Intra-Articular Pressure in the Horse

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ABSTRACT

The aim of the present study was to evaluate the intra-articular pressure in horses with chronic distal forelimb lameness. Fifty-six distal interphalangeal (DIP) joints of the forelimbs of 36 horses were clinically and radiographically investigated in addition to measuring intra-articular pressure. Forty coffin joints of sound horses were used as controls. The peak pressure was registered for each articulation. The mean and Standard deviation pressure measured in sound horses bearing weight on both limbs was 36.8±16.0 mm Hg and 69.6±23.7 mm Hg when the contra-lateral was raised. In diseased horses the mean and standard deviation pressure measured in the two positions was 66.5±7.6 mm Hg and 132.8±43.3 mm Hg respectively. These results indicate that pressure values of the coffin joint are higher in horses with a painful condition of the distal portion of the forefoot in comparison to normal horses. No correlation was found between articular pressure and the pattern of radiographical changes of the DIP joint or distal sesamoid bone. No weight, breed or attitude differences were detected among sound horses and no complications have been reported after pressure measurements. Pressure measurement may be considered as a useful aid to localize pathologic conditions involving the DIP joint or the navicular bone.

Keywords: Horse, coffin joint, navicular bone, manometer.

INTRODUCTION

Diseases confined into the hoof of the horse remains a significant problem for clinicians despite many technological advances and difficulties related to the exact localization of pain in the distal portion of the limbs (1). Regional anaesthesia of the equine limb is routinely performed to localize the source of pain to an approximate location. Nevertheless the diagnostic value of the intra-articular anaesthesia of the distal interphalangeal joint has been criticized due to its low specificity regarding several diseases involving the equine foot (2, 3). It has been proposed that measuring the pressure of the distal interphalangeal (DIP) joint could be a valid method to identify subjects with synovitis or navicular syndrome and may facilitate the differentiation between diseases of the DIP joint or navicular bone from diseases involving the surrounding tissues (4).

Intra-articular pressure determination by articular puncture has been carried out in several joints of the horse including the distal interphalangeal (5). Different opinions exist about the diagnostic value of the pressure evaluation in this joint and several authors have attempted to understand the clinical relevance and the possibility for practical application (4, 6, 7, 8, 9).

Variations in intra-articular pressure have been described in healthy and diseased joints with increased joint pressure to be associated with the development of osteoarthritis. The end stage of osteoarthritis is characterized by the damage to the articular cartilage, osteophytes formation, inflammation, pain and effusion (10). The synovial membrane, and mainly the elastic collagenous tissue overlying the joint capsule restricts the joint synovial space and in so doing causes an increase in joint fluid volume resulting in an increased the intra-articular pressure (11).

Furthermore, a slight increase of intra-articular pressure has been found to be associated with damage to the articular cartilage and the release of metalloproteinases. Whether the increase in joint pressure actually leads to articular cartilage damage or if the articular cartilage damage and the articular metalloproteinases release lead to increased synovial fluid volume and thus intra-articular pressure is unclear (11).

In Schött's opinion (1989) a physiologic coffin joint pressure should be below 16 mm Hg, but it is commonly thought that the normal pressure of this joint should be below 20 mm Hg when both forelimbs are bearing weight and below 40 mm Hg when the contra-lateral limb is raised.

Increased pressure values are always a pathological feature and are the result of acute or chronic synovitis (4, 9, 12). The aim of this study was to contribute to the dearth of literature available regarding sound horses and to assess the diagnostic value of this technique.

MATERIALS AND METHODS

Horses and selection criteria

Fifty-six forelimb distal interphalangeal (DIP) joints of 36 horses were examined. The horses were divided in two groups: the first composed of clinically sound horses (control group) and the second group of orthopaedic patients.

The criteria for inclusion in the control group (group A) were:

1) No report of recent signs of lameness;
2) Lack of signs of lameness during walking and trotting;
3) Negative results at hoof tester application and at flexion and extension tests of the axis digitalis.
4) No radiographical evidence of lesions in the examined area.

