

Dept. of Anatomy.  
Fac. Vet. Med., South Valley university.

**DIGITAL TENDON SHEATH OF THE PES IN THE DONKEY  
AND ITS RELATION WITH THE ADJACENT SYNOVIAL  
STRUCTURES**  
(With 6 Figures)

By  
**SALMA A. MOHAMED**  
(Received at 24/6/2002)

الغمد الزلالي الأصبغي للقدم الخلفي في الحمار وعلاقته  
بالتراكيب الزلالية المجاورة

سلمى أحمد محمد

أجريت هذه الدراسة على عشرين حمرا بالغاً لدراسة موقع ومسار وعلاقة وبداية ونهاية الغمد الزلالي الأصبغي للقدم الخلفي. وقد تم تحديد طول وعرض ومساحة هذا الغمد. وقد وصفت الجيوب المختلفة لهذا الغمد وعلاقتها بالأربطة الحلقية في هذه المنطقة. ومن الجدير بالذكر أن جيوب الغمد الزلالي الأصبغي لقدم الحمار تقع تحت الجلد ولهذا فإنه يمكن حقن الغمد من خلالها. الغمد الزلالي الأصبغي ينفصل عن المفصل التابوتي وعن الكيس الزلالي الزورقي بواسطة شريط مستعرض رقيق نسبياً ولا يوجد اتصال بين هذه التراكيب الزلالية في القدم الخلفي للحمار.

**SUMMARY**

The present work was carried out on twenty healthy donkeys to study the position, course, relation, proximal and distal lines of attachment of the digital tendon sheath of the pes. The length, width and capacity of the sheath were determined. The different diverticula of the sheath and their relation with the annular ligaments were described. The diverticula of the digital tendon sheath are subcutaneously located, therefore the sheath can be injected through them. The sheath is separated from the coffin joint and the navicular bursa by relatively thin transverse band and there is no communication between these structures in the pes of the donkey.

*Key words: Digital tendon sheath pes donkey.*

## INTRODUCTION

Among our native domestic animals, the donkeys need a special attention due to their valuable importance as working animal. Tendovaginitis is one of the main causes of lameness in equine (Taylor, 1955). The digital tendon sheath is a common site of inflammation (Dyce *et al.*, 1996). The available literature lacks any data about the digital tendon sheath of the pes of the donkey. Hence the aim of the present study is to give detailed information on the morphology and radiology of this sheath and its relation with the other neighbouring synovial structures.

## MATERIAL and METHODS

This work was performed on 20 adult healthy donkeys of both sexes. Ten animals were bled thoroughly through the common carotid artery, injected with formalin and dissected for description of the morphological features and determination the dimensions of the digital tendon sheath. The remaining specimens were injected with gum milk latex and radiopaque substance (urographine) for studying the extension and communications of the sheath with the other adjacent synovial structures.

## RESULTS

The superficial and deep digital flexor tendons are enclosed by extensive common tendon sheath called digital tendon sheath (Fig. 1). The line of attachment of its beginning differs dorsally from plantarly. It commences dorsal to the flexor tendons by 17.24mm above the level of the proximal sesamoid bones, while plantarly the line of attachment lies 20.79mm above the previous bones. The sheath passes distally plantar to the terminal limbs of the M. interosseous medius as well as the proximal sesamoid bones and the intervening plantar ligament to gain the region of the proximal phalanx (Fig. 1). Here the digital tendon sheath continues its course distalwards plantar to the straight sesamoidean ligament and the plantar ligaments of the pastern joint to reach the middle phalanx where it terminates. The line of attachment of the sheath termination differs also dorsally from plantarly. On the dorsal aspect of the deep digital flexor tendon it ends 12.77mm below the level of the pastern joint, but on the plantar aspect of this tendon it terminates 6.31mm below the same joint.

After the termination of the superficial digital flexor tendon, the digital tendon sheath extends distally enclosing only the deep digital

flexor tendon (Fig. 1). Distal to the termination of the tendon sheath the latter tendon continues its course free from the sheath up to its insertion in the distal phalanx. At this area the tendon is related to the navicular bursa.

