A DETAILED EXAMINATION OF 'WHITE LINE DISEASE'

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F.W.F.C. DISSERTATION

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1) The term "White Line Disease"

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Image 1 and 2: Subdural Erosive Lesion or Onychomycosis (Photo by M. Wildenstein)

The term "White Line Disease"

1) The term "white line disease" has been given to the progressive separation of the hoof wall of the horse. Dr. Ric Redden is said to have coined the term to describe a separation of hoof wall that is distinct from laminitis. Burney Chapman, who spent more time studying the condition than anyone else, refers to it as "onychomycosis" which is a fungal infection affecting the toenails or fingernails. Dr. Tracy A. Turner, DVM, MS, Dipl. ACVS has mentioned terms referring to the condition like yeast infection, candida, and hoof rot. Rob Sigafoos farrier at the University of Pennsylvania refers to the condition as "subdural erosive lesion". Past authors have used the terms, "hollow wall", and "seedy toe." The term "White Line Disease" is the term used prominently today.


Image 2 and 3: Lesion of the stratum medium (Photo by M. Wildenstein)

A Review of Foot Structure

2) The wall of the hoof grows from the epithelium covering the coronary dermis. It consists of horn tubules that are embedded in the intertubular horn, which is attached to the coffin bone and hoof cartilages. The three basic layers of the wall structure consist of the stratum externum, medium and internum. The stratum externum consists of horn tissue produced by the parabolic dermis, which lies directly proximal to the coronary dermis. The stratum externum is only a few millimeters thick and is somewhat rubbery near the coronary band and is dehydrated over the distal hoof wall. The bulk of the hoof wall is made up of the pigmented horn tubules of the stratum medium. The non-pigmented stratum internum consists of the approximately 600 laminae that interdigitate with the sensitive laminae of the laminar dermis. The dermis of the sole is firmly attached to the undersurface of the coffin bone and produced a mixture of horn tubules and intertubular horn. The junction between the sole and the wall is the white line (zona alba). The white line includes some of the non-pigmented stratum medium of the wall, the distal ends of the horny laminae and between these, and pigmented horn produced over the terminal papilliae of the laminal dermis.

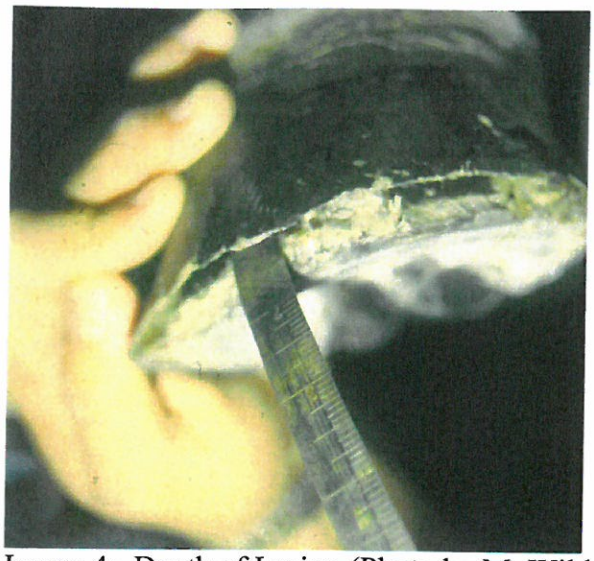

Image 4: Depth of Lesion (Photo by M. Wildenstein)

Historical Evidence of Hoof Wall Separation

3) Xenophon, the historian, in The Art of Horsemanship, writes of hooves and conditions of the hooves and gives advice on how to maintain the hooves to prevent breakage and separations

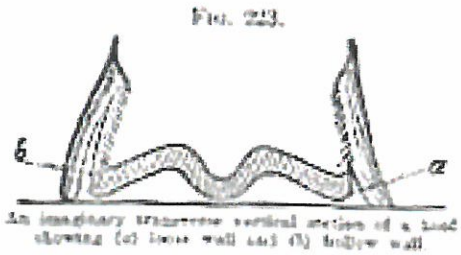

Figure 1: "An imaginary transverse vertical section of a hoof showing (a) loose wall and (b) hollow wall" (Lungwitz, A., A Textbook of Horseshoeing, 1897)

A. Lungwitz in 1884 described hollow wall as a separation between the middle layer of the wall and the keraphyllous layer. Lungwitz states that the occurrence is quite rare and that the cavity is usually filled with crumpling, disintegrated horn. In 1897, A.W. Dollar M.R.C.V.S described the condition as "loose wall" a rare condition. Doller states that the condition is due to the action of some fungus like organism, which obtains entrance to the inner sheath of the wall and induces change in the horn. In 1903, Prof. William Russell referred to the condition as "foot rot" or "seedy toe" which manifests itself by a wasting away or drying up of the sensitive laminae.

