Maintenance Claw Trimming in Cattle with Special Emphasis on the Dutch Method

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Application of the Dutch claw trimming method requires understanding of horn structure and function including growth and wear as well as the biomechanics of weight bearing. The shape and weight bearing surface of normal claws can be described as follows: The normal weight bearing area of the claw includes the heel, wall, and the white line as well as the sole.[6] It is important to note that the abaxial wall is weight bearing along its entire length from the abaxial heel wall junction to the toe.[6] The axial wall and white line is only weight bearing for a short distance up to a point where they diverge proximally in the interdigital space.[6] The sole is weight bearing along its entire surface except at its innermost portion directly adjacent to the interdigital space. Here the sole is sloped for approximately one-third of the width of the sole in that area.[6] See Figure 1.

In beef cattle the sole is typically more sloped than in dairy cattle. This is related to the fact that the wall grows more rapidly than the sole, is harder and wears less on dirt.[3] In dairy cattle a more flat bearing surface is created by the mechanical abrasive and shearing effect of concrete. On hard surfaces a flat sole allows for better weight distribution within the claw. A sole that is made to slope upwards towards the interdigital space will place greater mechanical stress on the abaxial white line and the interdigital structures.

The anterior margin of the dorsal wall should be straight, as observed from both the front as well as from the lateral side. See Figure 2.

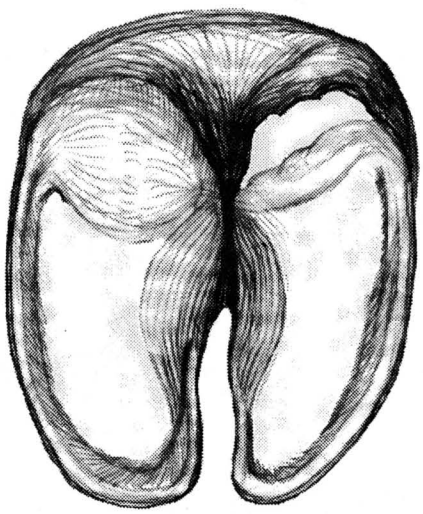

Figure 1.

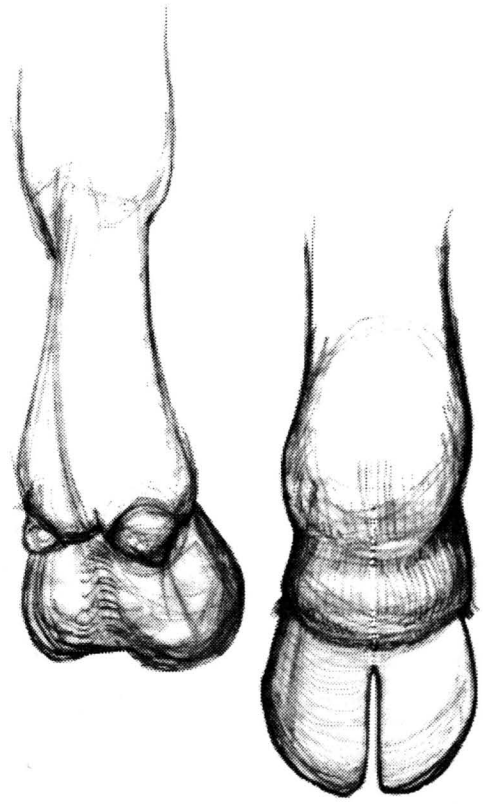

Figure 2.

A slight concavity in the profile of the dorsal wall as seen from the front is not a serious abnormality provided that the abaxial wall is positioned vertically. The same applies to the axial wall. Marked abaxial to axial deviation of the outside wall is abnormal, and often observed with corkscrew claw which is a heritable defect resulting in abnormal horn formation.[3] See Figure 3.

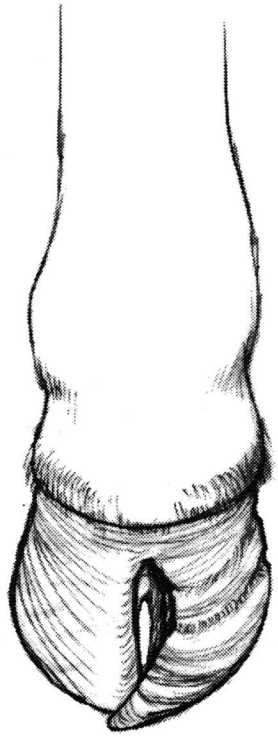

Figure 3.

Concavity of the anterior margin of the dorsal wall as seen from the lateral side is commonly seen with laminitis due to poor quality horn production and the presence of horizontal (hardship) grooves which represent interruption in horn formation.[3] See Figure 4.

