

# Case Report—Clinical Response to Treatment of Pododermatitis Circumscripta (Ulceration of the Sole) in Dairy Cows

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## Abstract

Seventeen dairy cows with sole ulcers were treated and the healing process observed. Nine cows had mature, uncomplicated ulcers where the exposed corium appeared only slightly damaged in six cases, and more seriously damaged in three cases. The remaining eight animals had complicated ulcers, all of which had a discharging tract at the ulcer site with swelling of the heel, coronary band and flexor aspect of the digit extending to and above the metatarsus. Ulcers were regarded as typical lesions (Rusterholz ulcers) in sixteen cows, and one cow had a heel ulcer. Sixteen of the 17 cows had ulcers that occurred on the lateral claw of the rear foot. Three cases had mature sole ulcers on one of the lateral hind claws, and early ulcers as evidenced by sole hemorrhage on the lateral claw of the opposite foot.

Eight of nine uncomplicated ulcers showed progressive reduction in size following treatment. Using finger pressure, no pain response was present at the ulcer site after one week in 8/9 (89%) of cases. Ulcers with granulating corium healed more slowly (range 41-60 days; mean 48) compared with those where the corium appeared normal (range 12-28 days; mean 20). Sole ulcers reoccurred in 2/9 cases (22%) within one month after the cow began bearing weight on the affected claw. In one of these cows, ulcers developed on three of the four hind claws. Histopathological examination of the left rear medial and lateral claws from this cow showed marked changes in the ventral surface of the third phalanx and the dermal papillae, as well as abnormal keratogenesis.

Partial tenovagotomy with resection of the deep flexor tendon was performed in six of the complicated

sole ulcer cases. In the other two cases, tenovagotomy was followed by claw amputation due to the intraoperative diagnosis of concurrent septic arthritis of the distal interphalangeal joint. In cases of partial tenovagotomy, healing occurred over a period of 49-81 days (mean 68 days). Complications included excessive granulation tissue, abscess formation of the proximal outer compartment of the digital flexor tendon sheath, and overextension of the toe.

For optimal healing to occur, weekly evaluation for the first four weeks following treatment may be beneficial with the following objectives: ascertain presence and position of the claw block; determine if progressive healing is occurring; determine if complications may be developing, such as a discharging tract at the ulcer site or swelling of the heel, coronary band or flexor surface of the digit; and finally, to recheck for the presence of loose horn overgrowing the ulcer site which might result in further injury to the exposed corium and delay healing.

## Résumé

Dix-sept vaches laitières avec des ulcères de sole ont été traitées et le processus de guérison a été observé. Neuf vaches avaient des ulcères matures sans complication incluant six cas où le derme exposé de la sole était endommagé légèrement et trois cas plus sérieusement. Les huit autres vaches avaient des ulcères avec complication incluant une voie d'écoulement au site de l'ulcère avec inflammation du talon, de la bande coronaire et de l'aspect caudal du pied s'étendant jusqu'au ou au delà du métatarse. Les ulcères étaient considérés comme des lésions typiques (ulcères de

Rusterholz) chez 16 vaches alors qu'une vache avait un ulcère du talon. Seize des 17 vaches avaient un ulcère sur l'onglon latéral de la patte arrière. Il y avait trois cas avec des ulcères matures de la sole sur l'un des onglons latéraux arrière de même que des ulcères en développement tel qu'indiqué par l'hémorragie de la sole sur l'onglon latéral de la patte opposée.

Il y a eu une réduction progressive de la taille des ulcères sans complication dans huit des neuf cas suivant le traitement. La pression exercée par un doigt sur le site de l'ulcère une semaine après le traitement ne causa pas de douleur dans huit des neuf cas (89%). Les ulcères avec granulation du derme ont guéri plus lentement (de 41 à 60 jours avec une moyenne de 48) que ceux avec du derme d'apparence normale (de 12 à 28 jours et une moyenne de 20). Les ulcères de sole sont réapparus dans deux des neuf cas (22%) moins d'un mois après l'application du poids corporel sur l'onglon affecté. Dans l'un des cas, des ulcères se sont développés sur trois des quatre onglons des pattes arrière. L'examen histopathologique des onglons médiaux et latéraux gauche arrière de cette vache dévoila des changements profonds dans la surface ventrale de la troisième phalange et de la papille dermique de même qu'une kératogénèse anormale.

