdigitais distais, a *manica flexoria* e os tendões flexores digitais superficiais e profundos. A técnica de dissecação empregada nesta pesquisa foi considerada útil para a realização de estudos anatômicos na face flexora dos dígitos e sugere-se que possa ser adotada na dissecação de outras regiões de membros onde existam tendões e respectivas bainhas tendíneas e ligamentos anulares, com o objetivo de descrição detalhada dos achados anatômicos observados.

**PALAVRAS-CHAVE:** Bovino. Bainha digital tendínea. Dígito. Morfologia. Tendões flexores.

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<sup>1</sup> Graduate student, FCAV- Universidade Estadual Paulista "Júlio de Mesquita Filho"-UNESP-Jaboticabal.

<sup>2</sup> Professors, FCAV- Universidade Estadual Paulista "Júlio de Mesquita Filho"-UNESP-via de acesso Prof. Paulo Donato Castellane, s/n, ZIP: 14884-900, Jaboticabal, SP, Brazil.

\* Corresponding author

## INTRODUCTION

Lameness is common and extremely important in cattle. Clinical manifestations of discomfort and pain caused by injuries and abnormal distribution of weight, result in joint, tendon and ligaments overload, predisposing the area to distal limb injuries (REBHUN, 1995). In cattle, lameness originates in the hoof or in areas directly connected to it (PETERSE, 1992).

Locomotor and cutaneous structures of the digits between the thoracic and pelvic limbs are similar. The most common orthopedic conditions in cattle are verified in the pelvic limbs, especially on the nail side. Although the reason is not well understood, weight distribution is considered to be the most relevant factor (DYCE et al.,1997).

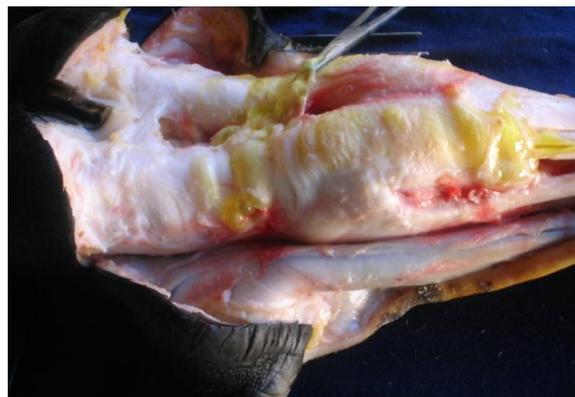
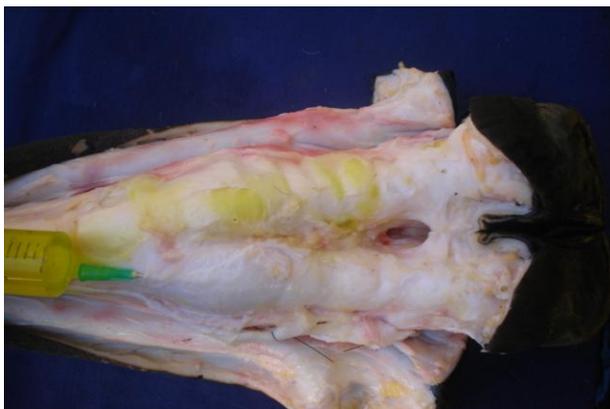
Synovial cavity infections are common causes of distal phalangeal deformities in cattle, and both distal interphalangeal joint and digital flexor tendon sheath are often affected as well, especially when there are puncture wounds on the proximal or distal digits (KOFLEK & MARTINEK, 2005). Anderson & St-Jean (1996) consider that, although unusual, the distal involvement of the digital flexor tendon sheath, the clinical signs involved are similar to sepsis of the distal interphalangeal joint and navicular *bursa*.

The recent interest to adopt conservative surgical techniques to treat bovine digital disorders (ANDERSON, 1997; KOFLEK & MARTINEK, 2005) coupled with lack of detailed anatomical information of digital flexor structures justify additional research on the subject. Therefore, this work focuses on structures that make up the face of bovine flexor digit, with emphasis on the digital tendon sheath and its flexor tendons in order to add information about these anatomical structures.

