White Line Disease - An Update

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White line disease (WLD) is a term used to describe a keratolytic process on the solar surface of the hoof, which is characterized by a separation of the inner zone of the hoof wall (Redden, 1991). The separation occurs in the non-pigmented horn at the junction between the stratum medium and the stratum lamellatum. This separation is invaded by opportunistic bacteria/fungi at the toe, quarter and/or heel leading to infection, which progresses to varying heights and configurations toward the coronet. The disease process occurs secondary to a primary hoof problem such as chronic laminitis, abnormal hoof conformation, hoof imbalance or any other condition that causes a hoof wall separation. The disease has been termed seedy toe, yeast infection, Candida and onychomycosis.

Onychomycosis is a mycotic disease that originates in the nail bed of the human and the dog. In WLD the infection originates at the solar surface of the hoof and migrates proximally approaching the coronary band but never invading it. In many cases of WLD, the pathogens cultured are purely bacterial. Until proven otherwise, onychomycosis may not be the appropriate term when referring to white line disease in the horse.

Anatomy of the hoof wall

The hoof wall consists of three layers; the stratum tectorium (external layer), the stratum medium (the middle layer), and the stratum lamellatum (the inner layer). The stratum tectorium is the thin layer of keratinized cells that give the wall its smooth shiny appearance. The stratum medium forms the bulk of the wall and is the densest part of the hoof wall. It consists of cornified epidermal cells arranged in parallel horny tubules surrounded by intertubular horn which grow distally from the coronary groove to the basal border. In dark hooves it is pigmented except in the deepest layer. The stratum lamellatum arises from the laminae, is nonpigmented, and is responsible for attaching the hoof wall to the third phalanx. Distally at the sole wall junction, the dermal laminae end in terminal papillae. These papillae are lined by stratum germinativum which produces intertubular horn that fills the spaces between the non pigmented horny laminae. This association forms the bond between the hoof wall and the sole known as the white line or zone (Figure 1A, 1B). When observed from the solar surface, this white line or white zone is actually yellow in color and is a different consistency than the dorsal hoof wall.
Aetiology

Multiple causes of white line disease have been proposed, but none have been proven. WLD can affect a horse of any age, sex or breed. One or multiple hoofs may be involved. One or multiple horses on the same farm may be affected. The problem occurs throughout the world.

Moisture may play a role as WLD is seen more in wet humid areas but it is also seen in hot arid conditions. Excessive moisture softens the foot, allowing easier entry of dirt and debris into a separation leading to a secondary infection. Continual bathing of show horses especially during the warmer months may contribute to the incidence of WLD in this population of horses. Excessive dry hoofs may form cracks in the wall or fissures in the white line allowing pathogens to invade. Poor hygiene is questionable since WLD often appears in well-managed stables.

Infectious organisms, bacteria, fungi or a combination of the two have been continually incriminated as a cause. What is not known is whether these organisms are primary invaders or secondary opportunists. Given the nature of these pathogens usually isolated (mixed flora of bacteria, Pseudoallsheria and Scopulariopsis fungi) they are most likely secondary opportunists, which further damage an existing hoof wall separation. The fact that WLD can be resolved with debridement alone further detracts from this as a primary cause.
"Seedy toe" refers to a small circular separated area at the sole/wall junction (Figure 2A). It is located on the solar surface of the foot in the middle of the toe. This damaged area lies directly dorsal to the notch on the third phalanx.

Excessive toe length or a clubfoot may compromise the blood supply associated with this normal anatomical notch in the third phalanx called the crena marginalis (Figure 2B). If the circulation is continually affected, the commonly found "seedy toe" lesion may progress to WLD.

Mechanical factors that lead to a separation appear to be a logical cause. These would include excessive toe length, poor hoof conformation and various hoof imbalances such as long toe-underrun heel or a clubfoot (Figure 3A). Damage to the stratum medium/laminar junction will cause increased stress on the remaining junction. Weight bearing and the force of the deep digital flexor tendon will cause cycling to occur, further weakening the bond. The more the sole/wall junction becomes damaged; it removes all remaining exterior protection allowing the separation to become more extensive.

Vascular damage to the hoof associated with chronic laminitis results in a compromised laminar bond and a loss of integrity (separation) at the sole/wall junction. Trauma from a localized blow to the hoof causing vascular damage will also lead to a focal hoof wall separation. WLD can be a sequel to extensive sub solar or sub mural abscesses.