Une ténovagintomie partielle avec résection du tendon fléchisseur profond a été faite dans six cas d'ulcère avec complication. Dans les deux autres cas, la ténovagintomie a été suivie de l'amputation de l'onglon en raison du diagnostic opératoire d'arthrite septique au niveau de l'articulation interphalangienne distale. Dans les cas de ténovagintomie partielle, la guérison s'effectua sur une période de 49 à 81 jours (moyenne de 68 jours). Les complications incluaient une granulation tissulaire excessive, la formation d'abcès au niveau de la partie proximale externe de la gaine du tendon fléchisseur superficiel et une extension excessive de l'orteil.

Une évaluation hebdomadaire pendant les quatre premières semaines suivant le traitement est primordial pour le succès de la guérison. Les objectifs du suivi sont de déterminer la présence et la position du bloc sur l'onglon, la progression de la guérison, la présence de complications tels que le développement d'une voie d'écoulement au site de l'ulcère, l'inflammation du talon, de la bande coronaire ou de l'aspect caudal du pied, et enfin de vérifier à nouveau la présence d'excroissance de corne envahissant le site de l'ulcère ce qui pourrait provoquer une nouvelle blessure au derme exposé de la sole et retarder la guérison.

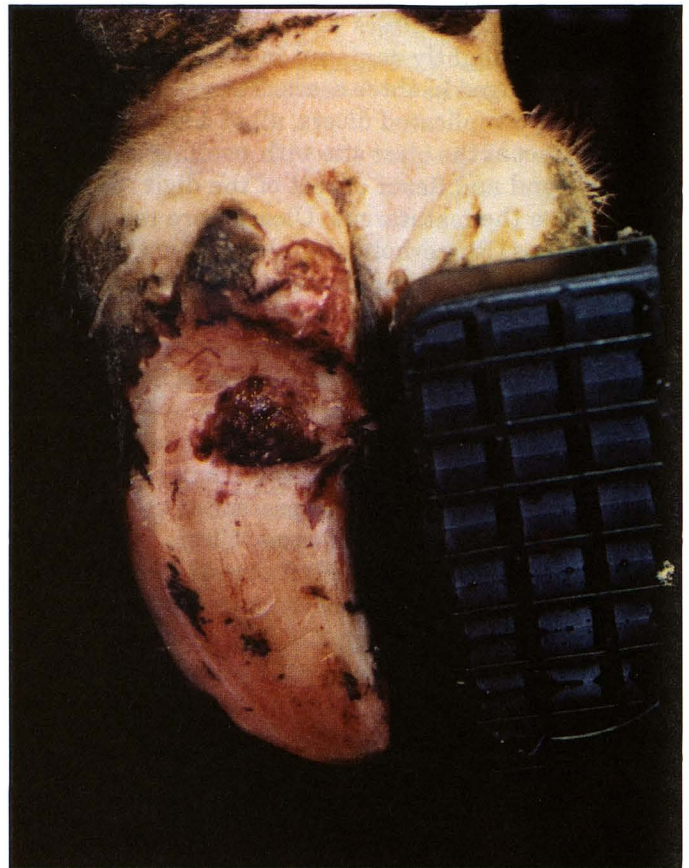
### Introduction

Sole ulcers are among the most frequent causes of lameness in dairy cattle. They are most commonly found

in the hind lateral claw, frequently are bilateral and have a high rate of recurrence.<sup>5,6,10,11</sup> An incidence of 13.6% during one lactation was reported in a survey of 7526 cases of lameness.<sup>16</sup> Another study found that a sole ulcer occurred in one foot or more than one foot in 20.0 and 29.7% of cows in lactation one, and in 23.5 and 24.7% of cows in lactations 2-9.<sup>5</sup> The same authors found that sole ulcers occurred most frequently three-to-four months after calving, but earlier in lactation one, especially if associated with postpartum disease.