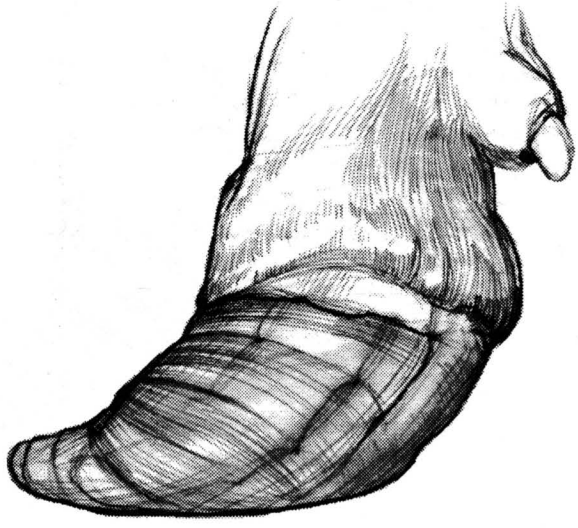

Figure 4.

The claws of the normal animal are of almost equal height, particularly when viewing from the rear. In the hind feet the axial part of the heel of the inside claw is usually less developed than the corresponding area of the outside claw. See Figure 5.

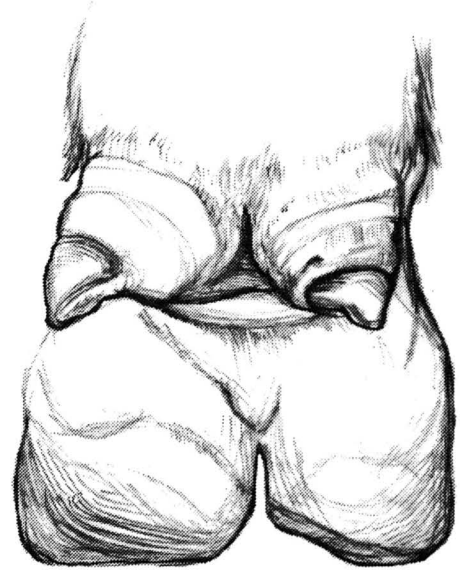

Figure 5.

The heel of the inner claw has therefore a smaller weight bearing surface as compared to that of the outer claw of the hind leg. In addition the weight bearing area of the axial wall and white line extend over a shorter distance on the inside claw as compared to the outside claw of the hind leg. See Figure 6.

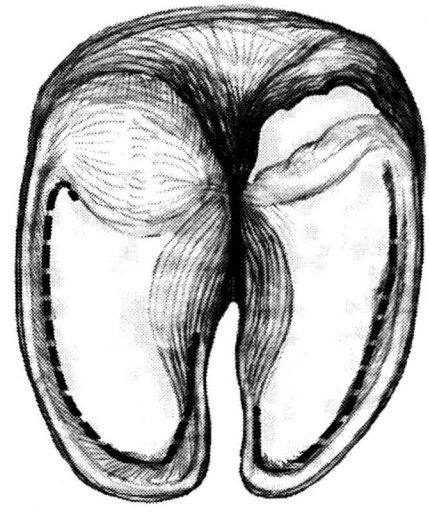

Figure 6.

The result is that the inner claw has a smaller supporting surface on the axial side which makes it less stable particularly on a hard surface.[6] This instability of the inside claw of the hind leg on hard surfaces is

further increased by the normal upward slope and concavity of the sole in that claw. The inner claw is therefore less developed axially as compared to the outside claw and does not provide stable support on a flat hard flooring surface. The outer hind claw is flatter and therefore more stable. In the front legs, both feet are equally stable because there is little discrepancy in weight bearing between the inner and outer claw.[6]

Structure and Function of the Claw and the Biomechanics of Weight Bearing

The horn producing germinal layer of the epidermis and its supporting dermal structure, the corium, consists of four different regions, each producing a structurally different type of horn.[1] See Figure 7.

These include the perioplic horn just below the skin horn junction (coronet) which extends to the back of the claw to include the heel horn; the wall; white line and sole. Horn of the wall is produced by the germinal layer of the epidermis overlying the coronary corium. It represents the hardest horn in the claw and grows at an approximate rate of a quarter of an inch per month.[2] However, this growth rate will depend on several factors including breed, nutrition, environmental factors, integrity of the blood supply to the corium and the biomechanics of weight bearing. The horn of the sole grows at just a little more than half the rate of that of the wall. Horn of the wall, sole and heel consists of tubular and intertubular horn. Tubular horn gives the claw its structural strength.[1] Wall horn has more tubules per square millimeter compared to that of the sole and the heel and is therefore the hardest horn of the claw. The horn of the white line also known as laminar horn (produced by the laminar corium or sensitive laminae) has no tubules and is therefore soft and flexible and has the highest turnover rate.[1]

