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COMPARATIVE IMAGING STUDY OF THE CHANGES APPEARED IN NAVICULAR SYNDROME IN HORSES

STUDIU IMAGISTIC COMPARATIV AL MODIFICĂRILOR APĂRUTE ÎN SINDROMUL NAVICULAR LA CABALINE

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ABSTRACT | REZUMAT

The navicular syndrome in horses is an acropodium disease, which is associated with pain at the level of the distal sesamoidian bone known as the navicular bone. In the navicular syndrome there are also included abnormalities of the surrounding structures, like navicular bursa, collateral sesamoidean ligaments, distal sesamoidean impar ligament, deep digital flexor tendon and distal interfalangeal joint. The most common lesions that occur are subchondral cyst and osteolysis of the navicular bone, articular osteophytes, adhesions of the navicular bursa and vasodilatation of the nutrient foramina. Structural changes appear progressively and evolve with an acute or chronic onset which are difficult to diagnose because in some horses the radiological changes will not appear. After the clinical exam of 134 horses, 15 horses of different ages were included in the study and fifteen feet from the lame horses that we suspected of having navicular syndrome where retained after slaughter. We performed Computer Tomography (CT) scan and radiography of the limb with or without contrast medium to detect the changes that occurred as a result of a navicular bone disease. Contrast solution was used to check and distend the navicular bursa. Administration of contrast medium in the navicular bursa was performed under fluoroscopic guidance, for more accuracy. Subchondral cyst, distension, adhesion of the navicular bursa were observed. CT scanning with contrast solution are more sensitive than simple scanning or than radiographic images for lesions involving navicular syndrome.

Keywords: navicular bone, lesions, imagistic exam, syndrome

Sindromul navicular la cai este o afecțiune acropodială care se manifestă prin durere cu afectarea sesamoidului distal, cunoscut sub denumirea de os navicular. În sindromul navicular sunt incluse și leziuni ale structurilor învecinate, precum bursa naviculară, ligamentele sesamoidiene colaterale, ligamentul sesamoidian impar, tendonul flexor digital profund și articulația interfalangiană distală. Cele mai frecvente leziuni care apar sunt osteoliza osului navicular și prezența chistului subcondral, osteofitele intraarticulare, aderențe ale bursei naviculare și creșterea diametrului găurilor de nutriție ale osului navicular. Modificările apar progresiv și pot evolua acut sau cronic, în ultima situație fiind greu de diagnosticat deoarece nu se observă modificări decelabile radiografic. În urma examenului clinic a 134 de cai, 15 cai cu vârste diferite au fost incluși in studiu, iar în urma abatorizării 15 membre au fost recoltare de la caii cu șchiopătură pe care i-am suspectat de sindrom navicular. Au fost efectuate imagini Computer Tomografice (CT) și radiografice ale membrelor, investigații simple sau cu substanță de contrast pentru a detecta modificările apărute consecutiv sindromului navicular. Au fost observate prezența de leziuni chistice subcondrale cât si aderențe și distensii ale bursei naviculare. Imaginile CT cu substanță de contrast s-au dovedit mai fidele decât imaginile CT simple și decât cele radiografice permițând identificarea modificărilor apărute consecutiv sindromului navicular.

Cuvinte cheie: os navicular, leziuni, examen imagistic, sindrom

The navicular syndrome has been considered one of the most common causes of forelimb lameness in horses. The navicular bone is articulated with the short pastern and the coffin bone that presents an important purpose in shock absorption in the propulsion phase of the stride (2, 4, 6). It is characterized by degenerative processes in the structure, composition of the subchondral bone, navicular bursa and also affects the deep digital flexor tendon, impar ligament, collateral ligaments and interphalangeal distal joint (1, 2, 6, 11, 12). The aetiopathogenesis of the disease is multifactorial and involves a complex interaction between biomechanical stress and circulatory disturbances, on top of a hereditary predisposition.