### Case Study

Seventeen adult dairy cows with sole ulcers from two different commercial dairies (Farms A and B), milking approximately 250 cows each, were identified during routine visits. Nine cows with mature uncomplicated ulcers, defined as full-thickness sole horn defects with visible or protruding corium, were identified on Farm A over an eight-month period. Of these, the exposed corium appeared only slightly damaged in six cases, but the remaining three cows had severely damaged corium with granulation tissue formation (Figure 1).



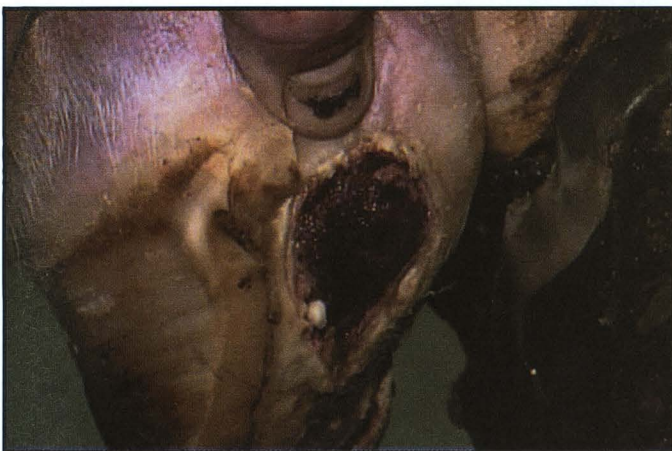
**Figure 1.** Exposed corium with excessive granulation tissue.

Eight cows with complicated ulcers were selected (three from Farm A and five from Farm B) over a period of approximately two years. Clinical signs of septic tenovaginitis associated with complicated sole ulcers found in these cows included a history of persistent lameness and non-healing of the ulcer, despite corrective trimming and application of a claw block, and severe swelling and erythema of the heel bulb and flexor surface of the digit proximal to the dewclaws and along the coronary band. A sinus tract was present, which could be traced with a probe into the back of the heel. The tract in the ulcer exuded purulent material when strong finger pressure was applied to the back of the heel (Figure 2). A hypoechoic area surrounding the deep flexor tendon (DFT) was visible with ultrasound imaging of the heel and flexor surface of the digit and pus was obtained with ultrasound guided needle aspiration. All cows were treated and the healing process observed for up to four months.

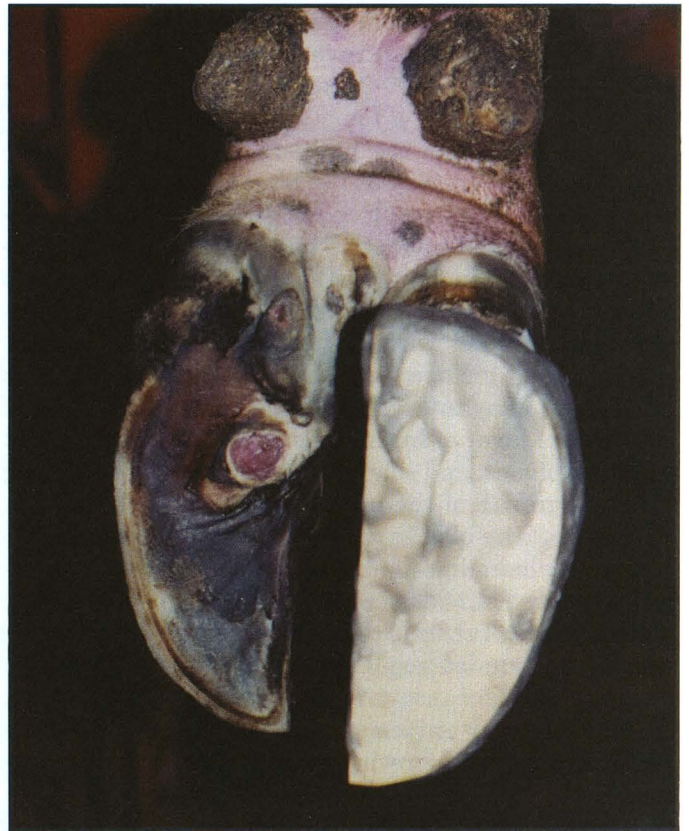
Based on their location, ulcers were regarded as typical lesions (Rusterholz ulcers; Figure 3) in sixteen of the cows, and a heel ulcer in one case (Figure 4). All ulcers, except for one, occurred on the lateral claw of the hind leg. Three cases had mature sole ulcers on one of the lateral hind claws, and developing ulcers (sole hemorrhage) on the opposite lateral claw.