Within the vaginal cavity the superficial digital flexor tendon forms a tube lodging the deep digital flexor tendon (Figs. 1,2). The cavity of the tube communicates with the cavity of the tendon sheath through an elliptical opening. This opening lies on the dorsal wall of the tube facing the proximal sesamoid bones and the intervening plantar ligament. It begins opposite to the upper level of the proximal sesamoid bones and ends 12.0mm distal to these bones. The opening measures 52.77mm long and 15.27mm wide at its middle. It is wide at its middle but narrower at both ends. Its width at the middle is equal to that of the deep digital flexor tendon. The margin of the opening is thin proximally and distally but thick on both sides (Fig. 2). The deep digital flexor tendon has no connection with the tube proximally. However distally at the level of the middle of the proximal phalanx a connective tissue band 7.50mm wide extends from the dorsal aspect of the deep digital flexor tendon attaches the dorsal wall of the tube.

The superficial digital flexor tendon has a relatively wide mesotendon attaching to its plantar aspect. It extends from the beginning of the tendon sheath till the distal level of the fetlock joint. Below this level the plantar aspect of the superficial tendon is free from the tendon sheath because the fibrous layer of the sheath adheres this aspect of the tendon.

The fibrous layer of the digital tendon sheath attaches dorsally to the M. interosseous medius and its terminal limbs, the abaxial borders of the proximal sesamoid bones, the lateral borders of the straight and oblique sesamoidean ligaments and the adjacent area of the proximal phalanx and finally to the complementary fibrocartilage of the middle phalanx. Plantarly the fibrous layer is related to the skin and fascia, moreover it is replaced in some areas by three anular ligaments, which represent the thickening of the deep digital fascia (Fig.3).

The plantar anular ligament which extends between the abaxial borders of the proximal sesamoid bones replaces the fibrous layer of the sheath in the fetlock region. The proximal anular ligament has two limbs attaching to the sides of the proximal phalanx near the proximal and distal tubercles. It replaces the fibrous layer of the tendon sheath at the proximal two thirds of the proximal phalanx. The distal anular ligament attaches to the plantar aspect of the deep digital flexor tendon. Its

proximal concave border forms the distal boundary of the digital tendon sheath. The capsule of the sheath is thick where it is reinforced by the anular ligaments, on the contrary it is thin in the other areas, therefore it bulges forming a numbers of diverticula. As a result there is a relation between the position of the anular ligaments and the distribution of these diverticuta. The digital tendon sheath has three diverticula proximal, middle collateral and distal.

The proximal diverticulum (Figs. 1,3), extends between the proximal end of the tendon sheath and the upper border of the plantar anular ligament. The presence of the deep digital flexor tendon within the tube divides this diverticulum into three compartments, which are dorsal, middle and plantar, these compartments lie behind each other. The dorsal compartment is located between the dorsal wall of the sheath which covers the middle interosseous muscle and the dorsal wall of the tube. The middle and plantar compartments are located within the tube consequently surrounding the deep digital flexor tendon. The middle compartment lies between the dorsal wall of the tube and the deep flexor tendon and the plantar one between the tendon and the plantar wall of the tube or the superficial digital flexor tendon. The dorsal compartment extends above the proximal sesamoid bone by 17.24mm, the middle and plantar ones have the same level about 20.79mm above the latter bones. The three compartments communicate with each other through the opening of the tube.

The middle collateral diverticula (Fig. 3) include the medial and lateral ones. Each one comprises of two compartments which are located above and below the proximal limb of the proximal anular ligament. The proximal compartment is the smaller and lies between the lower border of the plantar anular ligament and the proximal limb of the proximal anular ligament, the distal compartment is situated between the two limbs of the latter ligament. The proximal and the middle collateral diverticula are related to the medial and lateral digital blood vessels and nerves.

The distal diverticulum is plantarly situated (Fig. 3). It lies at the level of the pastern joint between the deep digital flexor tendon dorsally, the skin and fascia plantarly, the lower border of the proximal anular ligament proximally and the upper border of the distal anular ligament distally.

From the clinical point of view the diverticula of the digital tendon sheath are subcutaneously located, therefore the injection of the sheath can be applied through them. Above and below the proximal

sesamoid bones the injection can be performed in the proximal and middle collateral diverticula respectively. At the level of the pastern joint the tendon sheath can be injected through the distal diverticulum.