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There are several theories in the occurrence of the navicular syndrome, such as:

- the vascular theory: local ischemia leads to occurrence of necrotic areas in the bone's structure (1, 15);

- the biomechanical theory: the continuous and exaggerated pressure on the navicular bone caused by the deep digital flexor tendon leads to an abnormal modeling as a result of degenerative processes (2, 8, 15);

- the congenital theory/bipartition or tripartition: the navicular bone is segmented into two or three parts, as a result of growth disorders during foetal life. Thus, it is considered that in the intrauterine period there is a vascular disturbance that will lead to enchondral ossification or the appearance of several ossification centres resulting in bone partition. From a clinical point of view, lameness debuts progressively from the age of 6 months (5);

- the breed theory: it is considered to be a breed predisposition in warmblood horses, such as Arabian Horse, Thoroughbred, Quarter Horse. Clinical signs appear between 7 and 14 years of life, faster in those used for show jumping and intense work (1, 8).

In case of navicular syndrome, the diagnosis is based on anamnesis, clinical exam, hoof tester check, lameness examination, and lateral digital nerve/or intraarticular anaesthesia (2, 7, 9, 10).

Different imaging techniques are used to identify lesions associated with the navicular syndrome. Nuclear scintigraphy and thermography reveal the presence of active processes within the hoof (1, 2, 15). CT scanning is the best choice to see details of the bone changes, involving the cortex and the trabeculae from different angles, but presents a disadvantage in horses because it requires general anesthesia (2, 10).

Structural changes of the deep digital flexor tendon, the navicular bone, navicular bursa, and collateral sesamoidian ligaments can be impossible to detect using MRI or CT scanning if bursal fluid within the bursa is absent, and for this saline podotrochlear bursography was performed to produce distension of the bursa and separation of the structures in the podotrochlear apparatus (3, 7).

Studies from the international veterinary literature reveal using contrast media for performing bursography to identify adhesions and distension of the navicular bursa and any bony changes in lameness horses (6, 7, 13).

CT imaging may reveal adhesions of the suspensory apparatus and bone changes of the limbs and head. Also, odontogenic tumours can be diagnosed, along with accurately identifying the extension and aggressiveness of the tumour (3, 9).

In the Romanian veterinary literature, there are no studies regarding the changes in navicular syndrome, nor the imaging techniques used for diagnosis.

The aim of the present study was to compare the imaging methods that allow identification of lesions following the navicular syndrome in horses.

MATERIALS AND METHODS

The horses that were included in the study were examined prior to being culled, by performing the lameness examination, applying the hoof test pliers and local regional anaesthesia. From 134 horses that were clinical examined in a location near Timisoara, 15 horses that had a positive response to the performed tests were suspected of having a navicular pathology. From these, after being culled, the limbs were collected and submitted for radiographic examinations, using Siemens Multix Swing, and CT scanning, using Siemens Somatom Definition AS 64, in the Radiology and Computed Tomography Laboratories – Surgery Clinic of the Banat's University of Agricultural Sciences and Veterinary Medicine - "King Michael I of Romania" from Timisoara. Positioning and technical parameters used for the radiographic imaging were chosen according to indications offered by Reeden – 2003 (12), and for the CT scans, the protocol presented by Yamada – 2017 was used (16).

Ultravist 370 (370mh/ml) Bayer contrast medium was injected in the navicular bursa for the positive contrast studies. Injection in the navicular bursa was performed under fluoroscopic guidance (Siremobil Compact L). The needle was inserted between the heels, on the palmar surface. After the needle came in contact with the navicular bone, a fluoroscopic image was taken to confirm the position, and then the needle was withdrawn approximately 2 millimetres, followed by administration of 4 ml of Ultravist 370 (370 mg/ml) Bayer solution. Another fluoroscopic image was taken in order to confirm the correct administration and distension of the navicular bursa. During administration, the limb was maintained in the latero-medial position.

Fig. 1. Guided administration of the contrast medium into the navicular bursa

RESULTS AND DISCUSSIONS

The obtained results after conventional and positive contrast studies, both radiographic and CT scanning are shown in the Table 1.

Table 1

The incidence of the lesions observed depending by the imaging method used to diagnose the navicular syndrome

Investigation method	Changes (lesions) discovered			
	Increasing opacity on the navicular bone flexor face (Number of the lesions / Total number of the investigations)	**Adhesions of the navicular bursa to the navicular bone and /or to the deep digital flexor tendon** (Number of the lesions / Total number of the investigations)	**Subchondral defects** (Number of the lesions / Total number of the investigations)	**Distension of the navicular bursa** (Number of the lesions / Total number of the investigations)
Radiographic image	**6 /15**	**0 /15**	**7 /15**	**0 /15**
Radiographic image with contrast medium	**6 /15**	**8 /15**	**7 /15**	**7 /15**
Computer tomography	**8 /15**	**0 /15**	**12 /15**	**0 /15**
Computer tomography with contrast medium	**8 /15**	**10 /15**	**12 /15**	**7 /15**

In case of conventional radiographic studies (simple, without contrast solution), the observed changes consisted in increased opacity of the flexor aspect of the navicular bone and in the insertion area of the deep digital flexor tendon (Fig. 2).

