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ULTRASOUND EXAMINATION OF HORSE TENDONS - COMPARING ULTRASOUND AND ANATOMY FINDINGS

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SUMMARY: The aim of this research was to investigate a procedure of ultrasound examination of horse tendons in the region of metcarpus and metatarsus. The investigation was caried out using abattoir samples with performing ultrasound during a clinical examination of horses. The anatomy studies consisted of cutting a frozen samples in order to establish analogy between macroscopic picture of transverse section at standard zones of the metacarpus/metatarsus region and ultrasound image at the same position. The superfitial digital flexor tendon, deep digital flexor tendon, inferior chek ligament and suspensory ligament were the structures of interes in this research. The shapes, echogenity, structure of health horses were described.

Key words: *horses, tendons, ultrasound examination.*

INTRODUCTION

Tendon and ligament injuries are relatively common among equine athletes. Horses engaged in strenuous work such as racing, jumping, endurance or barrel racing are more likely to sustain a tendon or ligament injury. However, injuries can and do occur in horses of all breeds and uses, including the backyard or light use horse. Tendon lesions are a dominant in equine locomotor system pathology. The palmar tendons of the horse's hand are the most often affected, and among them, the superficial digital flexor tendon is the most frequently injured, especially in its metacarpal part. Early development of diagnostic ultrasound in veterinary medicine focused on cardiology, theriogenology and examination of abdomen and thorax. Ultrasound examination of the soft-tissue structures of the limbs of horses developed more slowly. In 1982, Rantanen et al., introduced diagnostic ultrasonography as a potential tool for examining tendons and ligaments in horses. Since than has greatly improved veterinarians' capacity to accurately diagnose the presence and extent of soft-tissue injury and to monitor the progress

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of healing, using measurable criteria such as the size of the lesion, the echogenicity of the lesion, and the quality of fiber pattern (Van Shie and Bakker, 2000). The ultrasonographic appearance of normal and injured tendons has been described (Denoix et al., 1994; Gillis et al., 1993; Gillis et al., 1995; Henry et al., 1986; Rantanen et al., 1985; providing a improvement of patient rehabilitaion program to become more practic, an to base on the evidence of direct visualization of tendon architecture using a mentioned criteria rather than clinical signs based on pain, heat, sweling and lameness. So diagnostic ultrasound is considered the gold standard in the evaluation of tendons and ligaments in horses. The most important criteria for the ultrasonographic assessment of tendon or ligament injuries over time are changes in echogenicity, size, contour, and definition of the margins (Smith et al., 1994).

MATERIAL AND METHODS

The investigation was carried out using abattoir samples, and live animals. At abattoir samples, collected from 14 animals, the visual postmortal examination was performed in order to determine the fore-hind and left-right limbs. Then the samples were marked and left hind and left fore limb were frozen at -37°C, and tranfersaly cut at several zones (as describe below) with electric saw. The right fore and right hind limb from one of the animals were prepared for ultrasound examination. The preparation for ultrasound examination consists of washing, dehairing and shaving to the level of the skin. The ultrasound examination was performed using the ultrasound device Falcovet (Esaote Pie Medical) and linear probe 6-8 Mhz of general purpose, using B mod, real time ultrasonography. The linear probe has an advantage over the convex because it provides better visualization of tissue closer to probes. The examination procedure, started from the proximal part of the metacarpus/metatarsus on the palmar/plantar site. The three zones marked as (FZ1, FZ2, FZ3), (fig.1a) were used for three standard transfersal positioned probe at fore limbs, and four zones marked as (HZ1,HZ2,HZ3,HZ4), (fig. 1b) were used with analogy at hind limbs. This method divides metacarpus/metatarsus in three/four zones. Zone 1 of the matacarpus (fig 1a) includes the origin of the suspensory ligament and inferior chek ligament and the deep and superficial flexor tendon emerge ring from the carpal sheath. Zone 2 is the middle one third of the metacarpus and includes structures distal to the bifuriction of the suspensory ligament. Zone 3 is the distal one third of the matacarpus from the bifurication of the (SL) to the fetlock joint. The metatarsus is anatomically longer and it is separated in four equal zones (fig 1b). This method is only because of the need for recording the parameters at standard position for further control examination. Ultrasound examination means continuous examination over all parts of tendons, not just at places of described. In this investigation comparing the anatomy and ultrasound image the conclusion about quality, possibilities, analogy, sharpness of ultrasound image were done. With live animals the ultrasound examination were executed on six horses with no clinically obviously lameness, comparing the image between the two same limbs. The ultrasound examination consist of identification of superficial digital flexor tendon (SD), deep digital flexor tendon (DD), inferior chek ligament (ICL), suspensory ligament (SL), bone (Mc3), (fig. 1c). The longitudinal scaning of tendons were performed too in order to determine a direction and structure of collagen fibers.