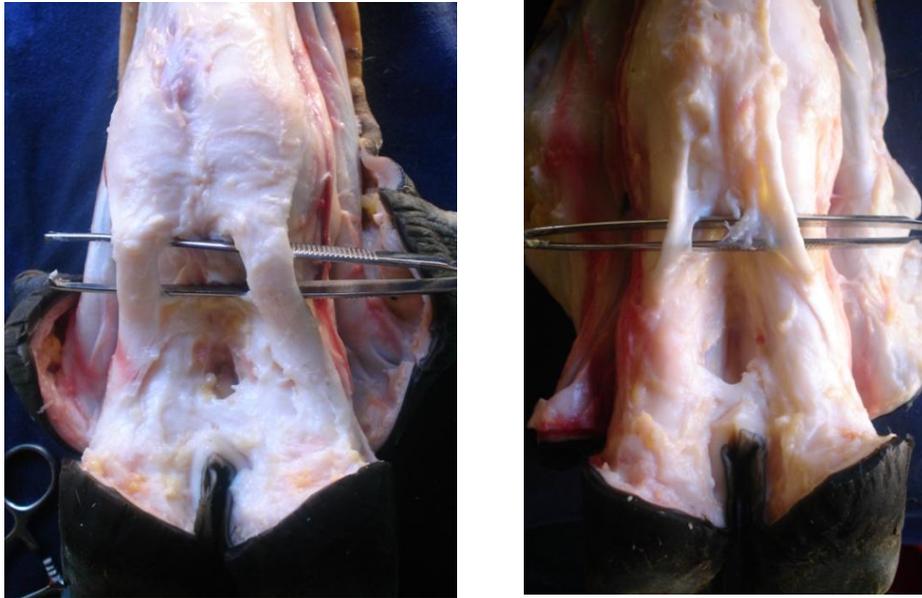
## MATERIAL AND METHODS

In this research, 40 forelimbs and 40 pelvic limbs of healthy cattle supplied by a slaughterhouse under supervision by the Official Inspection Service were used. The parts were obtained from 20 female crossbred Nelore aged between 24 and 36 months and raised under extensive management. These parts, separated at the radiocarpal joints (thoracic limbs) and tibial-tarsal (hind limb), were identified, numbered, packed in plastic bags and kept frozen (-18°C) until dissection. When each limb was then thawed, cleaned under running water and shaved on the palmar, plantar, lateral and medial faces from the proximal metacarpal and metatarsal region up to the coronary region.

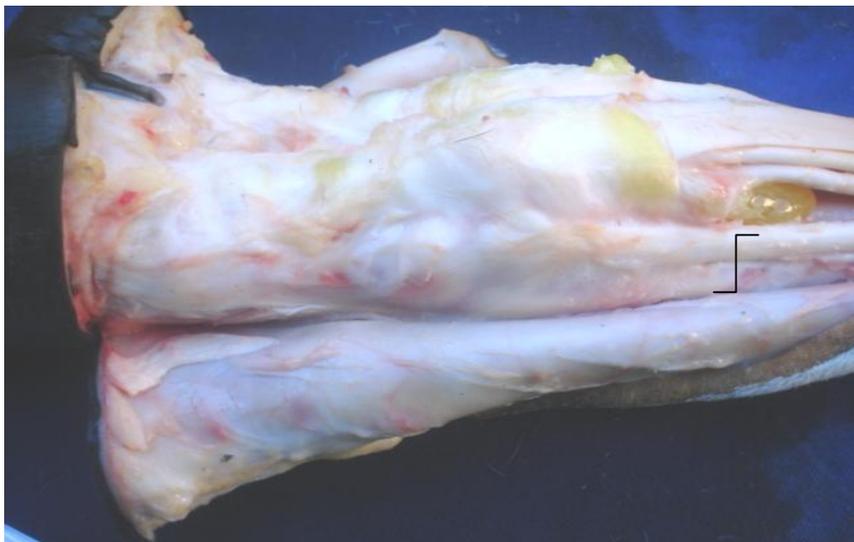
The dissection technique of the flexor face was standardized for thoracic and pelvic antimeres. The specimens were dissected at room temperature after thawing through a skin incision of about 20 cm from the middle thirds of the palmar and plantar metatarsal and metacarpal regions up to the interdigital space, bypassing the bulbs and coronary regions of digits III and IV. This was followed by a blunt dilation of the subcutaneous tissue, including the paradigits to achieve better exposure of deep flexor structures. An intrasynovial injection of saturated solution of picric acid in 7.5 mL volume for each digit, was used in order to better visualize the digital tendon sheaths and the anatomical structures included. The solution was injected using a 20 mL syringe coupled to a 25X8G needle gauge, introduced in the distal metacarpal and metatarsal regions, right before where the sheath separates in each digit. Subsequently, the hole resulting from the drilling was obliterated with cyanoacrylate ester adhesive to prevent the solution from overflowing (Figure 1).