Fig. 2. Conventional radiography: increased opacity on the flexor aspect of the navicular bone (black arrow) and on the insertion area of the deep digital flexor tendon (white arrow)

It was not possible to identify adhesions of the navicular bursa on conventional radiographic images and CT scanning. After administration of the contrast medium in the navicular bursa, adhesions between the navicular bursa and navicular bone and/or the deep digital flexor tendon were identified in eight limbs on the radiographic images, respectively in ten limbs on CT scans (Table 1, Fig. 3).

Distension of the navicular bursa was identifiable only after administration of the contrast medium. For both diagnostic methods (CT and radiographic), distension of the navicular bursa was highlighted in seven cases from those 15 examined. In none of the limbs that we examined; no rupture of the navicular bursa was observed.

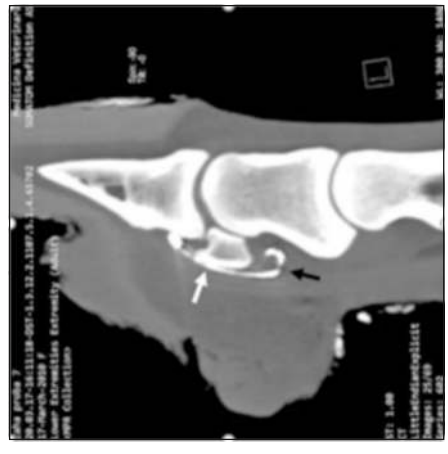

Fig. 3. Exaggerated distension of the navicular bursa (black arrow), adhesions between the navicular bursa and navicular bone (white arrow)

According to Turner – 2013 (14), following bilateral bursograms performed on a number of 344 horses, changes of the navicular bursa were observed in 86 cases. Rupture of the joint capsule with appearance of a direct communication between the bursa and the distal interphalangeal joint was observed on CT scanning, being frequently associated with desmitis of the collateral ligaments (14).

Dyson -2006 (2) in a post-mortem study of 263 equine cadaver limbs, identified the presence of adhesions between the navicular bursa, navicular bone and deep digital flexor tendon in 46 of them (2).

The most common lesion observed after simple CT examination was the presence of subchondral cysts in the palmar cortex of the navicular bone (12 limbs) and in seven limbs the subchondral cysts were constantly associated with adhesions of the navicular bursa (Fig. 4, Fig. 5).

Fig. 4. Subchondral cyst (black arrow)

Fig. 5. Subchondral cyst (black arrow), navicular bursa adhesion (white arrow)

Degenerative lesions located on the surface of the navicular bone fibrocartilage associated with subchondral cysts are often encountered in horses diagnosed with navicular syndrome (2, 4, 6). In a study performed by Seghrouchni – 2019 (13) on 127 horses, subchondral defects were identified in 100 of them.

The number of limbs that presented an increased opacity of the palmar cortex of the navicular bone was identical for each examination technique (conventional versus contrast studies). Thus, for CT scans, the lesion was identified in eight limbs and on radiographic images, in six limbs Table 1.

Turner -2013 (14) found an increase in opacity on the flexor aspect of the navicular bone in 210 horses out of 344 that were examined radiographically (14).

Distension of the navicular bursa was identified only after administration of the contrast medium Table 1.

Dyson – 2006 (2) shows that although the aetiology of navicular bursitis is unknown; hyperplasia and hypertrophy of the synovial membrane were consistently described after MRI investigations (2).

Following MRI imaging, it was found that abnormal distension of the bursa is a common change in horses diagnosed with navicular syndrome and the presence of adhesions leads to decreased mobility of the deep digital flexor tendon (4, 6, 10). The distention of the navicular bursa was notice in the study only after intrabursal contrast medium administration Table 1.

