Radiographic morphometry of the hoof and third phalanx of apparently healthy Nigerian horses

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ABSTRACT
The objective of the study was to establish reference values for radiographic soft tissue indices of the hooves of apparently healthy Nigerian horses and to identify sex and age-related variations if any. Lateromedial radiographic examinations of the forelimb hooves of 52 apparently healthy Nigerian horses of both sexes aged young (1 – 5years), adult (6 – 10years) and old (11years and above) were carried out in the cross-sectional survey design. Radiographic soft tissue indices such as hoof wall distal phalanx distance (HWDPD), hoof wall proximal phalanx distance (HWPPD), coronary extensor distance (CED), sole depth (SD), hoof cup (HC), palmarocortical length (PCL) of the third phalanx, hoof wall angle (HWA), angle of third phalanx (AP3) and angle of rotation (AR) were measured and compared between sexes and among age groups. There was no significant sex variations in the indices investigated. However, the mean SD and HC showed age-related significant variation. The mean SD was only significantly (P < 0.05) lower in old horses compared to young and adult horses. The mean values of HC were significantly (P < 0.05) lower in adult and old horses compared to young horses. Radiographic morphometric indices assessed in this study may differ with those reported from other breeds, so they can be used in the future as reference values for diagnosis of laminitis in front feet of Nigerian horses.

Key words: Horse, Hoof, Radiographic morphometry, Third phalanx.

INTRODUCTION
In Nigeria, horses are maintained by research institutes, universities and security agencies for parade and crowd control, Emirs and Local Chiefs for ceremonies, and some elites for racing, agriculture, transportation, polo games and pleasure riding (Ememe et al., 2015). Horses and human beings are intrinsically connected to each other, and as such, protection of horses from diseases and unnecessary suffering should become prime responsibility of human (Kumar et al., 2017). Routine radiographic assessment of the hoof could be a preventive measure for laminitis progression in horses, since subclinical form of laminitis can be diagnosed radiographically (Cripps and Eustace, 1999).

The ability of horses to fulfill their functions is dependent upon its possession of four good feet (Redden 2003). Hoof problems constitute one of the major causes of lameness in pleasure and sports horses (Kaneene et al., 1997), and have been associated with poor hoof balance and conformation (Turner, 2006). Lameness in crossbred animals has emerged as the most severe problem in recent years, and acute lameness can turn a healthy animal into a physical wreck over a matter of days (Man et al., 2015). Traditionally, hoof conformation is described by linear and angular measurements of the hoof capsule, the digital bones and their relationship to each other, including direct linear measurements of the hoof capsule (Kobluk et al., 1990).

Laminitis is a major hoof problem that can compromise the ability of horses to perform its functions effectively. Laminitis is the most serious disease of the equine foot that causes structural and pathological leading to long lasting, crippling changes in function (Cripps and Eustace, 1999). The laminitic animals may refuse to move or have difficulty in moving (Sing and Gill, 2004).

The clinical manifestation of laminitis has been very unclear and controversial for several decades, which is most likely the reason for the overall failure of the majority of many drugs that have been introduced to treat the disease (Cripps and Eustace, 1999).

In the normal horse, the distal phalanx (coffin or pedal bone) is attached to the inside of the hoof by a tough, but flexible suspensory apparatus called laminae (lamellae). Laminitis is the separation or failure of laminae, which connects the hoof wall to the coffin bone within, and this results in severe pain and lasting lameness (Pollitt, 2008). Radiographic indices can be used for detection and diagnosis of lameness (Mansmann and vom Orde, 2007). Assessment of soft tissue indices of the healthy hooves is necessary for

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laminitis detection because the indices correlate with the structural integrity of the hoof (Linford et al., 1993).

There is no information available in the literature on the radiographic soft tissue indices of the hooves of apparently healthy Nigerian horses. Hence, the present study was designed to establish the reference values of some morphometric radiographic soft tissue indices of the hooves of apparently healthy Nigerian horses at Obollo-Afor horse depot, Southeastern Nigeria.