### Treatment

To treat uncomplicated ulcers, cows were restrained in a stand-up foot chute, and both the medial and lateral claws of the affected leg were trimmed using an adaptation of the Dutch method of foot trimming.<sup>17</sup> A claw block was applied to the healthy claw to reduce weight bearing on the affected claw. Depending on the size and shape of the claw, either a commercially available orthopedic shoe<sup>a</sup> or a wooden block was used



**Figure 2.** Finger pressure on heel bulb demonstrates presence of sinus tract.



**Figure 3.** Typical sole ulcer lesion or "Rusterholz" ulcer.



**Figure 4.** Heel ulcer.

as a claw block. Care was taken to ensure that the shoe or claw block provided good heel support and a flat weight bearing surface. Loose and defective horn tissue around the ulcer was removed and sloped until only a thin layer of normal horn was left surrounding the exposed corium. The slope was made at about a 45° angle and, depending on the size of the ulcer, extended to the abaxial wall (Figure 1).

In three cases where the corium resembled granulation tissue, regional intravenous anesthesia was performed by injecting 20-35 ml of 2% lidocaine into a distended vein below a tourniquet applied to the mid-metatarsal region of the limb. The granulation tissue was surgically removed at the level of the thinned horn tissue surrounding the ulcer. In these three cases, a bandage was applied to control hemorrhage, and was removed after seven days. The size of the horn defect was determined with two measurements at 90° angles, using a plastic ruler with a measurement accuracy of 1 mm (Figure 5). Repeat measurements were taken at seven-to-ten day intervals until the defect was covered with a thin layer of horn. Other observations included presence of pain and sole horn hemorrhage at the ulcer site, overgrowth of the ulcer site with loose horn from the edges of the ulcer, and placement of the claw block. If present, loose horn surrounding the ulcer was carefully removed at each visit.

Treatment of six of the eight cows with complicated sole ulcers included tenovagotomy and resection of the deep flexor tendon, as previously reported.<sup>18</sup> In one case, the digital flexor tendon sheath (DFTS) was opened to its proximal limit following regional intravenous anes-

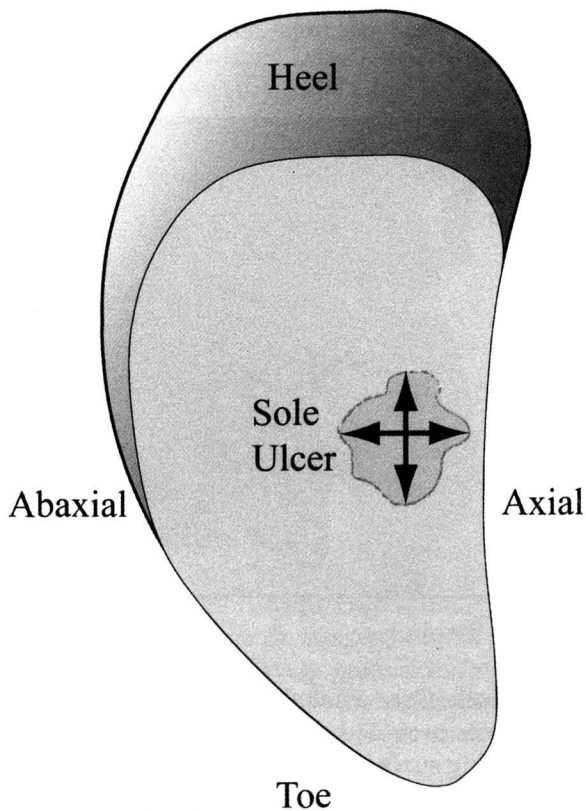
thesia (as described earlier), and the deep DFT was transected just below its bifurcation. In the other five cases, only the common compartment of the DFTS was opened, and the DFT was transected where it emerges through the tendinous tube formed by the superficial flexor tendon. In all six of these cases, the DFT had avulsed from its insertion on the flexor tubercle of the third phalanx and was necrotic. The navicular bursa and retroarticular space (recess) had been transformed into an abscess, and was lined with a dark necrotic layer (pyogen membrane). Using a curette, this necrotic membrane was carefully removed, taking care not to penetrate the flexor pouch of the distal interphalangeal joint. At the same time, any bone lysis was removed from the flexor surface of the navicular bone. In two of the six cases, an indwelling drain was placed in the proximal outer compartment of the DFTS.