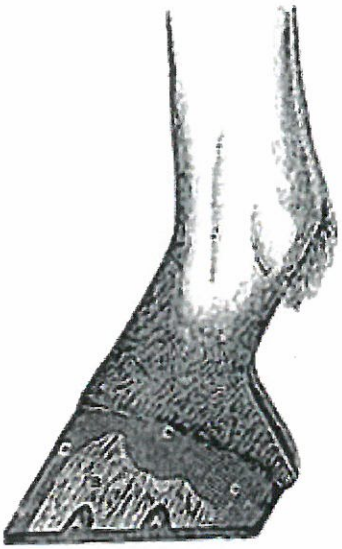

Fig. 75. HOOF, WITH SEEDY TOE—SHOD. A, A, Clips on shoe. B, diseased portion. C, C, C, Sound hoof.

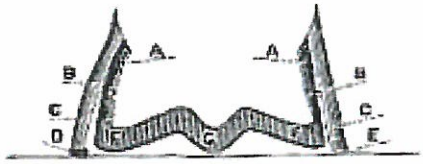

Fig. 76. SECTION OF HOOF AFFECTED WITH SEEDY TOE.

A, A, Insensitive laminæ. B, B, Outer wall. C, C, Wall separated from laminæ. D, Bulging or dishing effect of separation. E, Wall removed opposite separation. F, F, Insensitive sole. G, Frog.

Figure 2 and 3: "Hoof with seedy toe-shod. A, A, Clips on shoe. B, diseased portion. C, C, C, Sound Hoof." "Section of hoof affected with seedy toe. A, A, Insensitive laminae. B, B, Outer wall. C, C, Wall separated from laminae. D, Bulging of dishing effect of separation. E, Wall removed opposite separation. F, F, Insensitive sole. G, Frog." (Russell, William. Scientific Horseshoeing. 1882.)

In 1864, Antonio Pires described hoof wall separation and the treatment there of. The descriptions of the hoof wall separations are accurate and define the condition in the horse's hoof that we call white line disease, as shown in the following. (Figures 4 and 5)

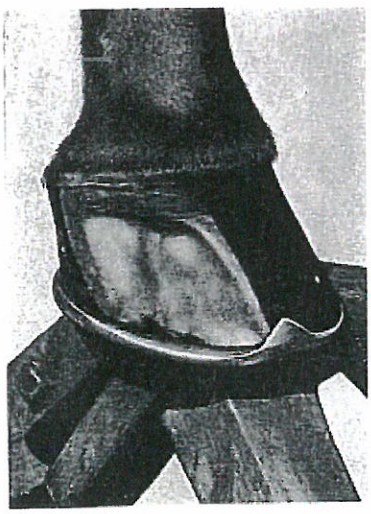

Fig. 47. — UN CASO DE TAPA HUECA OPERADO.

Fig. 48.— UN CASO DE TAPA HUECA OPERADO.

Figure 4 and 5 "Un Caso ar. Tapa Heuca Operado." "Un Caso ar. Tapa Hurca Aperado" (Pires, Antonio. Tratado De Las Enfermedades Del Pie Del Caballo. 1864)

Modern Review of Hoof Wall Separation

4) Hickman's Farriery 1997 describes "seedy toe" as a cavity between the horny and sensitive laminae, filled with a mealy type of horn.

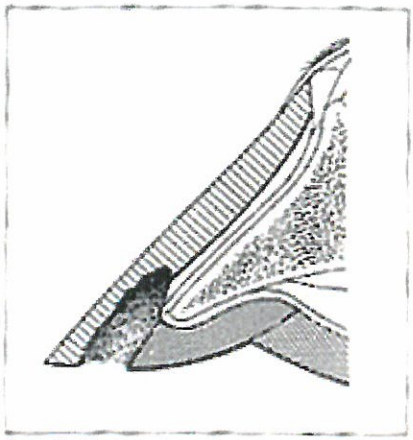

Fig. 11.43 A seedy toe is a cavity between the horny and sensitive laminae, filled with a mealy type of horn.