**Figure 1** - Anatomical preparation of cattle thoracic limb showing the injected saturated solution of picric acid in the tendon digital sheath and the yellow color conferred by the contrast.



**Figure 2** - Palmar and plantar plans of the anatomical preparations of the thoracic (left) and pelvic (right) right limb of heifer no. 7, showing distal accessory ligaments of the paracarpals isolated by dissection tweezers. Observe the differences of thickness and width of these ligaments between the thoracic (left) and pelvic (right) digits.



**Figure 3** - Anatomical preparation of the right pelvic limb showing the plantar recess (arrow) of the digital tendon sheath under digital flexor tendons, superficial and deep, and the intraosseous muscle band.

The digital tendon sheaths of digits III and IV were distally removed in the metacarpophalangeal and metatarsophalangeal regions for visualization, identification and description of anatomical structures contained within it. *Nomina Anatomica Veterinaria* (NAV, 2005) was used to describe the anatomical findings.

## RESULTS AND DISCUSSION

The external structures of limb distal face that were observed before the actual dissection included digits II and V, which are non-functional and also known as rudimentary, vestigial digits or paradigits. These structures are attached to palmar and plantar surfaces of metacarpophalangeal and metatarsophalangeal regions by a tissue that adheres to palmar and plantar annular ligaments and by accessory ligaments of the distal paradigit that extend to the coronary region. Digits III and IV, considered the most important are functional and responsible for supporting animal weight, corroborating descriptions by Dyce et al. (1997) and König & Liebich (2002).

The technique used in this research allowed to visualize and describe, individually and sequentially, anatomical structures such as accessory ligament of the distal paradigit, palmar and plantar annular ligament, digital tendon flexor sheath, distal and proximal annular ligaments, distal interdigital ligaments, *manica flexoria* and superficial and deep digital flexor tendons. After skin incision and dilation of the subcutaneous tissue, it was observed that externally to the digital tendon sheath, the palmar and plantar annular ligaments are arranged as a thick tape involving palmar and plantar surfaces of the metacarpophalangeal and metatarsophalangeal regions, respectively. Disposed distally and attached to palmar and plantar annular ligaments followed accessory ligaments of the distal paradigit up until the abaxial face of the coronary region.

During dissection, it was observed that accessory ligaments of the distal paradigit are wider and thicker in thoracic limbs compared to pelvic limbs (Figure 2). Dyce et al. (1997) described these palmar and plantar annular ligaments as thick membranous conjunctive tissue that joins the palmar and plantar faces of paradigits in the metacarpophalangeal and metatarsophalangeal regions, towards the abaxial faces of the coronary region. König & Liebich (2002) considered that the union of the paradigit to metacarpophalangeal and metatarsophalangeal regions is due to this membranous conjunctive tissue forming the distal and proximal ligaments that sustain these structures and are fixed on these regions by accessory ligaments.