This control group was composed of 20 horses: The selected patients were characterized by a great variability of age, sex, weight (from a minimum of 430 kg to a maximum of 590 kg) and demeanour. Nine horses came from a breeding farm of standard bred horse and were in training during the study: 6 horses from a riding school where they carried out mild daily activities and 5 horses which were referred to the Hospital for reasons not involving the locomotors apparatus and all of which were used occasionally by the owners as pleasure horses.

Criteria for the inclusion in the second group of orthopaedic patients (group B) were:

1) History of chronic forelimb lameness;
2) Positive diagnostic results from the DIP joint anaesthesia.

Sixteen horses referred to the Hospital for ipselateral lameness were included in this group; no horses with bilateral lameness were included and only the articulations of the lame leg were considered (total 16 DIP joints were studied).

In order to include horses in A or B groups, all of them were at first observed standing, walking and trotting for about 20 minutes in a straight line on firm ground. Afterwards, the hoof tester was applied to both forelimbs of all horses, from the sole to the wall, with the purpose to test the sensitivity of the sole.

A lower limb flexion test (avoiding flexion of the carpus) was then performed. As the limb was placed to the ground the horse was trotted for 15-20 meters in a straight line and the reaction observed. The examination was completed by the application of the *wedge test* which involved elevating the toe of the foot for 60 seconds and then observing the horses on the trot.

Radiology

All distal interphalangeal joints and the distal sesamoid bones were radiographically investigated by using a portable device (high frequency generator Gierth HF 80/15 plus ultra leicht, 16 A, XDT-F80, Weight: 6.5 kg, Size: L 320 mm, W 185 mm, H 170 mm, mAs: 0,15-30). Lateromedial 90 degree and dorsoproximal-palmarodistal oblique (Oxpring) projections were obtained.

Measurement of the intra-articular pressure

The measurement of the intra-articular pressure followed the clinical and radiographic examinations in both groups. Administration of sedatives was avoided and the application of a twitchnose during the punction of the joint was the only restraint used.

Two areas proximal to the coronary band were clipped laterally and medially to the sagittal plane and an aseptic preparation of the skin was obtained by the use of polyvinylpyrrolidone-iodine 10% (Betadine® Meda Pharma s.p.a., Milano, Italy) and denatured ethylic alcohol 90% (Alcool Etilico Denaturato, produced by Acoolital, Via Nazario Sauro n.78, 12045, Fossano (CN) Italy). The pressure transducer utilized was a hand held digital manometer GMH 3160-13 (-2000 to +2000mBar, 1mBar resolution, 0.2% accuracy, Amra Bvba, Klein Heiken 6, B-2950 Kappelen,

Belgium), employed in human medicine for intra-muscular pressure determination.

The manometer was connected to a sterile polyethylene catheter (Lecro-Cath, Vygon, L=200cm, Øint=1.0,–Øest=2.0mm, pharmaceutical laboratories VYGON, B.P.7. 95440 Ecousn- France) while the operator attached a 18G needle to the other head of the catheter and an assistant reset the pressure transducer to 0 mm Hg. With the horse standing on a flat and firm surface and with both forelimbs bearing weight on the same line, the needle was inserted into the dorsal recessus of the DIP joint, abaxial to the common digital extensor tendon, almost 2 cm laterally to the sagittal plane and nearly 1.5 cm proximally to the coronary band with a disto-axial orientation. When the tip of the needle reached the synovial cavity, the synovial fluid flowed into the catheter raising the pressure values which were read from the manometer.

The values were registered in two different positions: the peak pressure measured with the horse bearing weight on both forelimbs (indicated as position A) (Figure 1) and the peak pressure measured with the contra-lateral limb lifted up (indicate as position B) (Figure 2).

Following the examination a sample of 0.3 ml of synovial fluid was collected in a EDTA tube, cytocentrifugated (10 minutes at 500 rpm), air-dried and stained with May Grünwald Giemsa for cytological evaluation.