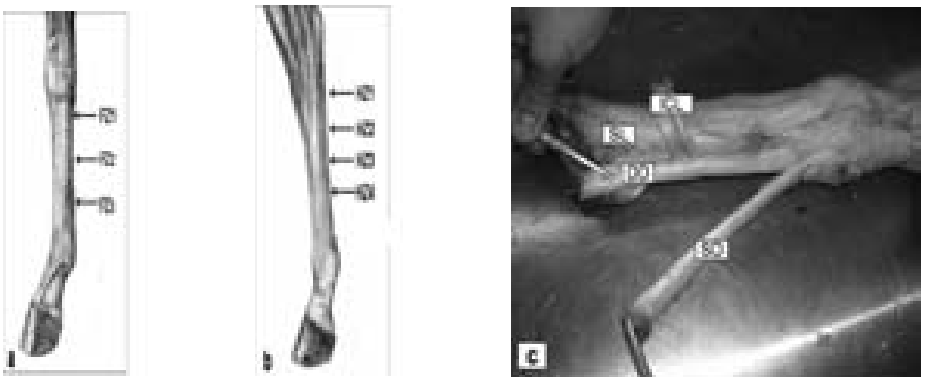

Figure 1. The position of probe during tendon examination at **a** - metacarpus, **b** - metatarsus. **c** - section of fore limb, **SD**-superfitial digital flexor tendon, **DD** - deep digital flexor tendon, **ICL** - inferior chek ligament, **SL**-suspensory ligament.

*Slika 1. Položaj sonde prilikom pregleda tetiva, **a** - na metakarpusu, **b** - na metatarzusu. c - preparat prednje noge, **SD** - površinska sagibačka tetiva, **DD** - duboka sagibačka tetiva, **ICL** - akcesorni ligament duboke sagibačke tetive, **SL** - suspenzorni ligament.*

RESULTS

The *musculus flexor digitorum superficialis* begining from the medial epicondyle of the humerus in the front limb. Near the carpal joint, this muscule becomes hhe **superficial digital flexor tendon (SD)**. The tendons of the SD and deep digitalis flexor tendon (DD) continue distaly through carpal canal. Below the carpus the tendon are positioned subcutanoesly and it's easy to palpate. The SD is ellipsioid shape just below the carpus, and distaly throught zone 1, she become to flattening (fig. 3). The flattening are continuous throught zone 2 (next 8 cm), end transverse section of the tendon are in "comma" shape with sharp edge orientated lateraly. This shape are wraps DD. When SD become the wraping around DD it become difficul or imposibile to "catch" a complete transverse section of SD in one probe position. So its critical to change probe position over the SD. Emerging from the carpal canal in zone 1, the **deep digital flexor tendon** (DD) has a triangular shape on transverse image. The near zone 2 the DD becomes narower and round. In the begining of this zone the DD merges with ICL. ICL has its origin from the palmar side of carpal joint's ligaments and joint capsule. From its begining ICL has s rectangular shape. The ICL has the most echogenic structure compared to the other structures. In zone 2 ICL merge with DD, and DD becomes a largr and rounder than a SD. Through Zone 3 the DD becomes elliptical as its surounded with SD and compressed in to sesamoidean growe. The distaly DD are passing through branches of SD. Distal to this region, a ultrasound examination is difficult to achieve, becouse of problem to adjust a probe in right position, to get a optimal angle of reflection. On the hind limb the DD has its origin from large muscle in regio cruris. The simmilar orientation, shape, and echogenity can be viwed over metatarsal region, but becouse of longitivity of metatarsus this region is divided in four zones. The inferior chek ligament (ICL) is not significant in the hind limb and merges DD in the zone 3.