During its course, the digital tendon sheath descends along the plantar aspect of the fetlock and pastern joints. Moreover it lies distally in close contact to the coffin joint and navicular bursa. The articular capsule of the fetlock joint extends proximally above the level of the proximal sesamoid bone forming a thin walled plantar pouch. This capsule is separated from the digital tendon sheath by the proximal sesamoid bones and the intervening plantar ligament, but its plantar pouch is separated from the sheath by the middle interosseous muscle and its terminal limbs. The articular capsule of the pastern joint and its small plantar pouch are separated from the digital tendon sheath by the plate of the fibrocartilage, straight sesamoidean ligament and the plantar ligaments of the pastern joint.

The navicular bursa and the coffin joint capsule extend proximally nearly to the same level about 5.53mm above the level of the distal sesamoid bone. A relatively thin transverse connective tissue band about 1.98mm thick separates the distal end of the digital tendon sheath from the previous two synovial structures. In general, the communications (Figs 4,5) between the digital tendon sheath and the neighbouring phalangeal joints in one hand and the navicular bursa in the other hand could not be demonstrated, except in 10% of the examined cases the sheath communicated with the fetlock joint (Fig. 6).

The digital tendon sheath measures 112.94mm long, 12.94, 25.30 and 21.75mm wide at the proximal end, at the level of fetlock joint and at the distal end respectively. Its capacity is 25ml.

#### DISCUSSION

The digital tendon sheath of the pes in the donkey is an extensive sheath, its capacity is 25ml. The manus of the camel has also extensive sheath (Ereisha, 1982). The capacity of this sheath in the pes of the camel is about 35-40ml (Karkoura, 1986), and in the mani of mule, buffalo and camel are 35, 37 and 40 ml respectively (Hifny *et al.*, 1988). According to the present study and the obtained literature the length of the digital tendon sheath varies in the different animals and also in the manus and pes of the same animal. In the pes of the examined donkeys it is 122.44mm, but in the manus of this animal it is 13.6cm (Abdalla *et al.*, 1988). In the pes of the camel it is 22cm (Karkoura, 1986), while in the manus of this animal, mule and buffalo is 15.7, 15.4

and 11.0cm respectively (Hifny *et al.*, 1988). In the manus of the horse the length of the sheath is 17-20cm (Seiferle and Frewein, 1986).

The present work shows that the proximal diverticulum which extends between the proximal end of the digital tendon sheath and the plantar anular ligament comprises of three compartments, lying behind each other. The dorsal compartment extends above the proximal sesamoid bones by 17.24mm, the middle and plantar ones have the same level about 20.79mm above the latter bones. The proximal end of the sheath is not palpable normally in the horse (DeLahunta and Habel, 1986). When the sheath distended bulges most noticeably above the proximal sesamoid bones (Dyce *et al.*, 1996). When it distended abnormally (tendovaginitis), the proximal diverticulum can easily be palpated above the fetlock joint between the flexor tendons and the limbs of the interosseous muscle (Seiferle and Frewein, 1986). In the proximal part of the sheath, the synovial membrane forms many folds and villi that increase its surface area for production and resorption of synovial fluid, a dynamic process that is normally in equilibrium (Smallwood, 1992).

The present study reveals that the digital tendon sheath, contains a tube lodging the deep digital flexor tendon, this tube faces the proximal sesamoid bones and the intervening plantar ligament. The tube has an elliptical opening which measures 52.77mm long and 15.27mm wide at its middle. The tube was also described in the manus of the mule, buffalo and camel by Hifny *et al.* (1988). From the anatomical point of view, the before mentioned authors stated that the opening results from the friction of the dorsal wall of the tube on the proximal sesamoid bones and the intervening ligament, consequently the tube increases in diameter as the dorsal wall is thin (mule and camel) and on the contrary in buffalo.

