

Radiographic Assessment of Prevalence of Laminitis from the Hoof-Related Forelimb Lameness Feet of Nigerian Horses

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Abstract

The objectives of the study were to use radiological indices to confirm laminitis in hoof-related forelimb lameness and to determine its prevalent rate between sexes, seasons and among age groups in a cross-sectional study. Lateromedial radiographic examination of the hooves of 66 Nigerian horses that presented with hoof-related forelimb lameness were investigated. The horses were aged as young, adult and old. Independent sample t-test was used to analyze the radiological indices between laminitic and non laminitic horses. Data for prevalence of laminitis were subjected to descriptive statistics and association between sex, age and season were analyzed using Chi square. Significance was accepted at $P < 0.05$. Of the 66 hoof-related forelimb lameness horses examined, 42 horses had laminitis. The mean values of the radiographic soft tissue indices of the hooves such as hoof distance phalangeal distance proximal (HDPDP), hoof distance phalangeal distance distal (HDPDD), ratios of HDPDP and HDPDD to the palmarocortical length (PCL), angle of rotation (AR), sole depth (SD) and coronary extensor distance (CED) varied significantly ($P < 0.05$) between laminitic and non laminitic horses. Male horses had 27.3% prevalence of laminitis while females had 31.8%. Prevalence of laminitis showed no significant association with sex ($P > 0.05$). Young horses had the least prevalent rate of laminitis (4.5%) whereas adult and old horses had 28.8% and 25.8% respectively. Prevalence of laminitis at dry and rainy seasons was 21.2% and 37.9% respectively.

Keywords: Nigerian horse; Hoof; Radiographs; Laminitis

Introduction

Laminitis is one of the most common causes of lameness in horses [1,2]. Laminae are the structures which attach the pedal bone to the inside of the hoof wall; if these laminae become inflamed or damaged they can cause severe pain and distress. When laminitis occurs, some of the laminae die off, which results in an unstable foot. The pedal bone may then rotate within the foot, or in more severe cases the pedal bone may sink within the foot [2]. Laminitis can occur in all shapes and sizes of horses and ponies, although it is more commonly seen in small, overweight native ponies [3]. Most frequently, laminitis will occur in both front feet which is logical given that horses bear approximately 60% of their weight on their front limbs [4].

Even the most experienced clinician cannot determine the location of the osseous structures within the hoof capsule in the absence of radiography. Therefore, radiographs are indicated in every suspected laminitis case because they provide valuable information about the presence, severity, relative chronicity and progressive nature of the disease [5]. In order to obtain maximum information from radiographs, preparation of the foot is essential. Particular attention should be paid to the cleanliness of the angles of the bars and the central and lateral sulci of the frog [6]. In horses with laminitis, radiographs are primarily obtained to determine the position of the distal phalanx within the hoof and the nature of the soft tissue changes. Although radiographs are poor at imaging soft tissue, information can be gleaned from plain film radiographs obtained with soft tissues in mind [6]. Radiographic assessment of the laminitic horse foot is of

primary diagnostic importance and a lateromedial radiograph represents the 'gold standard' for diagnosis of anatomical change [7]. The purpose of this study was to radiographically diagnose laminitis in Nigerian trade horses with hoof-related forelimb lameness and to assess its prevalence with respect to sex, age and season of the year.

Materials and Methods

Design

The study was a cross sectional study carried out in Nigerian trade horses at Obollo-Afor horse depot, Southeastern Nigerian. Nigerian horses are a collection of mixed Arewa breed 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 [8].

The study period was 4 months comprising of 2 months of dry season and 2 months of rainy season. Research visit to the depot was made once every week during the study period.

Clinical assessment of lameness

Each of the horses at the horse depot was observed while standing, walking and trotting and the gait evaluated according to Baxter [4]. Those that showed signs of lameness were further reexamined using palmar digital nerve blocks as follows; 25 gauge needle containing 2 ml of two percent Lidocaine HCL was inserted just in front of the superficial flexor tendon which is half way between the fetlock and the coronary band to desensitize the lateral and the medial posterior

nerves which innervate the foot. Hoof-related forelimb lameness horses were selected if the forelimb lameness was abolished after the nerve blocks were performed [9]. A total of 66 horses that were presented with hoof-related forelimb lameness were selected and radiographically assessed for laminitis. The horses were grouped based on sex, season and aged as young (1-5 years), adult (6-10 years) and old (11 years and above). Radiological indices of the foot were used to determine the presence or absence of laminitis in each of the horses.

Radiographic detection of laminitis

Radiographic techniques: Radiographic examination of the hooves of the 66 horses that had hoof-related forelimb lameness was carried out according to the methods of Cripps and Eustance [1].