The digital tendon sheath of all examined digits were clearly visualized after injection of 7.5 mL of picric acid saturated solution. It was observed in all anatomical preparations that distal portions of palmar and plantar surfaces of the metacarpals and metatarsals that the tendon sheaths of digits III and IV communicate. This finding was also reported by Kofler

& Martinek (2005); however, these authors mentioned that communication between digits III and IV occurs occasionally. The digital tendon sheath originates 6 to 8 cm from the metacarpophalangeal and metatarsophalangeal regions (ANDERSON & St-JEAN, 1996) covers palmar and plantar faces, including flexor tendons (KÖNIG & LIEBICH, 2002), and extends to up to the coronary region (ANDERSON & St-JEAN, 1996).

Inside the digital tendon sheath, it could be seen digital flexor tendons, superficial and deep as well, from the distal portion of the metacarpal and metatarsal up to axial and abaxial faces of coronary regions. A synovial recess could be seen on abaxial and axial digits. According to König & Liebich (2002), palmar and plantar recesses are located under intraosseous ligaments and superficial and deep digital flexor tendons (Figure 3). The distal limit of the digital tendon sheath extends to the distal phalanx of each digit (KÖNIG & LIEBICH, 2002).

Distal interdigital ligaments (Figure 4) are responsible for joining deep digital flexor tendons to the phalanges. The proximal annular ligament lies over the area where the deep digital flexor tendon is separated from the *manica flexoria* (Figure 4) and the distal annular ligament on the insertion area of the superficial digital flexor tendon. Annular ligaments are attached to the digital tendon sheath and are responsible for limiting the movement of superficial and deep digital flexor tendons in the distal region (Figure 4).

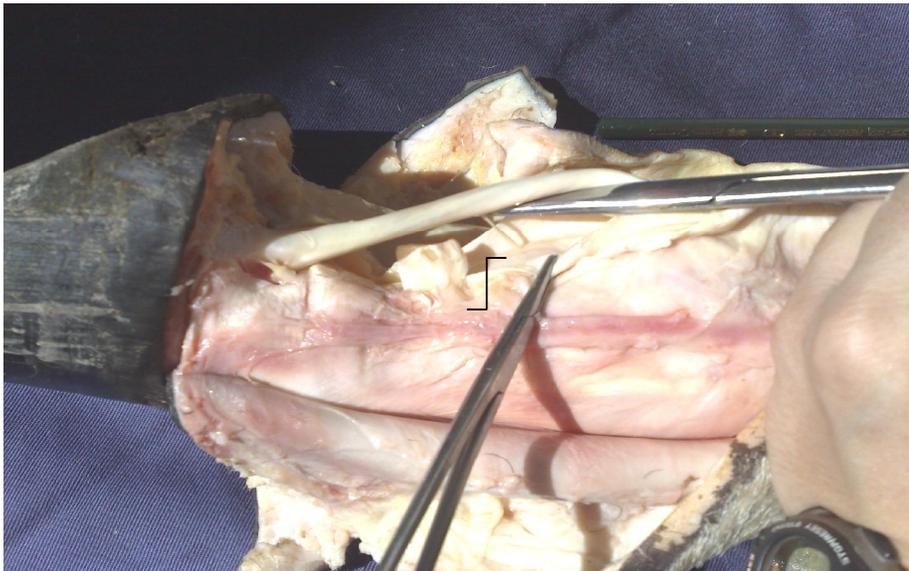
Dyce et al. (1997) reported that in the region distal to the proximal sesamoid bones, digital flexor tendons, superficial and deep, are kept in contact with proximal phalanges, where they remain suspended by two proximal and distal annular ligaments. Distally to distal digital annular ligaments, a thick and wide ligamentous band in the palmar and plantar surfaces of each digit covers the middle phalanx and the deep digital flexor tendon bypassing the coronary region in the axial direction, where a crossover and entanglement of fibers joins digits III and IV, which are called distal interdigital ligaments (GETTY, 1986; DYCE et al. 1997). Dyce et al. (1997) and König & Liebich (2002) described proximal and distal annular ligaments and distal interdigital ligaments as interdigital flexor ligaments responsible for involving superficial and deep digital flexor tendons on palmar and plantar faces of the digits.