In the remaining two cows with complicated sole ulcers, tenovagotomy was followed by claw amputation due to the intraoperative diagnosis of concurrent septic arthritis of the distal interphalangeal joint. In these cases there was severe lysis of the navicular bone, and the flexor pouch of the distal interphalangeal joint was found to be open during debridement.

Postoperatively, the cavities on the flexor surface of the cases on which tendon resections were performed were packed with gauze soaked in saline and bandaged. Bandages were changed every four days for the first two weeks, and every seven-to-ten days after that. The proximal outer compartment of the DFTS was flushed with a weak povidone iodine solution at every bandage change in the two cases with indwelling drains. The drains were removed after 10 days. The cows were treated with antibiotics and non-steroidal anti-inflammatory drugs for the first week following surgery. The surgical site was monitored for formation of a healthy bed of granulation tissue, further formation of pockets with necrotic tissue, discharging sinus tracts, persistent swelling of the remaining portion of the DFTS and swelling of the opposite digit.

## Results

The size of the full-thickness horn defects in uncomplicated cases varied from 4 x 5 mm to 15 x 15 mm (Table 1). Eight of nine uncomplicated ulcers showed a progressive reduction in size following treatment. Using finger pressure, no pain response was present at the ulcer site after one week in 8/9 (89%) of cases. At one month after initial treatment, 66% of ulcers were covered by a layer of horn, of which 44% were still flexible when finger pressure was applied, and sole horn hemorrhage was still present in 11% of cases. Ulcers with granulating corium healed more slowly (range 41-60 days; mean 48; Table 1) compared with those where



**Figure 5.** Arrows indicate measurements to determine ulcer size. © 2003 The University of Tennessee College of Veterinary Medicine.

**Table 1.** Description of lesions in cows with uncomplicated sole ulcers.

Cow no.	Claw confirmation	Lesion size (mm; WxL)*	Corium granulation	Ulcer type**	Healing time/days	Recurring ulcers
384	Laminitic	13x11	+	R	60	+
420	Laminitic	15x15	-	R	28	-
592	Screw claw	27x7	+	R	41	+
711	Normal	16x9	-	H	12	-
738	Normal	10x5	-	R	19	-
857	Screw claw	10x8	+	R	42	-
829	Normal	4x5	-	R	22	-
895	Normal	4x9	-	R	22	-
848	Normal	9x5	-	R	15	-

\*Size recorded at first examination; W = axial – abaxial/width; L = toe – heel/length

\*\*R = Rusterholz; H = Heel

the corium appeared normal (range 12-28 days; mean 20; Table 1). The ratio of healing time for non-granulating versus granulating ulcers was 1:2.4. Ulcers with granulation tissue developed loose horn overgrowth in all three cases, whereas no loose horn overgrowth was seen in the remainder of cases with uncomplicated sole ulcers. Sole ulcers recurred in 2/9 cases (22%) within one month after return of weight bearing on the affected claw. One of these cows (#592) developed ulcers in three of the four hind claws. Histopathological examination of the left rear medial and lateral claws from cow #592 showed that the ventral surface of the third phalanx of both claws had undergone remodeling with cortical osteoporosis and exostosis. The remodeled trabecular bone, with some osteonic bone, suggested increased compressive forces in the left rear medial claw. The dermal papillae showed marked plasma cell infiltrate (LR medial claw) or consisted of granulation tissue (LR lateral claw). Keratin was variably altered with expanded tubules containing hemorrhage. Tubules were generally parallel to the sole.



