AABP FACT SHEET

SOLE ULCERS

AABP Lameness Committee

Figure 1: A sole ulcer in the typical location under the flexor tuberosity of the pedal bone (P3). The sole horn has been pared away to expose the lesion and provide drainage. A wooden block is placed on the paired claw to alleviate weight-bearing on the affected claw.
Photo courtesy of Dr. Gerard Cramer.

Sole ulcers (*pododermatitis circumscripta*) are one of the most debilitating, costly, and common causes of lameness affecting dairy cows. While sole ulcers can occur in beef cattle, and while ulcer-like lesions can be found at the heel and toe, the focus of this fact sheet is on ulcers occurring at the "typical location" (Figure 1) beneath the flexor tuberosity of P3 in dairy cows (P3 = third phalanx = pedal bone).

PATHOGENESIS

Sole ulcers result from an insult to the solar corium (the tissue that produces sole horn) that disrupts normal horn production. The pathogenesis of a sole ulcer begins inside the claw. The highly vascular corium is located between the pedal bone (hard) and sole horn (moderately hard) and is therefore always at risk of harm by compression. Protection of the corium from compression is normally provided by digital fat pads (also known as the digital cushion) located between the pedal bone and the corium (Figure 2).

Factors that play a role in the pathogenesis of sole ulcers include:

- Insult to the corium secondary to decreased protection from the digital cushion. This has been demonstrated to occur in cows with low body condition, which is associated with decreased thickness of the fat-containing digital cushion. This may also occur transiently in dehydrated cows. The degree of protection afforded by the digital cushion may decrease with age.

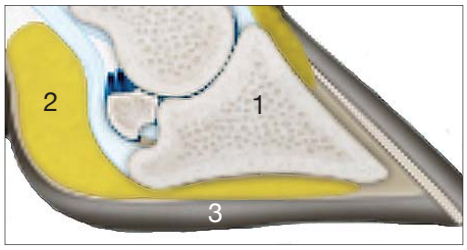

Figure 2: Anatomy of the bovine claw. 1: P3 (pedal bone). Note the flexor tuberosity on the caudal aspect of P3 that protrudes downward toward the sole, 2: Fat pad (yellow) which extends under P3, 3: Sole horn. The corium is located between the fat pad and the sole horn.
Diagram courtesy of Zinpro.

- Insult to the corium secondary to instability of P3. Hormones circulating in the periparturient period may increase the elasticity of the ligaments that support P3, allowing P3 to sink within the

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claw capsule, resulting in compression of the corium between P3 and the sole horn.

- Insult to the corium secondary to increased compression from prolonged standing on hard surfaces. In the hind limb of cattle, the lateral claw normally bears more weight than the medial claw. When faced with the challenge of an unnaturally hard surface such as concrete, the natural response is to accelerate the production of sole horn—particularly in the lateral claw. This results in a vicious cycle of further "overburdening" of the lateral claw and further growth. This overgrowth-overburdening cycle leads to increased compression of the corium in the lateral hind claw, the most commonly affected digit.
- Direct insult to the corium by inflammatory agents and/or inflammatory mediators, or indirect insult to the corium via effects of these agents upon the vasculature of the foot or upon the support structures of the pedal bone.
- Insult to the corium resulting from changes in the shape of P3 secondary to age, previous claw horn disease, or both. Bony changes to P3 may occur as a result of sole ulcers that make the cow more susceptible to subsequent occurrences of sole ulcer in the same claw.

PREVENTION

There is much still to be learned about the pathogenesis of sole ulcers. It therefore follows that there is still much to be learned about the prevention of sole ulcers. However, preventive measures that arise from what is known about the pathogenesis of sole ulcers can and should be implemented on dairy farms. The four "Ps" of sole ulcer prevention are:

- PRESERVE THE DIGITAL CUSHION
  Cows should have adequate body condition at the time of calving and be fed to maintain body condition above 2.5/5 throughout the lactation cycle.
- PROVIDE A LYING SURFACE FOR COWS THAT MINIMIZES TIME SPENT STANDING
  Many resources are available on the topic of cow comfort. The goal of "cow comfort" is to provide a space in which the cow chooses to lie down at least 12 hours per day—more is better. Recommendations include providing a deeply bedded, comfortable resting surface, maintaining an appropriate stocking density, ensuring that cows are away from their pen for milking less than three hours per day, and minimizing the time that cows must stand for management procedures.
- PREVENTIVE HOOF TRIMMING
  Functional trimming correctly done by a proficient hoof trimmer on a regular time schedule decreases the likelihood that a cow will become lame.
- PREVENT CONDITIONS ASSOCIATED WITH SOLE ULCERS—PARTICULARLY IN THE TRANSITION PERIOD
  - While the exact mechanisms of how events in the transition period lead to lameness are unclear, it is clear that events in the transition period are associated with lameness. Actions taken to ease the transition period generally and prevent disease in the transition period specifically will minimize subsequent lameness.
  - Redouble efforts to prevent metabolic disease as well as mastitis, metritis and other transition cow disorders.
  - First-lactation cows should be transitioned into the herd gradually, preferably separately from multiparous cows, so that they can become accustomed to the environmental and nutritional changes associated with calving without having to compete with larger mature cows.
  - Redouble efforts to improve heat abatement and prevent heat stress.
  - Redouble efforts to prevent subacute rumen acidosis.

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TREATMENT
Rapid detection and treatment of lameness is important regardless of the cause. In cases of lameness due to sole ulcers, rapid detection and treatment is critical to achieving a successful outcome. Treatment of sole ulcers involves removal of all loose horn tissue to achieve full exposure of the ulcerated area and thinning of the margins of the ulcer. If granulation tissue penetrates through the ulcer it may be debrided under local or regional anesthesia to alleviate pain and shorten the healing time. However, all of the preceding is likely to fail unless the cow's weight is removed from the affected site by application of a block to the healthy claw of the affected limb. (Figure 3). The corium must be given the opportunity to heal and begin to produce new sole horn. Therefore, a hoof block should be applied to the paired claw of the affected claw of all cows with sole ulcers.

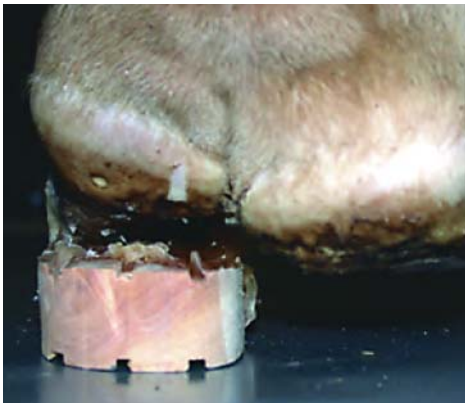

Figure 3: A correctly placed hoof block allows the cow to stand squarely on the healthy claw and allows the corium to heal in the diseased claw.

Sole ulceration results in chronic and intense pain. In addition to applying a hoof block to the paired claw to alleviate weight-bearing, administration of a non-steroidal anti-inflammatory drug during the first few days following treatment will provide pain relief. Bandaging or applying any type of substance to the affected area is not recommended.

AFTER CARE
Following treatment, segregation to a deeply bedded pen and reducing the distance that the cow must walk is recommended for cows with a sole ulcer. The cow should be re-examined in 30 days. If the lesion has not fully healed, the cow should be re-trimmed and blocked again for a further 3-5 weeks. Leaving blocks on for extended periods without examining the claw may lead to ulceration in the blocked claw.

Authored by Dr. Lowell T. Midla; reviewed by the AABP Lameness Committee, August 2020.

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