Radiographs of the hooves were obtained using a portable X-ray generator with exposure factors of 4 mAmp and 84 kVolt. The radiographic beam was carefully positioned to pass perpendicularly to the sagittal plane through the foot while being centered in the middle of the hoof, 3 cm proximal to the bearing surface. The hoof also was placed on a 7 cm thick wooden block so that the distance of the center of the beam to ground surface was 10 cm. To differentiate the bearing surface from the block, a metal bar was placed on the block surface. The focus-film distance for each projection was 75 cm.

The frog sulci and the sole surface of the digits were cleaned prior to radiography. A metal marker (3 cm) was used to determine the amount of radiographic magnification as well as to delineate the coronary band at the lateromedial radiographs. All the measurements from lateromedial radiographs were multiplied using the magnification correction factor (MCF) to gain the actual distances. The MCF was determined by dividing the actual metal marker length to the length of the radiographic image of the marker.

The following were the radiographic soft tissue indices of the hoof assessed;

Hoof distance phalangeal distance proximal (HDPDP) or also known as total soft tissue thickness dorsal to the proximal aspect of the third phalanx (STTP).

Hoof distance phalangeal distance distal (HDPDD), or also called total soft tissue thickness dorsal to the distal aspect of the third phalanx (STTD).

Palmarocortical length (PCL) of the third phalanx: The distance from the tip of the solar margin to the middle of the articulation between the phalanx and the navicular bone.

Ratio of HDPDP to PCL: $HDPDP / PCL (\%)$

Ratio of HDPDD to PCL: $HDPDD / PCL (\%)$

Hoof wall angle (HWA or S-angle): The caudal angle formed between a line along the dorsal surface of the hoof wall and a line along the bearing surface of the hoof

Distal phalanx angle (Angle of P3 or T-angle): The caudal angle formed between a line along the dorsal cortex of the phalanx and a line along the bearing surface of the hoof wall.

Angle of rotation of third phalanx (AR). The difference between S and T-angles is the angle of rotation (AR) of the P3

Sole depth (SD): SD is generally measured from the tip of distal phalanx to the solar surface of the hoof.

Coronary extensor distance (CED): The coronary extensor (CE) distance (also referred to as founder distance) is the vertical distance between the most proximal extent of the outer hoof wall immediately below the coronary band and the proximal aspect of the extensor process of the distal phalanx.

The above radiographic indices of the foot were used to confirm laminitis and the distribution of laminitis in each of the sex, age and season were noted and recorded.

Data analysis

Independent sample t-test was used to analyze the radiological indices between laminitic and non laminitic horses. Data from the prevalence of laminitis were subjected to descriptive statistics and association between sex, age and season were analyzed using Chi square. Significance was accepted at $P < 0.05$.

Results

The mean values of all the radiographic soft tissue indices of the hooves assessed were summarized in the Table 1.

Radiographic soft tissue indices	Laminitic horses	Non laminitic horses
HDPDP (mm)	23.45 ± 0.6a	16.58 ± 0.50b
HDPDD (mm)	24.45 ± 0.3a	14.58 ± 0.21b
PCL (mm)	65.86 ± 2.19a	66.60 ± 4.60a
HDPDP/PCL (%)	30.71 ± 1.15a	25.30 ± 0.46b
HDPDD/PCL (%)	32.19 ± 1.10a	24.84 ± 0.52b
HWA (°)	47.86 ± 1.84a	46.400 ± 2.29a
AP3 (°)	54.00 ± 1.65a	47.60 ± 2.25b
AR (°)	6.14 ± 0.74a	1.40 ± 0.11b
SD (mm)	11.43 ± 0.67a	16.40 ± 0.943b
CED (mm)	21.029 ± 1.26a	13.06 ± 0.84b

Table 1: Mean ± SEM of the radiographic soft tissue indices of the hooves of laminitic and non laminitic horses. Indices with different superscript indicate significant difference ($P < 0.05$)

The mean values of hoof distance phalangeal distance proximal (HDPDP) to the third phalanx was significantly higher ($P < 0.05$) in laminitic than non laminitic horses. The mean values of hoof distance phalangeal distance distal (HDPDD) to the third phalanx was significantly higher in laminitic than non laminitic horses. However, the mean values of the palmarocortical length (PCL) showed no significant variation ($P > 0.05$) between laminitic and non laminitic horses.