The distal interphalangeal joint analgesia was performed only in the horses belonging to the group B. For this purpose, at the end of the pressure determination, 5-6 ml of mepivacaine hydrochloride 2% (Mepivacaina Angelini®, Aziende Chimiche Riunite Angelini Francesco – A.C.R.A.F. S.p.a., Viale Amelia 70, Roma, Italy) was instilled into the synovial pouch. The horse was rested in a box and examined 10 minutes later while trotting for 15-20 minutes in a straight line.

All patients of the study were monitored for 4-5 days after the evaluations.

Statistics

The mean values and the standard deviations of peak pressures were assessed both in A and in B positions, in both groups of horses. Data analysis was conducted by one-way repeated measures analysis of variance (ANOVA). Results were considered significant for P values of less than 0.05.

RESULTS

Every patient of the group B had an obvious lameness during walking or trotting and a positive hoof and flexion and extension test. In eight horses of this group the lameness was difficult to observe during walking in a straight line but the lameness became clearly apparent at trotting.

In the group A, there was no statistical difference of pressure between the right and the left joints with the mean of 36.8 ± 16.0 mmHg in the position A and 69.6 ± 27.3 mmHg when the contra-lateral limb was raised. No correlation was found between the DIP joint pressure and the weight of the horse ($P > 0.05$); in addition pressure values were not associated with age, sex or the horse's demeanour ($P > 0.05$).

Figure 1. "Position A", both limbs weight bearing

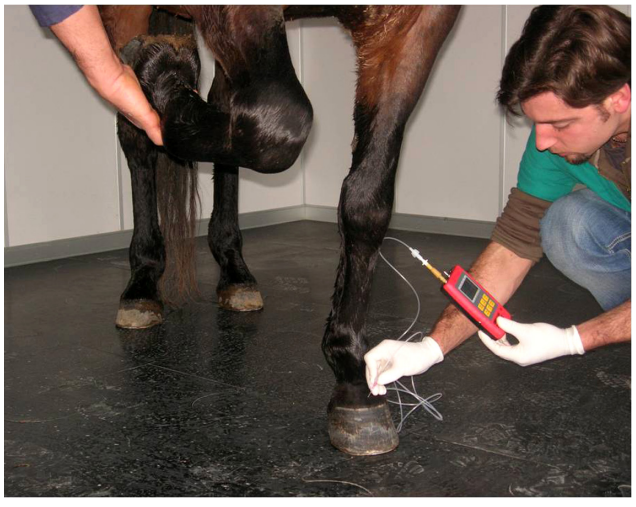

Figure 2. "Position B", contra-lateral limb lifted up

In the joints of the group B a higher mean pressure was found in comparison to the pressure measured in the control group; the mean value calculated was 66.5 ± 7.6 mm Hg with both forelimbs bearing weight and 132.8 ± 43.3 mmHg when the contra-lateral was raised up. A significant difference was found in joint pressure between group A and group B ($P < 0.001$).

The cytological evaluations were performed in 19 DIP joints of the group A did not reveal any pathological findings. In group B the synovial fluid examination was possible only in 7 of 16 articulations and a mild synovitis was diagnosed in each joint based on an elevation of leucocytes and/or total protein. Cytology was not preformed due to sampling failure as a result of needle displacement or due to blood contamination of the samples.

At the end of the study no side effect or complications were reported.

As already stated, all the horses of the group A were free from any kind of radiographic changes. Five joints in the group B were radiographically characterized by reduced corticomedullary demarcation of the navicular bone and well defined, crescent shape lucent areas on the distal border of the bone (lollypop lesions); 4 horses had radiographic evidence of osteoarthritis with the presence of periarticular osteophytes on the distodorsal and palmar aspects of the second phalanx and the proximal articular surface of the third phalanx and navicular bone. One horse showed a prominent entheseophyte on the proximolateral navicular border and asymmetry of the medial and lateral aspects of the bone. No radiographic changes were evident in 6 horses of the group B.