In the examined donkeys the digital tendon sheath is separated from the navicular bursa and the coffin joint by a relatively thin transverse connective tissue band about 1.98mm thick. Communication between these three structures is not demonstrated in this work. In the horse the three structures are in close proximity to each other. There is only a small T-shaped connective tissue bridge separates them. There is no communication between the bursa and joint, but in some foals (not in adult) communication between the bursa and joint was demonstrated (Smallwood, 1992).

Concerning the relation of the digital tendon sheath and the fetlock and the interphalangeal joints, the present findings indicate generally that there is no communication between the sheath and these

joints in the pes of the donkey, but in 10% of the examined cases the communication between the sheath and fetlock joint was observed. In the horse, the proximal palmar pouch of the coffin joint is in contact with the connective tissue that extends from the deep flexor to the middle phalanx, and the pouch communicates through opening in the connective tissue with the diverticulum that touches the distal end of the digital tendon sheath (Delahunta and Habel, 1986). Though the sheath is in close proximity to the fetlock, pastern and coffin joints and to the navicular bursa, these cavities do not communicate except for a connection between the sheath and the coffin joint in the foal. Despite this anesthetics injected into the coffin joint of adult horses reach navicular bursa by diffusion (Dyce *et al.*, 1986). In this respect, Delahunta and Habel (1986) stated that in spite of their impermeability to latex, the membranes between the digital tendon sheath, coffin joint and navicular bursa permit the diffusion of anesthetics solutions from one to the other. Peters (1965) reported that the communication between the digital tendon sheath and the proximal interphalangeal joint was demonstrated in cattle.

The distal line of attachment of the digital tendon sheath differs dorsally from plantarly in the pes of the investigated donkeys. It terminates 12.77mm dorsally and 6.31mm plantarly below the level of the pastern joint. But in the manus of this animal it ends at the middle of the middle phalanx dorsally and opposite to the pastern joint palmarly (Abdalla *et al.*, 1988). In the horse it terminates at the middle of the middle phalanx (Muller, 1936; Sisson, 1975; Eichbaum, 1983, Frandson, 1986 and Dyce *et al.*, 1996), or at distal third of the middle phalanx (Seiferle and Frewein, 1986), or it extends distally in the hoof (Smallwood, 1992). In the latter animal, the sheath extends 2cm farther distal on the dorsal surface of the deep flexor tendon than it does on its palmar surface. This is, however, the lowest accessible point of drainage (Delahunta, and Habel, 1986). On the contrary, the gap between the proximal and distal annular ligaments is the lowest available access to the digital tendon sheath in the horse (Smallwood, 1992). In the pes of the camel, the sheath terminates dorsally about the middle of the second phalanx just proximal to the proximal plantar pouch of the coffin joint, plantarly it ends just proximal to the plantar end of the middle cushion (Karkoura, 1986).

From the clinical point of view, the present study reveals that the injection of the digital tendon sheath of the pes of the donkey can be applied through its diverticula. Above and below the proximal sesamoid

bones the injection can be performed in the proximal and middle collateral diverticula respectively. At the level of the pastern joint the tendon sheath can be injected through the distal diverticulum. The digital tendon sheath is easily injected on the sides through the proximal pouch in the horse (Westhues, 1934; Berg and Westhues, 1961 and Berg, 1973) and in the mule (Hifny *et al.*, 1988), or through the middle palmar pouch in the horse (Tufvesson, 1963) and in the mule (Hifny *et al.*, 1988).