The mean ratios of HDPDP/PCL and HDPDD/PCL varied significantly between laminitic and non laminitic horses. The mean values of hoof wall angle (HWA) for the laminitic and non laminitic horses did not differ significantly ($P > 0.05$). The mean values of angle of the third phalanx (AP3) of the third phalanx (P3) between laminitic and non laminitic showed significant variation ($P < 0.05$). Also, the mean values of angle of rotation (AR) for laminitic and non-laminitic

horses differed significantly ($P < 0.05$). The mean CED (mm) values for laminitic and non-laminitic horses varied significantly ($P < 0.05$). The results of the prevalence of laminitis showed that male horses had a higher prevalence of laminitis than females (Table 2). However, prevalence of laminitis showed no significant association with sex ($P > 0.05$) (Table 2).

Sex	No of horse presented with lameness	Freq. of laminitis	Prevalence of laminitis (%)
Male	30	18	27.3%
Female	36	21	31.8%
Total	66	39	59.1%
$\chi^2=0.019$, $df = 1$ ($P > 0.05$)			

Table 2: Prevalence of laminitis between sexes

Young horses had the least prevalent rate of laminitis whereas adult and old horses had the least respectively (Table 3). Prevalence of laminitis was higher at rainy season than dry season (Table 4). Prevalence of laminitis had a significant association with age and season (Tables 3 and 4).

Age of horse	No of horse with hoof-related lameness	Frequency of laminitis	Prevalence of laminitis (%)
1 – 5 years (Young)	13	3	4.5%
6 – 10 years (Adult)	28	19	28.8%
11 years plus (Old)	25	17	25.8
Total	66	39	59.1
$\chi^2=8.69$, $df = 2$ ($P < 0.05$)			

Table 3: Prevalence of laminitis between age groups.

Season	Horses with hoof-related lameness	Freq. of laminitis	Prevalence of laminitis (%)
Dry season	27	14	21.2%
Rainy season	39	25	37.9%
Total	66	39	59.1%
$\chi^2=20.7$ $df = 1$ ($P < 0.05$)			

Table 4: Prevalence of lameness between seasons.

Discussion

Generally, morphometric radiological changes in laminitic hooves results from movement of the distal phalanx in either the sagittal or frontal planes or even a combination of the two. Mechanical collapse of the lamellar attachment of the distal phalanx to the hoof wall precipitates the abnormalities that results [10].

The significantly higher mean values of both the HDPDP and HDPDD in the laminitic horses than the non laminitic horses is in agreement with the work of Cripps and Eustance, Redden and Fraley

who that radiological abnormalities associated with the development of laminitis include widening of the dorsal hoof [1,6,11]. This widening of the HDPD is a consequence of dorsal rotation of the distal phalanx (P3) attributed to mechanical failure of the dorsal lamellae [12]. However, the mean values of the proximal and the distal HDPD in the non laminitic hooves were within range of normal horses as reported by Collins et al. [13]. Redden reported that HDPD greater than 15 mm in Thoroughbreds, Quarter Horses is suggestive of laminitis. Redden reported that HDPD greater than 15 mm in Thoroughbreds, Quarter Horses is suggestive of laminitis [6]. Linford et al. and Cripps and Eustace reported a mean range of HDPD to be 14-18 mm in normal Thoroughbreds, Quarter Horses and other light breed horses [1,14]. Increases in this width that are of the same magnitude along the entire proximal to distal length of the distal phalanx are suggestive of distal displacement of the distal phalanx [11,14].

The significant higher coronary extensor distance (CED) in laminitic than non laminitic horses could be due to lamellae collapse with resultant distal displacement of the third phalanx. The mean range of CED for the non laminitic horses in this study is in consonant with the work of Redden and Linford et al. who reported a mean range of 2 -15 mm [6,14]. An increase in the CED above the normal range is commonly identified when the lamellae collapse evenly all around the hoof due to excessive shear forces [14].

In the laminitic group of this study, the ratios of both the proximal and the distal HDPD were greater than 30% of the palmarocortical length of the distal phalanx (>30%) whereas the non laminitic groups had their mean values less than 30% of the length of distal phalanx. This result agrees with the work of Peloso et al. who reported that greater than 30% ratio of the HDPD to the length of third phalanx (P3) is laminitis suggestive [10]. However, this result fail to agree with the work of Redden who reported that in normal horses (non laminitic) the mean values of the ratio of the HDPD to the length of distal phalanx is $\leq 25\%$ and that an increase above the 25% is suggestive of laminitis [6]. When this occur, the distal phalanx drops within the hoof capsule (distal displacement of the distal phalanx, 'sinking') making the solar margin of the distal phalanx to becomes closer to the ground surface [12].

