RELEVANCE OF SOME MEASUREMENTS ON RADIOGRAPHS FOR HOOF BALANCE EVALUATION IN HORSE

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Summary

The study was carried on 15 horses (7 sound and 8 lameness horses). Both forelimbs were radiographed and lateromedial and dorsopalmar view were obtained. More parameters, distance and angle, was measured for hoof balance evaluation. In sound horses that the trimming were made four or more a lateromedial imbalance was accompanied from a more intense side bones formation. In lameness horses the values of measured angles, especially of phalanx three bottom, allow evidence of three phalanx rotation that is laminitis specific feature. Three phalanxes fall in the hoof through founder distance measurement was not record.

Key words: horse, hoof balance, radiographs measurements.

Hoof-related lameness is common in performance and pleasure horses. Radiography is still the most common diagnostic tool to assess hoof injury and radiological measurements are important in the evaluation of hoof balance, hoof trimming or displacement of the pedal bone in laminitis hooves (2,5). Objective assessment of geometric hoof balance with the use of hoof measurements and quantitative description of the digital bones in relation to the hoof capsule have been proposed to achieve ideal trimming for an individual horse’s conformation. A great deal of information has been published about how abnormal balance initiates foot and limb disorders. There is, however, no question that a great deal remains to be understood about the relationship between hoof balance and lameness (1,3,5). The objective of this study were to determinate the significance of some parameters measurements in horse on radiographs for hoof balance evaluation.

Materials and methods

Fifteen horses ranging in age from 3 to 20 years 15 (8 mares and 7 geldings) (table 1) were included in this study. From this, 7 horses were clinically sound, without lameness. The other 8 have presented lameness to the front legs. Before radiographs were taken, the shoes were removed and the sole and frog cleaned. The horse was positioned alternating, with to be radiographed forelimb on a wooden block. The exposure factors for lateromedial (LM) and dorsopalmar (DP) view were 60-65 kV and 20-25 mAs (Nanomobil 2, Siemens). For the LM view the vertically positioned cassette touched the hoof capsule on the medial side and for
DP the palmar region of the pastern. For the LM view the horizontal X-ray beam was centred on coronary band at the mid-point between the bulbs of the heel and the proximo-dorsal aspect of the hoof wall and for DP x-ray beam was centred on the median of the dorsal hoof wall. For boot LM and DP views, the dorsal, lateral and medial wall was marked with a flexible band of lead, with the upper end placed at the coronet bordering the hair line.

Table 1

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (year)</th>
<th>Sex</th>
<th>Breed</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
<td>F</td>
<td>Romanian sport horse</td>
</tr>
<tr>
<td>2</td>
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<td>Romanian sport horse</td>
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<tr>
<td>3</td>
<td>20</td>
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<tr>
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<td>4</td>
<td>F</td>
<td>Romanian sport horse</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
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</tr>
<tr>
<td>6</td>
<td>12</td>
<td>F</td>
<td>Mixed breed</td>
</tr>
<tr>
<td>7</td>
<td>11</td>
<td>M</td>
<td>Nonius</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>M</td>
<td>Nonius</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>M</td>
<td>Mixed breed</td>
</tr>
<tr>
<td>10</td>
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</tr>
<tr>
<td>13</td>
<td>13</td>
<td>F</td>
<td>Holstein</td>
</tr>
<tr>
<td>14</td>
<td>6</td>
<td>F</td>
<td>Holstein x Oldenburg</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>M</td>
<td>Mixed breed</td>
</tr>
</tbody>
</table>

On the obtained radiographs the KUMMER (5) system for hoof balance evaluation was applied. A number of 15 measurements were made on LM view (fig. 1): 1. Dorsal wall length (DWL); 2. Sole length (SL); 3. Length of three phalanx (LP3); 4. Three phalanx to toe length (P3T); 5. P3 to break over length (P3PB) 6. Toe length (TL); 7. Toe/foot length % (TFL%); 8. Hoof P3 distance - proximal (CF3P); 9. Hoof P3 distance - distal (CF3D); 10. Founder distance (MCPE); 11. Sole thickness (ST); 12. Distal interphalangian joint height (JH3). On the same LM view four angles were measured (fig 2): 1. Hoof Angle (HA); 2. Distal phalanx angle (P3A); 3. P3Bottom angle (P3 BA); 4. Dorsal hoof P3 angle (UCF3).
Fig. 1. View of a LM radiograph indicating the measured parameters (distance, cm)

Fig. 2. View of a LM radiograph indicating the measured angles

On DP view the following 11 measurements were evaluated (fig. 3): 1. Lateral wall length (LWL); 2. Medial wall length (LPM); 3. Foot width (FW); 4. Lateral height of coronet (LHC); 5. Medial height of coronet (MHC); 6. Coronet Width (CW); 7. P3 to bottom lateral (LP3B); 8. P3 to bottom medial (MP3B); 9. P2/P3 Joint Height (DIJH); 10. Lateral wall angle (LWA); 11. Medial wall angle (MWA).
Fig. 3. View of a DP radiograph indicating the measured parameters (distance and angle)

On DP view in four horses the angle $\theta$ proposed by Caudron (2) as important for hoof balance evaluation in DP view; it is measured laterally between intersection of the line through vascular holes of the phalanx three and the line through middle axis of two phalanx and frog.