#### REFERENCES

- Abdalla, K.E.H.; A.A. Mansour; H.A. Youssef and M.A. Alam Eldin (1988):* Surgical anatomical studies on the tendon sheaths of the flexor muscles of the manus in donkey. *Ass. Vet. Med. J. Vol. 19, No. 38*
- Berg, R. (1973):* *Angewandte und topographische Anatomie der Haustiere.* I Aufl. Vet. Gustav. Fischer Verlag Jena.
- Berg, F. und M. Westhues (1961):* *Tierärztliche Operationslehre* 28 Aufl. Verlag Baul Parey, Berlin.
- Delahunta, A. and R. Habel (1986):* *Applied Veterinary Anatomy.* W.B. Saunders Company.
- Dyce, K.M.; W.O. Sack and C.J.G. Wensing (1996):* *Textbook of veterinary anatomy,* 2<sup>nd</sup> ed. W.B. Saunders Company.
- Eichbaum, F. (1983):* Zur Anatomie und Histologie der Schleimbeutel und Sehenscheiden des Pferdes. *Arch F. Wissensch-U Prakt. Tierheilk. Jg. / Bet.9.*
- Ereisha, A. (1982):* Some anatomical studies on the region of the manus of the one humped camel with special reference to tendons, tendon sheaths and ligaments. M.V.Sc. (Anatomy). Thesis Faculty of Vet. Med. Cairo University.
- Frandsen, R.D. (1986):* *Anatomy and physiology of farm animals.* Lea & Febiger. Philadelphia.
- Hifny, A; K.E.H. Abdalla, M.A. Alam Eldin (1988):* Digital tendon sheath of the manus in mule, buffalo and camel. 17<sup>th</sup> Congress of the EAVA in Regensburg.
- Karkoura, A.A. (1986):* Surgical anatomical studies on the pes in the camel. M.V.Sc. (Anatomy). Thesis faculty of Vet. Med. Alexandria University
- Muller, F. (1936):* Schleimbeutel und Schnenscheiden des Pferdes. *Arch. Miss. Prakt. Tierheilk. No. 70, 351-370*



- Peters, E. (1965):* Zur Anatomie der gemeinsamen digitalen Sehnscheide am Vorder-und Hinterfuss des Rindes. Vet. Med. Diss. Hannover.
- Seiferle, E. and J. Frewein (1986):* Active Locomotor system in Nickel, R.; A.Schummer; E. Seiferle; J.Frewein; H. Wilkens and K.H. Wille. The locomotor system of the domestic mammals. Vol. 1 Verlag. Paul Parey Berlin Hamburg.
- Sisson, S. (1975):* Equine Myology in Sisson and Grossman's the anatomy of the domestic animals, 5<sup>th</sup> ed. Rev. By R. Getty. W.B. Saunders Company, Philadelphia. London. Toronto.
- Smallwood, J.E. (1992):* A guided tour of veterinary anatomy. W.B. Saunders Company.
- Taylor, T.A. (1955):* Regional and applied anatomy of the domestic animals part 1, head and neck. Edinburgh. Tweddale Court. London.
- Tufvesson, G. (1963):* Local anesthesia in veterinary medicine. Astra International Sodertalje, Sweden.
- Westhues, M. (1934):* Die diagnostische Injektion in Gelenke und Sehnscheiden bei Lahmheiten. DTSCHE. Tierarztl. Schr. 42, 829-832.

#### LEGENDS

**Fig. 1:** Photograph showing the relations of the digital tendon sheath (opened).

- 1- Superficial digital flexor tendon
- 2- Deep digital flexor tendon
- 3- M. interosseous medius
- 4- Plantar ligament
- 5- Straight sesamoidcan ligament
- 6- Proximal diverticulum

**Fig. 2:** Photograph showing the outline of the opening of the tube which lies within the vaginal cavity.

- 1- Superficial digital flexor tendon
- 2- Deep digital flexor tendon
- 3- Proximal boundary of the opening
- 4- Distal boundary of the opening

**Fig. 3:** Photograph showing the sites of the diverticula and the anular ligaments.

- 1- Proximal diverticulum
- 2- Proximal compartment of the middle collateral diverticulum
- 3- Distal compartment of the middle collateral diverticulum
- 4- Distal diverticulum
- A- Plantar anular ligament
- B- Proximal limb of the proximal anular ligament
- C- Distal limb of the proximal anular ligament
- D- Distal anular ligament

**Fig. 4A:** Mediolateral radiograph showing the digital tendon sheath (1) and the navicular bursa (2) in the pes of the donkey.

**Fig. 4B:** Sketch of Fig. (4A).

**Fig. 5A:** Dorsoplantar radiograph showing the digital tendon sheath (1) and the navicular bursa (2) in the pes of the donkey.

**Fig. 5B:** Sketch of Fig. (5A).

**Fig. 6A:** Mediolateral radiograph showing the communication (arrow) between the digital tendon sheath (1) and the fetlock joint (2).

**Fig. 6B:** Sketch of Fig. (6A).