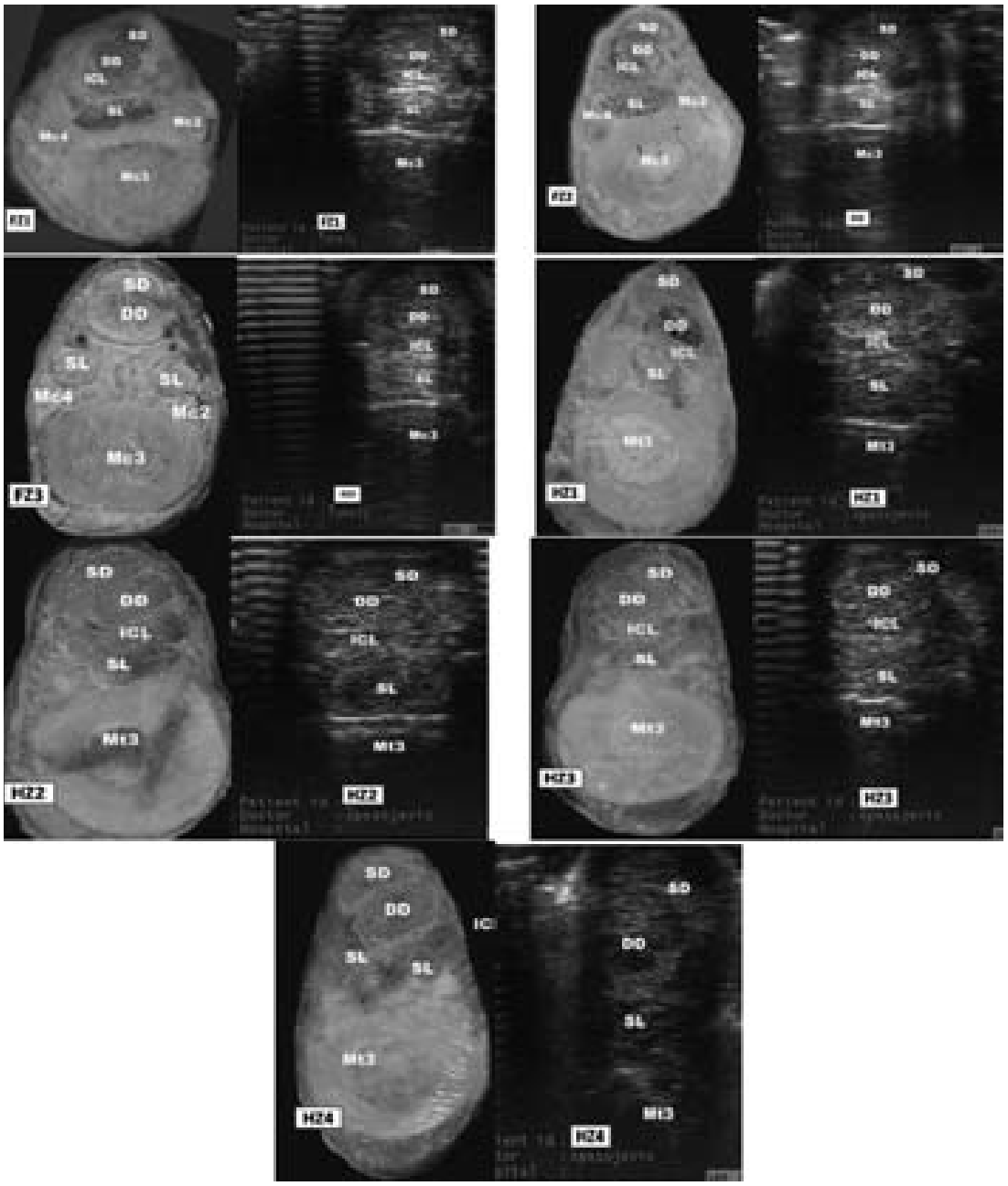

Figure 2. Transverse section and transverse and longitudinal ultrasound image of fore and hind limb. **FZ1, FZ2, FZ3, FZ4** - fore limb zone 1,2,3,4. **HZ1, HZ2,HZ3, HZ4** - hind limb zone 1,2,3,4,5; FL-longitudinal ultrasound image of fore limb, **HL**- longitudinal ultrasound image of hind limb. **SD**-superfitial digital flexor tendon, **DD** - deep digital flexor tendon, **ICL** - inferior chek ligament, **SL**-suspensory ligament, **Mc2,3,4**-metacarpal bone 2,3,4.

Slika 2. Transferzalni i longitudinalni ultrazvučni sken prednje i zadnje noge

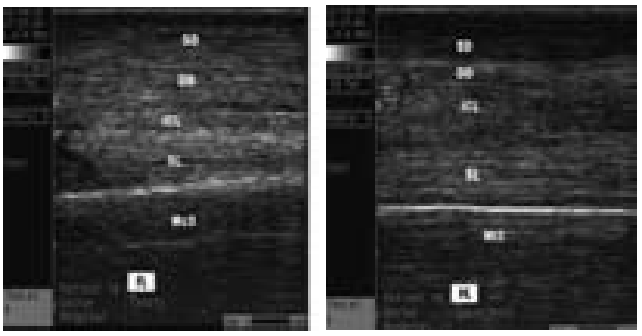

Figure 3. Ultrasound image from the longitudinal scaning. **FL**-longitudinal ultrasound image of fore limb, **HL**- longitudinal ultrasound image of hind limb. **SD**-superfitial digital flexor tendon, **DD** - deep digital flexor tendon, **ICL** - inferior chek ligament, **SL**-suspensory ligament, **Mc3**-metacarpal bone 3, **Mt3** - metatarsal bone 3.

Slika 3. Ultrazvučni longitudinalni sken FL - prednje noge, HL - zadnje noge.

Suspspensory ligament (SD) has its origin from palmar/plantar side of carpal/ tarsal joint. In young foals its exist as *m.interoseus* with three branches. Later this muscular tissue becomes a tendineuous structure, but commonly with the remaining of muscular tissue depending of the age, breed and individual characteristic. The SL is hyperechoic, compared to DD and SD and the least proximal part of ICL. Becouse of remaining muscular fibers in proximal part of SL anechoic or hypoechoic areas may be a function of hypertrophy of the muscle fibers in well trained horses and its commonly bilateral finding. Similar area in the distal portion of SL or branches should be considered as abnormal. In zone 1 SL can be recognized as rectangular shape in transversal section closlly positioned on the surface of Mc/Mt3. In the zone 2 the SL can be more easily recognized becouse of increased quantity of hypoechoic connective tissue separating SD from DD. In the proximal part of zone 3 the SL divides into diverging medial and lateral branches. They are obliquely possitioned to the proximal sesamoid bones. It usaully quit difficult to image both branches in one single ultrasound image. So its nessesary to change position of the transducer. The difficulity can be and to indentificate branches, unless one palpate the branch and place probe while watching a horse leg and not the ultrasound image. Near the branch the ligament become a more triangular as it is nears to proximal sesamoids. The sasamoid contains essentially no musscle tissue and have a homogenous hyperechoic structure. Both branches are equal in the diameter and should be less than 1 cm in the normal adult race horse. The majority part of SL branches has insertion of the palmar/plantar side of the proximal sesamoidean bones, but smal part are passing dorsaly and joint with extensor tendon.

