Lesions associated with atypical black hole seedy toe in the equine foot

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Summary

This paper describes a lesion in the toe of equidae that previously has not been definitively described in a way that differentiates it from other lesions, which, on a brief inspection, may be thought to be aetiologically, and pathologically the same. Post mortem examination, dissection and histology were used to determine the underlying changes associated with these lesions. Parameters are defined to identify and classify the condition as a specific abnormality, aetiologies are explored and an understanding sought of the progressive nature of the deficit.

Introduction

The terminology, both lay and professional, for lesions in the foot of the horse is often vague and ambiguous. Descriptions widely found of lesions in the toe region at the white line solar junction may include stretched white line, white line separation, gravel, white line with granulation, keratoma, black hole separation of the white line and sole, and now the name being used for this lesion described in this paper 'atypical black hole seedy toe'.

It is recognised amongst farriers and veterinarians that the generic 'seedy toe' is a common condition and that is rarely the primary cause of a lameness but that the predisposing condition, for example laminitis and chronic founder, will be the cause of the lameness and that structural changes, due to the pathology, have caused the 'seedy toe' condition to develop.

'Seedy toe' can be apparent without any lameness and can be associated with toe flare and hence a stretched white line solar junction, just as white line disease at the quarters can be associated with quarter flare.

This lesion described has been observed to be associated with a low grade lameness, and is considered by the authors to be a cause of lameness rather than a benign secondary effect of another primary disease process.

It is important to differentiate this lesion described here from other types of 'seedy toe'. Investigation has revealed that often the presence of 'black hole seedy toe' represents an aberrant change to the dermal /epidermal junction at the site of the *crena marginalis*.

Horses presented with a chronic lameness associated with a lesion similar to this have sometimes been candidates for surgical removal of a lesion defined as a keratoma, as described by Hamir, A.H. and others (1992), and Lloyd, K.C and others (1988).
Several papers, for example by Bowker (2003), Daradka and Pollitt (2004), Hamir and others (1992), and Lloyd and others (1988), on the study of the keratoma type lesion provide evidence that may support the hypothesis that these black hole seedy toe lesions may be a form of keratoma not yet defined.
These authors above as well as Honnas and others (2003), Hickman and Humphry (1977) and Stashak (1987), all describe keratomas as aberrant masses of keratin produced by the epidermal cells of the coronary band.

Materials and Methods

Twenty post mortem distal equine limbs, both front and hind were obtained from a rendering plant (slaughter house) in Ocala, Florida, U.S.A. All specimens chosen showed a black seedy toe lesion at the toe at the junction of the sole and white line, and a convexity to the solar epidermis at the dorsal sole as it approaches the junction with the white line.
These external appearances are usually considered to be associated with the presence of a mass at the distal tip of the third phalanx commonly called a keratoma.
Prior to dissection, the external appearance of the deficit and the health of seven structures of the foot were graded, these being the frog, sole, angle of the bar (ground surface of the heel), bars, quarters, dorsal wall and the palpable proximal extent of the collateral cartilages. These structures were graded on a scale 1 (very poor) to 9 (very healthy). An average of the seven scores was calculated to give a value for the individual hoof as a whole.
Measurements were taken of the ventral surface of the hoof capsule (see Figure 1) which included the length from the axis of the foot to the widest part of the frog **B,** the length from the axis of the foot to the junction of the sole and white line **C**, and the length from the apex of the frog to the junction of the sole to white line **A**, a method of measuring the various parts of the solar aspect of the foot which is described by La Pierre, K.C. (2003).

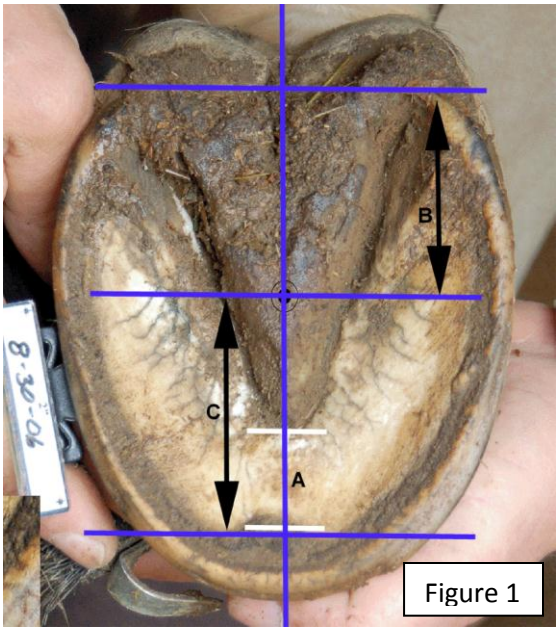


Figure 1. Showing how the solar aspect of the foot is measured.

The black hole deficit diameter was rated by scale, with 1 being small at less than 6 mm, and 5 being greater than 5 cm, with the average rating being 2.85 for the 20 specimens.
After assessment and measurement, the hoof capsule was dissected, and the underlying lesion in the dermis was rated on a scale of 1 to 5 as above, the average rating being 2.65 for the 20 specimens.
A total of 1200 feet were assessed, then dissected and the lesion in the dermis assessed. Twenty of these were sampled for histopathology.
Forty tissue blocks were prepared from the 20 specimen lesions, with a sagital and parasaggital section being harvested from each mass. Each was fixed in 10% buffered formalin, processed routinely for histopathology, cut at 4µm and stained with haematoxylin and eosin for light microscopy. Some slides were stained for collagen with Masson's trichrome.