Figure 6 "A seedy toe is a cavity between the horny and sensitive laminae, filled with a mealy type of horn" (Hickman, J. Hickman's Farriery. 1997.)

Doug Butler PhD, CJF, FWCF in 1995 described a progressive pododermatitis that appears like a granulated cheese mixture.

Fig. 14-4 Yeast infection. Photo by B. Laraway

Figure 7 "Yeast infection. Photo by B. Laraway" (Butler,D. The Principles of Horseshoeing. 1995)

Dr. Susan Kempson (1996) used an electron micrograph to show in detail how fungi and bacteria can invade the hoof. Mr. Burny Chapman was urging horseshoers to send samples from diseased hooves to Mt. Sina. Medical Center to be analyzed. Susan Sharp PhD. cultured 156 separate fungi from 100 samples. Lay equine literature and farrier trade journals contain many anecdotal reports and uncontrolled mini-studies postulating a great number of causes and predisposing factors.

Appearance of a Fungal Infection of the Hoof

5) The condition is restricted to the inner most area of the stratum medium. This area has a moisture content of 75% in a normal hoof. The first indication would be a separation between sole and wall as viewed from the solar surface. Material removed from the separation with a thin probe will yield dirt, manure, digested horn and residue that resembles dry cheese. The separation may advance to the coronary corium. The extent of the separation can be seen by taking radiographs. Gently tapping on the hoof wall the affected area will sound hollow. In a chronic case a bulge will be present in the hoof wall at the most proximal point of the infection. Fungal infections of the hoof wall have a distinct odor.

Image 5 and 6: Proximal Supungual fungal infection. (Photos by M. Wildenstein)

Onychomycosis Review

6) Onychomycosis refers to a fungal infection affecting the toenails or fingernails. It may involve any component of the nail unit including the nail matrix. According

to John Ratz M.D., bed or plate onychomycosis is caused by a fungus. Sometimes trauma or damage to a nail predisposes to the development of the condition. Subtypes include: distal lateral subungal, white superficial, proximal subungal and candida. Patients may have a combination of the subtypes. The pathogenesis of the disease depends on the subtype. The distal lateral subungual is the most common form in humans and invades the nail bed from the plantar skin. White superficial infection is caused by a direct invasion of the surface of the nail plate and secondary infection of the nail bed. With proximal subungual subtype, the fungi invade the cuticle and proximal nail fold and then penetrate the dorsum of the nail plate. Candida infection may present three ways: onycholysis, may be caused primarily by yeast, Candida parochial is secondary to trauma of the nail fold, and Chronic muccutaneus candidiasis involves the nail plate and eventually the proximal and lateral nail folds.

Image 7: White superficial fungal infection. (Photo by M. Wildenstein)

An Attempt to End The Controversy

7) White line disease has been a debated issue for years. The disease has been a source of contention between farriers and veterinarians. A great number of bacteria and fungi have been incriminated in the path physiology, but sample collection technique is either unreported or can be criticized regarding contamination of the samples. There is one report in the veterinary literature: (Path morphological findings in a case of onychomycosis of a Racehorse, by Kuwano, et al, from the Japan Racing Association, Journal of Veterinary Medical Science 58 (110: 1117-1120, 1996) that demonstrates, with histopathology, disease of the white-line area caused by a fungus. The questions remain: Is the

disease primary or secondary infection caused by bacteria, fungi, or both and, if it is secondary, what are the predisposing factors? The hypothesis is that the term onychomycosis is appropriate with the disease being a fungal infection of the hoof wall secondary to mechanical stresses related to injury, poor management or other disease processes.

Image 8 and 9: Common sample collection method. (Photo by M. Wildenstein)

Case Selection

8) All horses presented to the farrier service are evaluated for the clinical signs of "white line disease." The hooves identified as having a visible separation of hoof wall with a dry/chalky texture or those with bulges and abnormal percussion were selected for the study. A total of five hooves have been evaluated with the average age of five years old. The hooves were of four geldings and one mare. Clinical signs at presentation consisted of the aforementioned horn quality in the white-line area and variable horn separation.