From 15 limbs that we examined, in five of them we identified simultaneous associations of several lesions: adhesions of the navicular bursa, subchondral cysts and thickening of the palmar cortex of the navicular bone. Similar findings are made by Dyson – 2006 (2), who report simultaneous adhesions of the navicular bursa and deep digital flexor tendon and subchondral defects in 60 of the 263 examined limbs (2).

CONCLUSIONS

Native and positive contrast CT scan allows better identification of lesions characteristic to navicular syndrome in horses, compared to radiographic studies. Positive contrast CT studies with contrast medium administered in the navicular bursa, allows a more detailed evaluation of the navicular bone and adjacent structures, increasing the diagnostic accuracy. *Ex vivo* evaluation of four imaging diagnostic techniques of characteristic structural lesions in navicular syndrome in horses, offer results which form a base of useful data for beginning of future investigations on live cases – *in vivo* cases.

REFERENCES

1. *Doige C.E.,Hoffer M.A.,*(1983), Pathological Changes in the Navicular Bone and Associated Structures of the Horse. Can J Vet Res, 47:387-395
2. *Dyson S., Murray R., Blunden T., Schramme M.,* (2006), Current concept of navicular disease, Equine Veterinary Education, 23(1):27-39
3. *Elemmawy Yahya M., Senna N., Abu-Seida A., Youssef A.,* (2019), Suspensory branch desmitis in a horse: ultrasonography, computed tomography, magnetic resonance imaging, and gross postmortem findings. JEVS, 80:49-55
4. *Hontoir F., Rejas E., Falticeanu A., Nissole J.F., Vincent S., Nicaise C., Clegg P., Vandeweed J.M.* (2019), Communication between the distal interfalangeal joint and navicular bursa in the horse at computed tomography arthrography. Anat Histol Embryol, 48(2):133-141

5. *van der Zaag E.J., Weerts E.A., van den Belt A.J., Back W.,* (2016), Clinicopathological findings in horses with a bi- or tripartite navicular bone, BMC Veterinary Research, 12:74
6. *Maher M., Werpy N., Goodrich L., McIlwraith W*., (2008), Distension of the navicular bursa to determine the presence of adhesions using magnetic resonance imaging. AAEP Proceed, 54:460-472
7. McGill S., Gutierrez-Nibeyro S., Schaeffer D., Hartman S., O'Brien R., Joslyn S., (2015), Saline arthrography of the distal interphalangeal joint for low-field magnetic resonance imaging of the equine podotrochlear bursa: feasibility study. Vet Radiol Ultrasound, 56(4):417-424
8. *Perlman M.D.,* (1988), Usage of Radiopague Contrast Media in the Foot and Ankle. J Foot Surg, 27 (1):3-29
9. *Rhiannon M., Fiske-Jackson A., Hellige M., Gerhauser I., Wohlsein P., Biggi M.,* (2019), Equine odontogenic tumors: clinical presentation, ct findings, and outcome in 11 horses. Vet Radiol Ultrasound, 60(5):502-512
10. *Resnik D., Sartois D., Hallen J., Mitchell M., Howard B., Gilula L.,* (1988), Arthrography, Tenography, and Bursography of the ankle and foot. Clin Podiatr Med Surg, 5(4):893-908
11. *Rijkenhuizen A.,* (2006), Recent developments in equine palmar foot syndrome: What has changed for the clinician ? Pferdeheilkunde, 22(5):579-586
12. *Reeden R.,* (2003)*,* Radiographic imaging of the equine foot*.* Vet Clin North Am Equine Pract, 19(2):379-392
13. *Seghrouchni M., Elkasraoui H., Piro M., Alyakine H., Bouayad H., Chakir J., Tligui N., Elallali K., Azrib R.,* (2019), Osteoarticular radiographic findings of the distal forelimbs in Tbourida Horses. Helyon, 5(9):e02514
14. *Turner T.,* (2013), How to perform and Interpret Navicular Bursography. AAEP Proceedings, 59: 197-202
15. *Waguespack W.R, Hanson R.R,* (2010), Navicular syndrome in equine patients: anatomy, causes and diagnosis. compendium: continuing education for veterinarians, 32(12):E7
16. *Yamada K., Inui T., Itho M., Yanagawa M., Sato F., Tominari M., Mizobe F., Kishimoto M., Sasaki N.,* (2017), Characteristic findings of magnetic resonance imaging (MRI) and computed tomography (CT) for severe chronic laminitis in a Thoroughbred horse. J Equine Sci, 28(3):105-106.