Results

Histopathological examination of the tissues demonstrated marked epithelial proliferation and keratinisation within the *stratum medium* causing distortion of the tubules of the hoof wall. Additionally the dermis was thickened by variable amounts of granulation tissue, see figures 3 and 4.
Bowker (2003), Budras and others (1989), Daradka and Pollitt (2004) and Lloyd and others (1988) believe that these changes are associated with changes in response to stress in those tissues in the area.

Solar measurements were compared to the relative size of each mass and plotted. The findings suggest that the greater the variance in the balance ratio of 50/50 about the dorsopalmar axis of the foot, the greater the size of the lesion. Hoof angles were not taken into account in this study.
Digital radiographs were obtained of four specimens with dorsoproximal-dorsodistal views used to establish a protocol for the use of radiographs for identifying the presence of a mass at the site of the *crena marginalis*. Over or under exposure may lead to misdiagnosis.
As the normal size of the *crena marginalis* has to date not been defined, it is suggested that further study to determine what presents a 'normal' *crena marginalis* is necessary. Observations published by other researchers support this belief**:** Remodelling with slight rarefaction at the *crena marginalis* of the distal phalanx was observed when a lesion was present, as recorded by Honnas and others (2003).

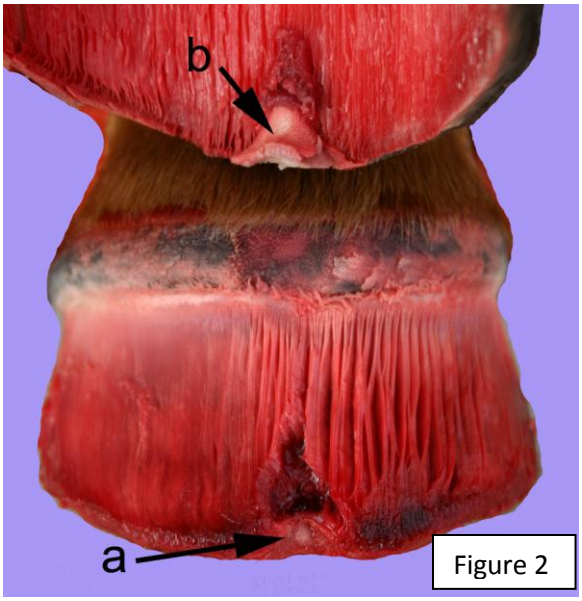


Figure 2. Photograph showing (a) mass inclusion of the dermal layer with the (b) mass visible on the epidermal layer.

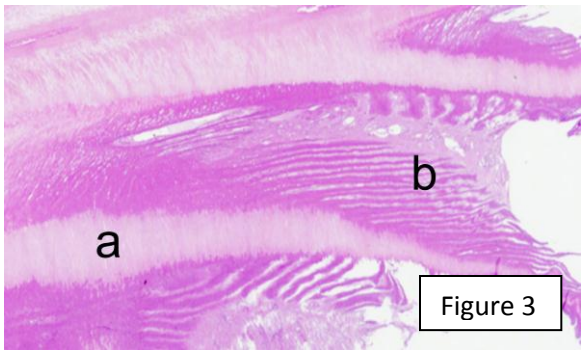


Figure 3. Photomicrograph showing morphological variation of epidermal laminae at the site of the mass. Arrow **(a)** shows the thickening of the primary epidermal laminae. Arrow (**b)** shows elongated and distorted secondary epidermal laminae.

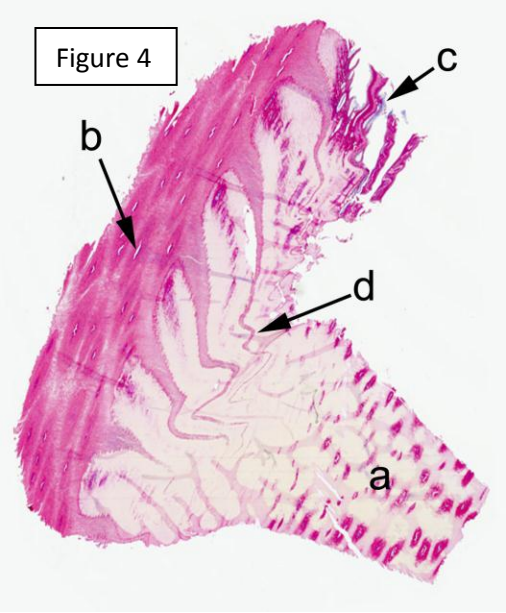


Figure 4: This microphotograph represents a parasagital view of a hyper keratinized lesion. The lesion was harvested from the area identified as the *crena marginalis*. Orientation resembles a dorsal segment of the hoof wall, due to the aberrant growth of the cells that proliferated from the dermal lamellae, and dermal terminal papillae located within the *crena marginalis*. The hyper keratinized cells **(a)** that constitute the bulk of the lesion migrate **(d)** toward the mass axis, and originate from dermal lamellae **(c)** within the *crena marginalis*. The terminal papillae of the *crena marginalis* develop perpendicular to those of the coronary papillae, and produce tubules **(b)** which orientate themselves perpendicular to those of the *stratum medium*. Papillae of the coronary band produce tubules with normal proximal to distal orientation of the *stratum medium*.