Internally to digital tendon sheath, superficial and deep digital flexor tendons could be visualized and described. In the forelimbs, the superficial digital flexor tendon shows its muscular portion arising from the medial epicondyle of the humerus, obliquely to the metacarpal. This is in accordance with the descriptions given by Desrochers & Anderson (2001) and König & Liebich (2002). The muscle of the hind limbs originates in the distal and caudal portions of the femur and inserts itself on the calcaneal tuberosity, confirming the findings of Desrochers & Anderson (2001).

The deep digital flexor tendons in the forelimbs, originate in the medial epicondyle of the humerus,



**Figure 4** - Anatomical preparations of the left thoracic limb showing (proximal-distal axis) proximal and distal ligaments (left) and distal interdigital ligament of digit III. On the right, it is shown the *manica flexoria* of digit IV over dissection tweezers and the superficial digital flexor tendon covering the deep flexor tendon.



**Figure 5** - Anatomical preparation of the right thoracic limb of cattle showing the *vinculum tendinis* (arrow).

from the three heads, humerus, radial and ulnar, have five expansions that are joined in the distal forearm and cross the carpal region medially to the accessory bone. This observation is in agreement with Getty (1986), Dyce et al. (1997), König & Liebich (2002) and Kofler & Martinek (2005). In the hind limbs, they originate from caudal and proximal faces of the tibia and fibula, through the medial face of the calcaneus within the tarsal sheath, which has also been described by Desrochers & Anderson (2001).

In the fore and hind limbs, digital flexor tendons fuse into a short tendon common to the distal thirds of the metacarpal and metatarsal. When the superficial digital flexor tendons cross the metacarpophalangeal and metatarsophalangeal regions, they are assisted by a band of intraosseous muscles encompassing the deep digital flexor tendon, which runs from the distal insertion of the superficial digital flexor tendon on palmar and plantar faces of the middle phalanx and continue distally on the distal sesamoid bone to its insertion into the flexor tuberosity of the distal phalanx. These findings corroborated the descriptions by Godinho (s.d.), Getty (1989), Stanek (1997), König & Liebich (2002) and NAV (2005).

The union of superficial digital flexor tendons and the intraosseous muscle band on plantar and palmar faces of metacarpal and metatarsal phalangeal regions, including the deep digital flexor tendon in this region, is called *manica flexoria* (Figure 4) (GODINHO, s.d.; GETTY, 1986; STANEK, 1997; KÖNIG & LIEBICH, 2002; NAV, 2005).

WAIBL et al. (2001) reported the existence of a cord like elastic structure inside the digital tendon sheath connecting the deep digital flexor tendon to the dorsal face of the *manica flexoria*, which was called vinculum tendinitis (Figure 5) and reported that such structure is only found in the distal portion of the *manica flexoria*, where the digital tendon sheath covers the deep digital flexor tendon. Vinculum tendinitis is a neurovascular bundle, Stanek (1988) described its importance in the blood and nerve supplies of the digital tendon sheath to the deep digital flexor tendons. In this research, the vinculum tendon was identified in every thoracic and pelvic limbs dissected. According to Waibl et al. (2001), vinculum tendon was identified macroscopically in 40 (66.66%) out of 60 hind limbs of adult cattle of unreported breed and gender.

## CONCLUSIONS

The dissection of cattle limbs, at room temperature, is suitable for anatomical identification of palmar and plantar digital structures. Intrasynovial injection of picric acid saturated solution in the digital tendon sheath ( 7.5 mL for each digit) is useful to visualize and determine proximal and distal limits of the digital tendon sheath and the anatomical structures contained therein. Therefore, it is suggested that the anatomical dissection technique described in this study can be used in other limb regions where tendons and respective tendon sheaths and annular ligaments are present in

order to give a detailed description of the anatomical findings.