Case Controls

9) Four horses selected and determined to have completely normal hooves.

Sample Collection

10) The leading edge of the lesion was found by using hoof wall percussion and radiographs. In all suspected cases there was a distinct hollow sound to percussion that disappeared half the distance or greater from the sole to the coronary band. A marker was placed at the point that the percussion changed and radiographs were used to verify the edge of the lesion. Samples were taken at that point. An attempt was made to sterilize the hoof wall prior to sample collection. The hoof wall was

painted with concentrated formaldehyde three times with five minutes between applications. At that time, a 1cm diameter portion of the stratum externum was removed with a sterilized dremel bit and the formaldehyde application was repeated with a final swabbing of concentrated iodine placed on the created wall defect. The hoof wall and pastern were then covered with an iodine impregnated surgical sticky drape and a small window was cut out over the created wall defect; sterile surgical gloves were worn. Sterile bone cruets were used to remove the stratum medium, which was discarded. Approximately seventy percent of the stratum medium was removed, revealing the edge of the lesion. The stratum medium removed for culture was dry and chalky and not of normal texture or integrity. The material was transferred into a sterile container for culture.

Image 10 and 11: Sterilizing hoof and application of iodine impregnated surgical sticky drape. (Photos by M. Wildenstein)

Microbiology

11) All samples were aseptically submitted to the New York State Diagnostic Laboratory for aerobic/anaerobic bacterial and fungal culture.

Preliminary Results

12) The four control hooves did not grow any bacteria or fungi

Foot Number	Bacterial Culture	Fungal Culture
1	No growth	Trichoderma sp
2	No growth	Mucor sp
3	No growth	Aspergillus glaucus
4	No growth	Gliocladium sp
5	No growth	Gliocladium sp

Preliminary Conclusion

13) The fact that all of the controls were negative for both bacterial and fungal growth validates the sample acquisition as a methodology for collection of sterile samples of the stratum medium for culture. The absence of bacteria and positive growth of fungi supports the role of a fungal infection and, therefore, supports the term "onychomycosis" in describing this disease. All four species of fungi cultured are known to be "keratinophilic." This does not mean that they have the ability to cause primary keritin disease, but have the ability to grow well on keratin. Characteristics of the fungi *Trichoderma*; readily degrades cellulose and will grow on other fungi. *Mucor*: is found in horse dung, leather products, animal hair and jute. *Aspergillus glaucus*: is a common outdoors fungus in the winter growing on leather, grain, and wool. *Gliocladium* is structurally similar to Penicillin. We hypothesize that mechanical stress created by excessive toe length, laminitis, poor management, and injury predispose to the collection of environmental contaminates within the stratum medium. All of the identified fungi are environmental organisms and can be cultured from soil and wood. The inner environment of the stratum medium (chemical composition, oxygen tension, and the limited availability of microbial substrates) selects for species of fungi that can survive and grow well on keratin.

Image 12 and 13: Partial and complete removal of hoof wall. (Photo by M. Wildenstein)

Treatment

14) Removal of the affected tissue, sterilization of the underlying tissue and antifungal treatments.

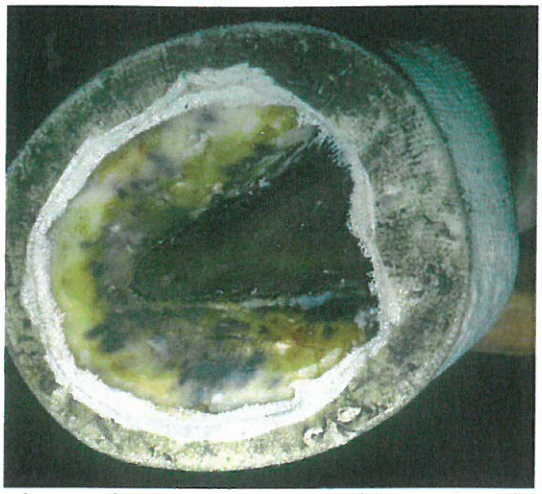

Image 14 and 15: Application of a hoof cast when a shoe can not be used to protect the hoof. (Photos by M. Wildenstein)

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