The results showed that laminitic horses had a mean value of sole depth (SD) less than 15 mm (<15 mm), and this agrees with the findings of Redden which state that less than 15 mm of SD is abnormal in most horses. Thinning of the sole is suggestive of structural damage as digital venograms performed in horses with sole depth less 15 mm (>15 mm) show solar papillae that are bent, compressed or even absent predisposing to further pain and lameness [6]. Therefore, horses with laminitis, a sole depth of greater than 15 mm (<15 mm) is more likely to be clinically significant and is suggestive of displacement of the tip of the distal phalanx distally which causes crush injuries to the distal soft tissues [6]. Absence of significant difference ($P > 0.05$) in the mean values of HWA between laminitic and non laminitic horses could be that the HWA is usually not affected during the episode of laminitis. However, the means of the angle of third phalanx (P3) in the age groups varied significantly between the laminitic and non laminitic groups. The reason for the significant variation could be because the angle of third phalanx (P3) increases when the P3 is sinking or rotating as seen in the cases of chronic laminitis [1,6].

The means of angle of rotation of the P3 (AR) in the study varied significantly between laminitic and non laminitic horses. This finding is expected since the more the P3 sinks into the solar corium of the

hoof, the higher the angle of the P3 which correlate with the degree of the rotation of the P3 [6].

A relative high prevalence of laminitis in male than female horses may be due to mechanical factors since male horses are more often engaged in varied activities ranging from racing and agricultural purposes than female horses. However, prevalence of laminitis showed no significant association between sexes and this is in consonant with the work of Slater et al. The seasonal increase in risk of laminitis in the rainy season compared with dry season is more likely to be related to true seasonal factors such as grazing behavior and the nutritional content of the forage. This is because pollit associated pasture as a major risk factor for laminitis in horses irrespective of breed, age and uses. Again, since all the sampled horses were unshed, working and walking on barefeet might also have predisposed them to laminitis.

Hamilton-Fletcher, reported that horses that are overworked on hard surfaces are often predisposed to laminitis and other hoof lesions. A higher prevalence of laminitis in horses aged 11 years and above agrees with the work of Allford et al. who reported that for chronic laminitis, horses aged 10 years and above are of greater risk for laminitis.

Conclusion

All the radiographic soft tissue indices of the hoof showed significant variation between laminitic and non laminitic horses with the exception of hoof wall angle (HWA) and length of the third phalanx (i.e., palmarocortical length).

Laminitis had a high prevalence in male horses than the female horses but was not significantly associated with sex. Laminitis showed a significant association with age and season of the year.

References

1. Baxter G (1994) Acute laminitis. *Vet Clin N Am Equine Pract* 10: 627-642.
2. Biggi M, Dyson S (2013). Hind foot lameness: Result of magnetic resonance imaging in 38 horses (2001-2011). *Equine Vet J* 45: 427-434.
3. Collins SN, Dyson SJ, Murray RC, Burden F, Trawford A (2011) Radiological anatomy of the donkey's foot: Objective characterisation of the normal and laminitic donkey foot. *Equine Vet J* 43: 478-486.
4. Cripps PJ, Eustace RA (1999) Radiological measurements from the feet of normal horses with relevance to laminitis. *Equine Vet J* 31: 427-432.
5. Fraley BT (2007) Acute Sinker syndrome - diagnosis and therapeutic options, North American Veterinary Conference, 117-118.
6. Herthel D, Hood DM (1999) Clinical presentation, diagnosis, and prognosis of chronic laminitis. *Vet Clin N Am: Equine Pract* 15: 375-394.
7. Ihedioha JI, Agina OA (2013) Serum biochemistry profile of Nigerian horses (*Equus caballus*, Linnaeus 1758). *Animal Research International* 10: 1826-1833.
8. Linford RL, O'Brien TR, Trout DR (1993) Qualitative and morphometric radiographic findings in the distal phalanx and digital soft tissues of sound Thoroughbred racehorses. *American Journal of Veterinary Research* 54: 38-51.
9. Peloso JG, Cohen ND, Walker MA, Watkins JP, Gayle JM, et al. (1996) Case control study of risk factors for the development of laminitis in the contralateral limb in Equidae with unilateral lameness. *J Am Vet Med Ass* 209: 1746-1749.
10. Redden RF (2003) Clinical and radiographic examination of the equine foot. *Proc Am Ass Equine Practnrs* 49: 169-185.
11. Rendano VT, Grant B (1978) The equine third phalanx: its radiographic appearance. *J Am Vet Radiol* 19: 125-135.
12. Sherlock C, Parks A (2013) Radiographic and radiological assessment of laminitis. *Equine Vet Edu* 25: 524-535.
13. Stashak TS (2002) *The Foot*. In: Adams SA Baltimore MD (Ed.) *Lameness in Horses*. 5th edn., Lippincott Williams and Wilkins, pp: 645-733.
14. Tachio G, Davies HMS, Morgate M, Bernardini D (2002) A radiographic technique to assess longitudinal balance in front hooves. *Equine Vet J Supl* 34: 368-372.