## REFERENCES

ANDERSON, D. E.; St-JEAN, G. Diagnosis and management of tendon disorders in cattle. **Veterinary Clinics of North America: Food Animal Practice**, Philadelphia, v.12, p.85-116, 1996.

ANDERSON, D. E.; ALLEN, D.; St-JEAN G., PARKS, A. H. Use of a multifenestrated indwelling lavage system for treatment of septic digital tenosynovitis in cattle. **Australian Veterinary Journal**, Georgia, v.75, n.11, p.796-799, 1997.

DESROCHERS, A.; ANDERSON, D. E., Anatomy of the distal limb. **Veterinary Clinics of North America: Food Animal Practice**, Philadelphia, v.17, n.1, p.25-37, 2001.

DYCE, K. M.; SACK, W. O.; WENSING, C. J. G. **Tratado de anatomia veterinária: O membro anterior dos ruminantes**, 2. ed., Rio de Janeiro: Guanabara Koogan, p.579-581, 1997.

DYCE, K. M.; SACK, W. O.; WENSING, C. J. G. **Tratado de anatomia veterinária: O membro posterior dos ruminantes**, 2.ed., Rio de Janeiro: Guanabara Koogan, p.593, 1997.

GETTY, R. **Anatomia dos animais domésticos: Fâscias e músculos dos apêndices**, 5.ed., Rio de Janeiro: Guanabara Koogan, v.1, p.789-805, 1986.

GODINHO, H. P. **Anatomia dos ruminantes domésticos** – apostila didática. Belo Horizonte: Universidade Federal de Minas Gerais, s.d., 420p.

International Committee on Veterinary Gross Anatomical Nomenclature. **Nomina anatomica veterinaria**. Editorial Committee Hannover, Sed, Columbia, 2005.

KOFLER J.; MARTINEK, B. New surgical approach to the plantar fetlock joint through the digital flexor tendon sheath wall and suspensory ligament apparatus in cases of concurrent septic synovitis in two cattle. **The Veterinary Journal**, New York, v.169, p.370-375, 2005.

KÖNIG, H. E.; LIEBICH, H., **Anatomia dos animais domésticos: Músculos do dedo** - Texto e atlas colorido, Porto Alegre: Artmed, v.1, p.187-197, 2002.

KÖNIG, H. E.; LIEBICH, H., **Anatomia dos animais domésticos: Articulações dos dedos dos ruminantes** - Texto e atlas colorido, Porto Alegre: Artmed, v.1, p.161-165, 2002.

NICOLETTI, J. L. M. **Manual de Podologia Bovina**. Barueri: Manole. 2004. 126p.

PETERSE, D. J. Foot lameness. In: ANDREWS, A. H. et al. **Bovine medicine: diseases and husbandry of cattle**. London: Blackwell, 1992. p.353-363.

REBHUN, W. C. Musculoskeletal diseases. In: **Diseases of dairy cattle**. Philadelphia: Williams & Wilkins, 1995. p.369-406.

STANEK, C. Morphologische, funktionelle, chemische und klinische Untersuchungen zu den Erkrankungen der Fesselbeugeschnenscheide des Rindes, **Wien Tierärztliche Wochenschrift**, v.75, p.170-180.1988.

STANEK, C. Tendons and tendon sheaths. In: GREENOUGH, P. R.; WEAVER, A. D. **Lameness in cattle**, 3.ed. Philadelphia: Saunders, p.188-190. 1997.

WAIBL, H. H.; REHAGE, J., LORENZI P., CONSTANTINESCU, G. Zur angewandten Anatomie des distalen "Vinculum tendinis" in der Fesselbeugeschnenscheide der Beckengliedmabe des Rindes. **Deutsche Tierärztliche Wochenschrift**, Alfeld, v.108, p.261-263, 2001.