**Figure 6.** Healing following partial tenovagotomy and deep flexor tendon resection.

When cows were treated with partial tenovagotomy, healing occurred over a period of 49-81 days (mean 68 days; Figure 6). Complications included abscess formation in the proximal outer compartment of the digital flexor tendon sheath (one case; Figure 7), and various degrees of overextension of the toe (all six cases). In one case, the overextension resulted in weight bearing on the soft horn of the heel bulb, causing traumatic damage and ulceration.



**Figure 7.** Abscess formation of the proximal outer compartment of the digital flexor tendon sheath following partial tenovagotomy.

## Discussion

The mean time for formation of a closed horn layer for uncomplicated sole ulcers, without or with granulation tissue, was 20 and 48 days, respectively. In another report, it took 25 days to form a closed horn layer when there were slight corium alterations, and 42 days when severe changes were present.<sup>9</sup> Histological examination found cornification and maturation of epidermal cells, as well as formation of a new vascular bed in the dermis, to be present in cases of sole ulcer 20 days after initiation of treatment, which included application of a claw block.<sup>4</sup> Even after 50 days, histological integrity of the epidermis was still incomplete.<sup>4</sup> In cases of severe injury to the corium, new epidermis is formed from the edges of the lesion, and re-attachment between the overgrowing epidermis and the basement membrane in the ulcer site is necessary for normal healing to take place.<sup>b</sup> Basement membrane integrity and attachment to basal epidermal layers are lost at sole ulcer sites, leading to loss of signaling cues between the basement membrane and basal epidermal layers.<sup>7</sup> Epidermal cells overlying the ulcer site, if still present, become dyskeratotic, resulting in a disturbed synthesis of keratin proteins.<sup>7</sup> Horn surrounding the ulcer shows dilated tubules, microcracks extending to the stratum spinosum, and necrotic areas in the epidermal layer.<sup>10</sup> In an attempt to close the ulcer, suprabasal epidermal mitosis and proliferation follows failure of normal proliferation and differentiation of the basal layer.<sup>3</sup> Re-attachment between the basement membrane and overgrowing epidermis appears to be lacking in ulcers with severe damage to the corium. In such cases, as was seen in three cases with granulation tissue in this report, layers of loose horn may partially grow over the exposed corium, leading to further damage. It is the opinion of the authors that removal of loose horn sped the healing process.

Vascular changes in the corium at the ulcer site include dilatation and thrombosis of capillaries in the dermal papillae, and proliferation of the tunica media in arterioles.<sup>1,3,14</sup> Further injury to the exposed corium, either mechanical or chemical, should be avoided. Examples include overzealous use of foot trimming equipment, or the use of copper sulfate. Exposure of heel and sole horn samples to copper sulfate has resulted in the uptake of copper sulfate into the horn tubules and intertubular horn after 24 hours, resulting in weaker horn due to the formation of a lipid-soluble metal oleate.<sup>8</sup> Application of copper sulfate powder to exposed corium will result in severe necrosis of the tissue.<sup>c</sup> Removal of granulation tissue is recommended, but only if excessive.<sup>6</sup> In this report, cases with granulation tissue that was surgically removed healed more slowly and had recurrence of the sole ulcers. However, failure to remove excessive granulation tissue often results in non-healing and further complications.

The use of a claw block or orthopedic shoe to relieve weight bearing on the affected claw is one of the most important treatment considerations in order to prevent further mechanical injury to the exposed corium.<sup>6</sup> In this report, pain response to finger pressure at the ulcer site disappeared in 89% of cases a week after application of the orthopedic shoe or claw block. Correct application of the orthopedic block is important to prevent further injury or discomfort.<sup>17</sup> Common problems include overextension of the claw due to insufficient heel support, and trauma to the heel bulb with incorrect application of the adhesive.<sup>17</sup> Failure to remove claw blocks, particularly plastic orthopedic shoes, may eventually lead to the development of traumatic pododermatitis due to prolonged pressure.<sup>15</sup> Histological evaluation suggests that relief of weight bearing should be maintained for at least 50 days.<sup>4</sup> Another method to reduce weight bearing on the diseased claw is to lower the heel on the affected side (Figure 8), thus transferring weight to the healthy claw and toe area on the affected side.<sup>13</sup> In this report, claw blocks were generally removed 7-14 days after closure of the ulcer site with an epithelial layer, at which time horn was still soft and flexible on palpation. In all cases, however, the heel on the affected side was kept lower than that of the healthy claw. Recurrence of sole ulcers was limited to two cases that had severe damage to the exposed corium and granulation tissue formation.