DISCUSSION

All unsound horses had an increased intra-articular pressure in both positions, resulting in a mean articular pressure value about the twice of that of sound horses. We concluded that pressure measurements could be considered a useful aid to identify a pathologic condition involving the distal portion of the foot, particularly when the disease is localized in the DIP joint or in the navicular bone. By making a statistical comparison between the pressure values in sound and diseased horses, it was possible to confirm the validity of this method. In this study we obtained statistical significance by comparing the pressure of sound and unsound animals bearing weight and also in the case where the contra-lateral limb was raised ($P<0.001$). The data indicated that both values have statistical significance in both positions independent of the limb affected.

Both sound and unsound horses had a wider pressure variation when one of the limbs was raised. This observation could be possibility explained by the decreased balance of the horse due to increased body movements in some animals. Furthermore, from analysing the same data in unsound horses, a higher variability was observed when a forelimb was raised up. This could be due to the discomfort of the lame horses when forced to bear weight on the painful limb, which may explain the increase in body movements and the modification of the limb position during weight distribution.

Our pressure ranges were higher than those found in other scientific studies (4, 6, 12). An explanation for the disparity is unclear. Perhaps, a standardization of the procedure should be helpful to avoid a variability of materials and methods used. Moreover, the dearth of bibliographic scientific data available did not allow adequate comparison of the results.

No relationship was found between the pressure value and the radiographic finding of the DIP joint and the distal sesamoid bone (Table 1). This finding demonstrates that pressure measurement cannot replace other instrumental diagnostic methods, such as radiography for a differential diagnosis of lameness.

Some studies support the thesis that pressure evaluation of the coffin joint and navicular bursa could substitute the diagnostic application of local anaesthesia (13). In other reports an absolute relationship between positive results of the DIP joint anaesthesia and increase of pressure was not found (5). In this case the diagnostic role of the anaesthesia was regarded as irreplaceable. In the present study, in each patient with a positive result of the intra-articular block an increase in pressure greater than the mean value in sound horses was observed.

Our results indicate that in these cases pressure measurements should be introduced as a part of the schedule for lameness examination. The technique is a simple, safe and relatively cheap; it does not require hospitalization and can also be used as a follow up in order to verify the progression of the process or the efficacy of the treatment.

Further studies are necessary to better understand which variables need to be standardized for improving the repeatability of the measurements. Furthermore, studies concerning the measurement of pressure in specific pathologic condi-

Table 1: Relationship between pressure, radiographic and cytological findings in the horse of group B.

Horse	Weight bearing (mm Hg)	Contra-lateral lifted up (mm Hg)	Radiographic findings	Cytological findings
1°	56.0	108.0	-----	-----
2°	74.7	214.5	Dip joint osteoarthritis	Mild synovitis
3°	61.6	103.7	Lolly pop lesions	-----
4°	67.8	109.8	-----	-----
5°	70.5	107.8	Lolly pop lesions	Mild synovitis
6°	61.8	104.4	-----	-----
7°	75.2	102.4	Dip joint osteoarthritis	-----
8°	65.4	101.7	-----	-----
9°	78.3	102.8	Entheseophyte	Mild synovitis
10°	66.0	191.5	-----	-----
11°	75.8	103.0	Dip joint osteoarthritis	Mild synovitis
12°	57.6	188.6	Dip joint osteoarthritis	-----
13°	54.0	105.0	Lolly pop lesions	-----
14°	71.5	104.7	Lolly pop lesions	Mild synovitis
15°	69.0	196.0	-----	Mild synovitis
16°	59.5	180.6	Lolly pop lesions	Mild synovitis
Mean	**66.5**	**132.8**	-----	-----
St.Dev.	**7.6**	**43.3**	-----	-----

tions (e.g. navicular bone diseases, DIP joint arthrosis) could improve our knowledge about the possible application in differentiating the origin of foot pain.

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