DISCUSSION

Diagnostic ultrasound imaging of the equine soft tissues began after the development of gray-scale real time scanner in the early 1980s. As the equipment become more portable and less expensive, ultrasound imaging of the equine reproductive tract was in widespread use by mid-1980-s. Imaging of the equine tendons and ligaments become more practical with availability of high-frequency near-focused ultrasound transducers and high resolution real-time display system. The field of use of ultrasound later became

ultrasound guided surgical procedures as desmotomy of the inferior chek ligament (accessory ligament of deep digital tendon) (Aziz, 2010).

Echogenicity depends on the amount of reflection and scattering of the ultrasound beam as it crosses the animal's tissues. In tendons, for a given ultrasound frequency and settings of the ultrasound machine, maximal echogenicity is obtained when the collagen fibre bundles are aligned parallel to the tendon axis and perpendicular to the ultrasound beam (Crevier-Denoix et al., 2005).

In this research a shape, *in situ* localization, and echogenity of tendous and ligaments in regio metatasus/metacarpus were assessed. The ultrasound image reveals quit real picture of composition and topography beneath transducer. The suspensory ligament was the most echogenic structure. This also were conclusion by other authors(Wood et al., 1993; Nicoll et al., 1993; Micklethwaite et al., 2001). In the proximal part of SL the echogenity were variable due to different amount of muscular fibers, as remains of *m.interoseus.* This can lead to misdiagnosis, as pronounce of normal findings as stretch or area of inflammation.

The SL is predominantly a strong tendinous band containing variable amounts of muscular tissue and fat (Dyson, 1998). Hence, the variable amount of muscular tissue could contribute to hypoechogenic areas in the proximal part (Dyson, 1998) The SD was the least echogenic which is similar to findings (Woodet al., 1993).

CONCLUSION

The ultrasound examination of horses tendons is usefull tool for visualisation of tendons and their structures. Shape, echogenity, fiber patterns are the basic parameters to make further decision about pathological changes.

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ULTRAZVUČNI PREGLED TETIVA KOD KONJA - UPOREĐIVANJE ULTRAZVUČNOG NALAZA I ANATOMSKE STRUKTURE

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Izvod

Cilj ovoga istraživanja je bio da se ispita procedura ultrazvučnog pregleda tetiva kod konja u regiji metatakpusa i metatarzusa. Istraživanje je obavljeno pregledom konja kao i koristeći preparate ekstremiteta sa klanice. Anatomski deo studije se sastojao u uočavanju struktura koje su bile predmet interesovanja ultrazvučnog pregleda a to su površinska sagibačka tetiva, duboka sagibačka tetiva, akcesorni ligament duboke sagibačke tetive i suspenzorni ligament. Preparati su zamrzavani na -37°C a zatim su sečeni u transverzalnoj ravni po tačno određenim zonama koje su deo standardizovane procedure kod ultrazvučnog pregleda tetiva. Ultrazvučni pregled podrazumeva analizu svih pomenutih struktura u svim njihovim delovima, ali je u specifičnim zonama, izvršeno snimanje fotografija ultrazvučnog nalaza. Poređene je vršeno između desne

noge koja je zamrznuta i secirana i leve noge koja je pripremljena za ultrazvučni pregled. Opisivan je oblik, ehogenost i struktura pomenutih tetiva kod konja bez klinički prisutne hromosti.

Ključne reči: konji, tetive, ulrazvučni pregled .

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