As in previous reports, nearly all ulcers occurred in the lateral claw of the hind leg. In this report, two of the cows had screw claw of the lateral claw of the hind leg, and one showed obvious claw horn abnormalities associated with laminitis, including the presence of horizontal wall fissures, lateral deviation (“flaring”) of the abaxial wall and upward rotation at the toe. The conformation of the claws of the remainder of the cows appeared normal (Table 1). Sole ulcers are a common



**Figure 8.** Lowering of the heel on the affected side to transfer weight to the healthy claw and toe of the affected claw.

complication of screw claw due to severe overgrowth.<sup>20</sup> The association of laminitis with sole ulcers is based on inflammatory and vascular changes leading to breakdown of the suspensory apparatus, followed by mechanical injury to the dermis, basement membrane and epidermis between the flexor tubercle of the third phalanx and the sole.<sup>12</sup>

In normal claws, the development of sole ulcers is primarily based on the biomechanics of normal weight bearing.<sup>19</sup> Overgrowth of the lateral claw of the hind leg results from unequal weight bearing between the two claws, with the lateral claw bearing more weight than the medial one.<sup>19</sup> Balancing of weight-bearing surfaces between claws, including the heels, is regarded as an important objective in functional claw trimming procedures.<sup>19</sup>

In this report, the healing time for tenovagotomy and resection of the DFT was longer (mean 68 days) than in a previous study where the average healing time was 42 days, and the success rate was 77%.<sup>18</sup> If the success rate is based on complete healing and the ability of the cow to bear weight on the affected claw, then the success rate for the six cases in this report was 100%. Infection of the contralateral digit was reported to be the most common complication resulting in a poor prognosis.<sup>18</sup> The most troublesome complication found in the six cases described in our report was overextension of the claw, causing caudal displacement of the weight-bearing surface, which in one case caused recurrent traumatic injury to the soft horn of the heel. Regular trimming after surgery is required to balance weight-bearing surfaces and correct overgrowth at the toe.

In our case study, only two of the eight cases had concurrent septic arthritis of the distal interphalangeal joint and septic tenosynovitis. Clinical signs of septic arthritis of the distal interphalangeal joint and septic tenosynovitis are similar, and attempts at radiographic diagnosis of early cases of septic arthritis can be unrewarding.<sup>2</sup> Another diagnostic option is to aspirate joint fluid from the dorsal pouch of the distal interphalangeal joint capsule, which can be facilitated with the use of ultrasound.<sup>2,18</sup> The clinical signs of joint infection, however, predominate in most cases of concurrent distal joint infection and DFTS sepsis.<sup>18</sup> Such signs include a swollen and red coronary band and in more advanced cases, a fistulous tract extending from the distal interphalangeal joint to the coronary band. This opening is usually abaxial or axial to the tendinous portion of the common or long digital extensor muscle.<sup>2</sup> In this case study, confirmation of the presence of distal interphalangeal joint infection was based on pathological rupture of the flexor pouch of the joint capsule, found during tenovagotomy and surgical resection of the DFT.

## Conclusions

For optimal healing of sole ulcers to occur, early identification and treatment is necessary, followed by weekly evaluation for at least the first four weeks. Once the exposed corium becomes damaged, healing occurs more slowly and complications are likely to follow.

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## Footnotes

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<sup>b</sup>Mülling Ch, personal communication.

<sup>c</sup>van Amstel, personal observation.

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## Gut Flora, Nutrition, Immunity and Health

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