**Clinical signs**

White Line Disease offers no threat to the soundness of an animal until damage is sufficient to allow mechanical loss of the attachment between the laminae and the inner hoof wall resulting in displacement of
the coffin bone in a distal direction (rotation). Only then does the horse begin to show discomfort. Most commonly, WLD is noted as an unexpected hoof wall separation found by the farrier during routine hoof care. In the early stages of White Line Disease, the only noticeable change on the solar surface of the foot is a small powdery area located anywhere along the hoof wall/sole junction. This area may remain localized or it may progress to involve a larger area of the hoof wall. Other early warning signs of White Line Disease may be tender soles as seen with hoof testers, occasional heat in the feet, and the sole will become increasingly flat. A concavity ("dish") can be seen forming along one side of the hoof and a bulge will present be on the opposite side directly above the affected area at the coronary band. There may be slow hoof wall growth, poor consistency of hoof wall and a hollow sound will be noted when the outer hoof wall is tapped with a hammer (Figure 3B)\(^3\). Often the disease goes undetected until the horse begins to show discomfort.

Diagnosis

Lameness may or may not be observed. Hoof tester examination does not always elicit a response. The clinical signs along with examination of the solar surface of the hoof will confirm the diagnosis. On the solar surface of the hoof, the sole/wall junction (white line) will be wider, softer and have a chalky texture. Exploring the inner hoof wall which lies dorsal to the white line will generally reveal a separation filled with a white/grey powdery horn material. Further exploration with a probe will give the depth and extent of the cavitation. There may be a black serous drainage from the separation.

If lameness is present a thorough lameness examination should be performed including nerve blocks to confirm the suspected area followed by radiographs. With extensive hoof wall damage, WLD accompanied by pain can mimic laminitis both clinically and radiographically.

Radiographs

Radiology can be very informative and should be considered necessary. Good quality radiographs will show
the extent of the hoof wall separation and if rotation of the third phalanx within the hoof capsule has occurred. They allow the clinician to differentiate between white line disease and laminitis (Figure 4). Radiographically, the separation in the lamina will originate at the ground surface in white line disease whereas the separation will originate at the junction of the inner hoof wall and the terminal laminar papillae in laminitis. Pedal osteitis may be noted in the chronic case of white line disease. Finally, radiographs can be used as a guide when trimming and shoeing the horse.

Laboratory

Cultures are extremely difficult since the samples taken from the separations are contaminated with dirt and opportunistic organisms. Aerobic cultures usually reveal a mixed bacteria flora while anaerobic cultures are negative. Fungal cultures require a special media and time. The most common fungal species cultured are Pseudoallsheria, Scopulariopsis and Aspergillus. A biopsy taken at the juncture between the normal and affected hoof wall shows a mixed population of microorganisms. These will generally include coccobacilli, yeast organisms and fungal spores. Inflammation in the laminar dermis will be seen deep to the affected area. Laboratory findings have been unrewarding with regards to treating this disease.

Treatment

Correct the primary cause of the hoof wall separation (i.e. excessive toe length, hoof imbalance, etc) if possible. Therapy of White Line Disease is directed at treating the affected area of the foot and supporting the foot with therapeutic shoeing if hoof wall damage is extensive. Complete hoof wall resection (removal of outer hoof wall to expose diseased area) and debridement of all tracts and fissures in the affected area is necessary. The veterinarian or farrier should not reach blood during debridement. Thorough exploration and debridement of any remaining tracts should take place at 10-day intervals. When all tracts are removed, a thorough examination is indicated at re-shoeing intervals every 4 to 5 weeks. A wire brush is used daily to keep the resected area clean.

Medical treatment follows hoof wall resection. Medical treatment is of no value without resection of the affected hoof wall. Disinfectants/astringents such as methiolate act as a good disinfectant as well as a dye marker of the remaining tracts. The dye marker will serve as an aid in making the remaining tracts more visible at subsequent examinations. A solution composed of equal parts gentian violet, acetone and alcohol is also a suitable disinfectant and dye marker (Blue Stuff R). Either preparation should be applied twice weekly as not to make the hoof too hard. After thorough hoof wall resection, the affected area can be left to grow out with debridement at frequent intervals. Medical treatment may not be necessary in many cases as debridement alone is sufficient. The records from twenty cases of extensive white line disease treated in this practice over a four-year period were reviewed (O'Grady, SE. unpublished data). Fifteen of these cases were treated with resection and continuous debridement only. The remaining cases were treated with resection, debridement and a dye marker. In all cases the resected portion of the foot grew out and the hoof returned to normal.