Evaluation of phalanx three on LM view was made according to the system proposed by Denoix et al. (4): modification of extensor process, distal tip of phalanx and cartilages was noted. On DP view evaluation of ossification stages of cartilage (sidebones) was made according with system proposed by Rouboneme, cited by Mosseri and Desbrosse (5): stage 0 - without ossification; stage 1 - law ossification at the basis of palmar process; stage 2 - ossification at the level of proximal part of distal interphalangeal (coffin) joint; stage 3 - ossification below to the proximal contour of navicular bone; stage 4 - ossification between proximal contour of navicular bone and middle of two phalanx; stage 5 - ossification to the middle of two phalanx.

The data were statistically analyzed by Pearson correlation mean and the mean moderate error for different parameters. Results were considered statistically significant at $p<0.05$.

**Results and discussions**

On all horses without hoof trimming in to the last six month (cases 1, 2, 4, and 15) lateral wall length and lateral high of coronet was greater lateral than medial, the differences were statistically significant. Those parameters, on recent timed horses, have had the same value.
The distance of hoof to three phalange was greater proximal than distal on recent trimmed horse. That was correlated with negative value of angle between the wall and three phalanges on 3, 9 and 14 horses. To untrimmed horses the distal hoof phalange distance were greater than proximal.

Founder distance has a median value of 1.19± 0.2 cm in horses without lameness and 1.2 ± 0.27 in lameness horses. The mean value of hoof angle was 49.2⁰ and maximal difference between left and right was 4⁰. The hoof angle was smaller in the horse were not recently trimmed compared with dorsal three phalange-bottom angle. In all recent trimmed horses dorsal three phalange-bottom angle were greater than hoof angle. In all horses without lameness phalange three - bottom angle and dorsal hoof / three phalange angles have had a normal value, smaller than 5⁰. In lameness horse's three cases have three phalange bottom angle greater than and three horses greater than 10⁰. In the horse were the P angle was evaluated (cases 2, 4, and 15) value of this was greater than 90⁰.

The lateral view underlines the importance of hoof trimming for the hoof balance, especially in the hoof top. A negative correlation were founded between hoof angle and dorsal wall length (r= -0.33) and between tool/foot length %, too (r=-0.42).

Kummer et al. (5) consider the hoof trimming as an important opportunity to improve the hoof balance. Compare to palmar region where hoof horn is wearing more constantly the hoof wall must be trimmed. Reduction of break over point has a favourable effect on the hoof balance through reduction of tension in to the deep flexor tendon and pressure exerted on distal sesamoid bone.

The natural balance described by Ovniceck (7) and characterized by a short hoof wall and bearing of sole and frog were not observed by us in horses maintained on pasture for a period for more that four month (cases 1,2,3,4). In all horses at bearing surface exams the bearing wall were present, the length of weight bearing surface were greater than bearing breadth surface.

Our results relieves a lateral hoof wall length greater to the horses were not recent trimmed, aspect that was similar with that presented by the other authors (2). Overcharging of lateral half of hoof when the horse bearing of the leg was demonstrated also in horses with normal conformation of the leg and can be explained through moves of the body weight on bearing leg. On longer lateral or medial hoof wall (LM hoof imbalance) can amplified this aspect and could be the explanation for side bones founding the case in this hoof trimming and shoeing were not systematically made. According to literature (4, 6) we didn’t find lameness into the horse with side bones and we observed the presence of this lesion starting to an early age of horses (4 years).

In lameness horses the changes of P3 bottom and dorsal hoof P3 angles have the signification of a three phalax in the hoof that is laminitis specific feature (2, 6). Founder distance was greater that 1cm in lameness and in sound horses, too. Reduction of this parameter under 1cm, values considered normally in middle
size horse by Deniau et al. (3) have the signification of three phalanx fall in to the hoof and can by a sing of laminitis.

Conclusions

In dorso-palmar view, wall length, height of coronet, phalanx three to bottom medial and lateral and hoof angle allow an easy evaluation of lateromedial and dorsopalmar hoof imbalance.

In horses with lateromedial imbalance sidebones presence was unregistered, a more intense ossification were on side with prolonged more bearing.

Position of phalanx three in to the hoof could by easy evaluated by three phalanx bottom angle measurement.

References