MATERIALS AND METHODS

Study area: The study was done at Obollo-Afor Horse Lairage, Southeastern Nigeria. Geographically, the Obollo-Afor Horse Lairage lies on the Latitude of 6.54°56” and longitude of 7.30°55” east.

Reason for site selection: The Obollo-Afor horse lairage has for the past five (5) decades been maintaining a steady availability of horses for sale, meat and others for use in social functions. The horse lairage has served as an invaluable equine research facility to the University town of Nsukka and specifically for researchers in the Faculty of Veterinary Medicine, University of Nigeria, Nsukka. The lairage is therefore considered an invaluable facility for lameness and hoof lesion studies.

Animals: The horses used for the study were Nigerian horses brought down from Northern Nigeria and are kept for sale at Obollo-Afor, southeastern Nigeria. These Nigerian horses are a collection of mixed Arewa breeds and their crosses with the Arabian, Dongola, Barb-Arab and sudanese breeds which are not distinguishable from one another based on any specific breed characteristics (Ihedioha and Agina, 2013).

Animal selection: The study period lasted for two months (January and February 2015), and research visit to the horse depot was made once a week during the study period. Horses that showed signs of lameness and evidence of hoof lesions were excluded for the study and a total of 52 horses with no evidence of lameness and hoof lesions or any other state of ill health were selected and their hooves radiographically examined according to Kumar et al. (2004) and Redden (2003).

Grouping: Their ages were determined based on tooth eruption and wear (Ihedioha and Agina, 2013) and were grouped as young (1-5 years), adult (6-10 years), and old (11 years and above). The selected horses were also grouped as male and female.

Radiographic technique: Excess sole and frog were trimmed off with a hoof knife and any mud and gravel removed with a wire brush. A radio-opaque marker in the form of a straight metal bar or rod, was embedded in the edge of the wooden block closest to the film cassette. This created a horizontal line on the radiograph against which the angle of the distal phalanx could be calculated. A straight metal marker (a 50-70 mm steel rod) was placed on the surface of the dorsal hoof wall, to locate the outer surface of the dorsal hoof wall on the radiograph. The marker served as a reference point for subsequent measurement of downward vertical displacement of the distal phalanx, should this occur. The hoof wall and the dorsal cortex of the distal phalanx are parallel in the normal horse. The x-ray beam was positioned at right angles to the sagittal plane of the foot and centered midway between the heel and the toe, 2-3 cm above the bearing surface of the hoof wall (Redden, 2003; Linford et al., 1993; Kummer et al., 2004). Radiographs were read and the indices such as palmarocortical length (PCL), hoof wall proximal phalanx distance (HWPPD), hoof wall distal phalanx distance (HWDPD), sole depth (SD), angle of rotation (AR), angle of third phalanx (AP3), hoof wall angle (HWA) hoof cup (HC), coronary extensor distance (CED) from lateromedial radiographs were multiplied using the magnification correction factor (MCF) to gain the actual distances (Masoudifard et al., 2014).

Data analysis: Student t-test was used to compare the measurements between males and females. Age-related variations in the measured parameters were subjected to one way analysis of variance and variant (ANOVA), and means were separated by the least significant different method. Significance was accepted at p < 0.05.

RESULTS AND DISCUSSION

Figure 1 represents a lateromedial radiograph of the front hoof of Nigerian horses showing various radiographic soft tissue indices that were measured. A. Coronary extensor distance (CED), B. Hoof wall proximal phalanx distance (HWPPD), C. Hoof wall distal phalanx distance (HWDPD), D. Hoof wall angle (HWA), E. Angle of third phalanx (AP3), F. Sole depth (SD), G. Hoof cup (HC), H. Palmarocortical length of the third phalanx.