Acrylic repair (medicated Equilox R) should only be considered after all tracts are resolved. It should only be used in selected cases where the client is unable to treat the resected area and where cosmetics are important. The composite may hide and/or foster infection and it tends to weaken surrounding normal hoof wall, which can encourage re-infection. The antibiotic in the composite is only effective against selected bacteria not fungi.

The type of shoe used depends on the extent of the damaged hoof wall. If the defect is small, the hoof can be shod accordingly. As the toe is involved in most cases of WLD, the breakover is moved in a palmar/plantar direction as much as possible. Fit the shoe so breakover is under the toe toward the apex of the frog to remove
the "lever arm" at the toe. This will eliminate stress and pressure from the dorsal hoof wall. It will also stop
the "pinching" that often occurs at the junction of normal hoof wall and the resection. If the resection is
extensive and/or if rotation of the third phalanx is present, a support shoe (heart bar or egg bar-heart bar
combination) can be used. This type of shoe provides support to the heel area of the foot and allows weight
bearing to be transferred from the affected part of the hoof wall (toe/quarters) to the frog.

An alternative method would be to use a bar shoe or open shoe combined with some type of impression
material. The impression material could be applied to the entire solar surface of the foot as long as it was
molded thicker at the heels to provide the necessary support. It can be applied with or with out a pad. If no
rotation is present, a good "rule of thumb" is if over half the dorsal hoof wall (distance from ground to
coronet) is resected, use palmar/plantar support.

Glue on shoes utilizing the ground surface of the foot may be the method of choice for shoeing the horse with
WLD (figure 5A, 5B). Hoof wall separations have historically been treated by resection and acrylic repair
so that nails can be placed in the affected area to attach the shoe. However, the disease process often will
continue under the repair, prolonging the time required for the hoof wall to grow out. By gluing the shoes to
the ground surface of the foot, the resected area can be left open to be observed, debrided and medicated
regularly. Good palmar/plantar support can also be provided with this procedure.

A change in environment is important. The feet should be kept as dry as possible. Keeping the bedding clean
and dry is helpful. No turnout in rain or wet weather. Turnout can be delayed in the morning until the sun can
dry the pasture. A well balanced diet with the addition of biotin and methionine can be helpful (Hoof Rite
R)b. The shoeing schedule should be maintained at four week intervals.

Commitment from the owner with regards to a continuous treatment schedule is necessary until all signs of
disease have been eliminated and then the foot/feet must be monitored monthly until the hoof wall grows out.
The extent of the damage will determine the amount of time required for the treatment process. For example,
if the affected area extended up near the coronary band in the toe area, it would take approximately 10
months for the defect to fully grow out. However, it is not always necessary for the horse to be out of work
for this entire period of time. The amount of exercise permissible while treating WLD is dependent on the
severity of the damage.

Prevention

Prevention of WLD is difficult because the exact cause is unknown. Discussing the problem with the farrier
and having him/her examine each foot when the horse is shod is extremely important. Any small abnormal
area involving the sole/wall junction should be explored and treated. Proper trimming and shoeing along with
maintaining a short toe are essential for creating a strong sole/wall junction that offers protection. Equally important is the necessity to carefully monitor hoses that have previously had white line disease. A year or two after WLD has been treated and resolved, it will suddenly reappear in some horses with strong hoof walls that show no sign of separation. WLD will often recycle time and again over the horse's life (Jim Randell, 2000 personal communication).

Discussion
Treating WLD has created a dilemma for owners, veterinarians and farriers. Owners have been deluged with many different causes and treatments. Many commercially available preparations have been marketed for treating WLD, all claiming success. Claims as to the efficacy of these products are anadotal as there is no scientific evidence reported. Veterinarians may be unaware of the magnitude of this problem as they only see the severe cases that present with lameness and radiographic changes. WLD may be a subtle contributor to other causes of lameness within the foot. Farriers are very aware of this disease as they are worried about nailing in compromised hoof wall or lack there of and keeping the shoe on between resets. They continually search for medical treatments since owners are reluctant to have parts of their horse's hoof wall removed at the farrier's recommendation.

An epidemiological study of the causes and relationships of this disease would be valuable. Research, owner education and continued farrier awareness appears to be the direction of the future.

References

1. Freeman LE, Dept of Anatomy, College of Veterinary Medicine, Virginia polytechnic Institute, Blacksburg, VA Personal Communication, 1993.

a.) Equilox® - Equilox Int'l, 110 NE 2nd Street, Pine Island, MN 55963
b.) Hoof Rite R---Professional Equine Products, P.O. Box 25, Black Canyon City, AZ 95324

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