Conclusions

From 2001 to 2010, 1200 specimens have been observed and recorded by La Pierre (2001-2010).
During this period a steady increase in the frequency of occurrence of the atypical black hole seedy toe lesions has been noticed. This increase coincides with the introduction of numerous trimming techniques and shoe styles which, as described by Butler and Butler (2004), promote radical reductions in digital breakover. This trend was likely to be a reaction to the negative results of the long toe low heel practices of the 1960's and 70's.
From radiographic studies it has been demonstrated that the distal phalanx undergoes an anterior downward rotation about the DIP (distal interphalangeal) joint during weight bearing, exerting a strain on to the tip of the third phalanx. The distal articulating surface of P2 applies a downward/forward force to the articulating surface of P3, creating a line of force to the tip of P3. It is hypothesized that this force is increased with imbalance.

The load bearing surface will determine the distribution of compressive and internal directed tensile forces at the moment breakover commences.
The dorsal hoof wall's epidermis/dermis junction must share in dissipating the internally directed tensile forces and compression. This can only occur when the solar bearing surface is perpendicular to this junction, see Figure 5.

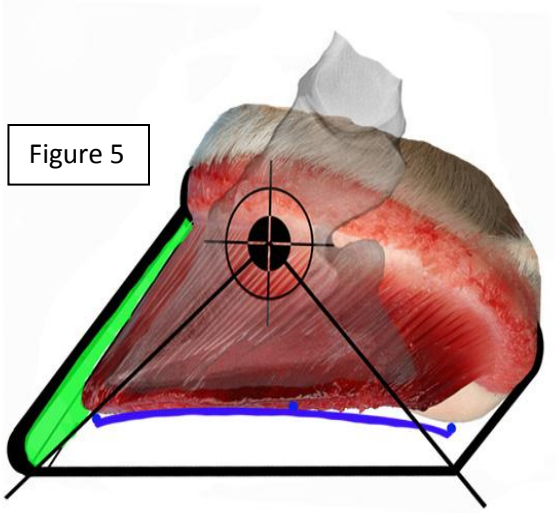
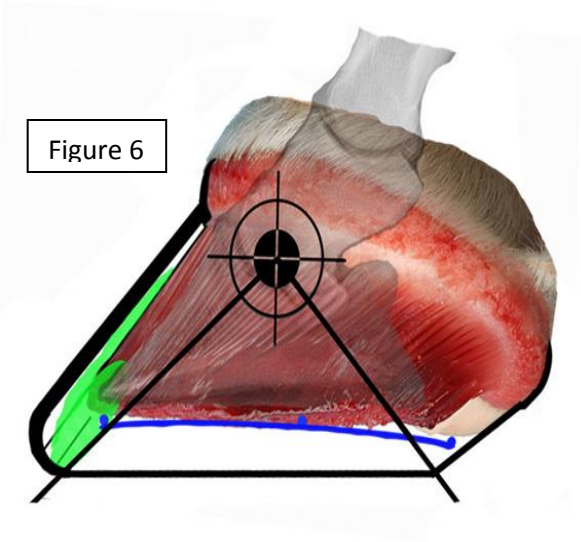


Figure 5: Schematic diagram of a lateral view of a hoof capsule to show the correct solar surface area which promotes proper distribution of the forces developed at breakover.

With the reduction of surface area needed to direct the forces vertically along this junction, stress and force is likely to be focused at the tip of the third phalanx, see figure 6.

Figure 6: Schematic diagram of a lateral view of a hoof capsule to show the reduced solar surface area due to excessive reduction in breakover and under run heels.



Although the 'atypical black hole seedy toe lesion' does share many attributes with the keratoma, further histological comparisons will need to be made. Although early signs of aberrant changes to epithelial cell proliferation could be indicative of pathological changes, they may simply be an indication of stress that is inducing imbalances within the hoof capsule, which may then cause problems in the future, particularly in the older horse.

Bowker (2003), Hickman and Humphry (1977), and La Pierre (2003) have studied, observed and commented on the fact that altered stresses in the region of the *crena marginalis* may be attributable to several factors, for example a decrease in the solar surface at the area of the dorsal wall to white line junction, unhealthy or underdeveloped palmar aspect of the foot which may cause a shift in weight to the bearing surface of the dorsal wall, and under run heels which would place increased force on the palmar processes of the third phalanx.

We hypothesize that the development of the lesions of the *crena marginalis* are the results of altered stress, and may be present in the horse that appears clinically normal, further studies will be required to explore this idea, furthermore, these 'atypical black hole seedy toe lesions' appear to be progressive in nature and further study will be necessary to explore their affect on lameness and reduced performance.

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