The mean radiographic soft tissue distances (mm) such as HWPPD, HWDPD, CED, HC and SD measured between sexes were shown in Figure 2 and among age groups were represented in Figure 3. The results showed no significant difference (P > 0.05) between male and female horses (Figure 2). However, the mean value of SD for old horses (11 years and above) was significantly (P < 0.05) lower compared to that of the young (1 – 5 years) and adult (6 – 10 years) horses (Figure 3). The mean values of angle of rotation (AR) between sexes and among age groups were shown in figures 4 and 5 respectively. There was no significant difference in the mean AR between male and female horses (Figure 4) and among age groups (Figure 5). The mean values of both the proximal and distal hoof wall phalanx distance (HWPD) to palmarocortical length (PCL) between age groups and sexes are shown in Figures 6 and 7.
Fig 1: Lateromedial radiograph of the front hoof of a Nigerian horse showing various radiographic soft tissue indices that were measured. A. Coronary extensor distance (CED), B. Hoof wall proximal phalanx distance (HWPPD), C. Hoof wall distal phalanx distance (HWDPD), D. Hoof wall angle (HWA), E. Angle of third phalanx (AP3), F. Sole depth (SD), G. Hoof cup (HC), H. Palmarocorticular length of the third phalanx.

Fig 2: Lateromedial radiographic indices of hooves of apparently healthy female and male Nigerian horses

Fig 3: Lateromedial radiographic hoof indices of apparently healthy Nigerian horses among age groups

Fig 4: Rotation angle of the third phalanx (P3) of the hooves of apparently healthy male and female Nigerian horses

Fig 5: Rotation angle of the third phalanx (P3) of apparently healthy Nigerian horses of different ages
respectively. The results showed no significant variation between age groups (Fig. 7).

Radiographic assessment of the distal phalanx is the backbone of the veterinary evaluation of the equine digit (Linford et al., 1993; Redden, 2003). Assessment of soft tissue indices of the healthy hooves is necessary for laminitis detection. Linford et al. (1993) reported that the widest measurement of the hoof wall phalanx distance (HWPD) was 18mm. O’Brien et al. (2011) stated that HWPD up to 20mm and above was the first radiographic sign of laminitis. Increase in HWPD is a consequence of inflammation of the hoof laminae, and will be seen on the lateromedial radiographs almost 48 to 72 hours after laminitis start to grow. In this study, both the proximal and distal HDPD were never more than 20mm. However, differences exist between HWPD in this and other studies, especially, Linford et al. (1993), Cripps and Eustance (1999) which may be due to breed, environment, hoof cares, level of activities or nutritional status of the studied horses. Linford et al. (1993) and Peloso et al. (1996) have reported HWPD to be less than 30% of the length of the distal phalanx (palmarocortical length (PCL)) while Redden (2003) reported HWPD to be 25% of the length of PCL in non-laminitic horses, and stated that a higher percentage would be a sign of laminitis. The mean ratios of both proximal and distal HWPD/length P3 (PCL) were less than 30% but greater than 25% as reported by Redden (2003). The ratios recorded in this study were however comparable to but slightly lower than those reported by Masoudifard et al. (2014) in east of Tehran, Iran. It is thought that the lower values recorded for Nigerian horses may be due to their smaller relative size when compared to western breed of horses.

All the soft tissue indices with the exception of sole depth (SD) and hoof cup (HC) did not vary significantly (P > 0.05) between sex and among age groups. This result is in consonant with the work of Perreaux (2002) and Peloso et al. (1996) who reported no significant variation between sexes.

CONCLUSION

This study has documented the radiographic measurements of morphometric variables of the front hooves of apparently healthy Nigerian horses. There was no significant sex variations in the indices investigated. However, the mean SD and HC showed age-related significant variation. The mean SD was only significantly lower in old horses compared to young and adult horses. The mean values of HC were significantly lower in adult and old horses compared to young horses. Radiographic morphometric indices assessed in this study may differ with those reported from other breeds, so they can be used in the future as reference values for diagnosis of laminitis in front feet of Nigerian horses.