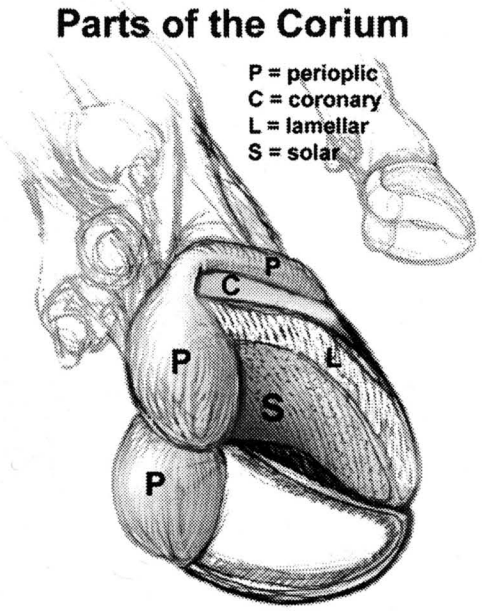

Figure 7.

Structural strength (horn quality) is further enhanced by keratinization and cornification. During the process of keratinization, keratin filaments are formed within the cell and act to reinforce the cell structure and give it rigidity. Keratin filaments within the cell closer to the horn surface undergo cross linking. This further enhances rigidity and strength of cells as they progress to the exterior.[1] The process of keratinization and cornification applies to all the horn cells in the various regions of the horn capsule. Horn cells are cemented together by a substance known as membrane cementing substance. This substance, a lipoprotein, is permeable, holds water, and thus gives horn its flexibility.[1] Horn quality is also dependent on internal and external factors. Internal factors relate to blood and nutrient supply whereas external factors relate to the environment in which the claw is found. Horn production is dependent on good vascular supply and thus, any compromise in blood flow will negatively affect horn production. Similarly horn production is dependent on the supply of certain nutrients which include adequate levels of protein, energy, calcium and phosphorous. Sulfur containing amino acids like cysteine are important for cross linking of keratin filaments. Trace minerals like zinc and manganese are also essential. Biotin appears to play a role in horn quality.[2] Several studies have shown a beneficial effect on the incidence of lameness including sole ulcers, heel horn erosion, white line disease and vertical wall cracks. The mechanism of action of biotin in epidermal health and synthesis of keratin protein is not fully understood. Biotin plays a role in keratin production and the quality of the membrane cementing substance which binds horn cells together.[4]

Horn quality is also influenced by extremes of environmental moisture becoming hard and desiccated under extremely dry conditions or can become very soft with increased flexibility under conditions of high moisture content. Both the horn cells and the membrane cementing substance can be influenced by certain compounds. High levels of copper sulfate for example can destroy the membrane cementing substance making the horn more brittle.[4] Likewise, urine and manure can destroy both the horn cells and cementing substance resulting in loss of horn as we see for example with heel erosion.[5] Both the internal and external factors may act synergistically to produce poor quality horn. For example, changes in blood supply as observed with laminitis will result in production of poorer quality horn. Poor quality horn is more susceptible to the effects of environmental influences.

Normal structure of the bovine foot promotes functional weight bearing. Functional weight bearing relates to even weight distribution within the claw and equal weight distribution between claws. Length of the

dorsal wall is directly related to the thickness of the sole.[6] The longer the dorsal wall, the thicker the sole will be, particularly at the toe. See Figure 8.

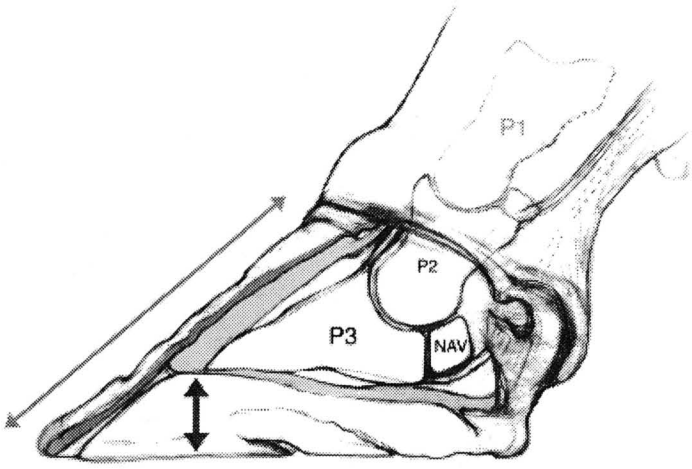

Figure 8.

Considering the size of the skeleton of the average Holstein cow, a claw with a dorsal length of three inches and a sole thickness of 5 to 7 mm (± .25 inch) will allow weight bearing forces to be evenly distributed within the claw. See Figure 9.

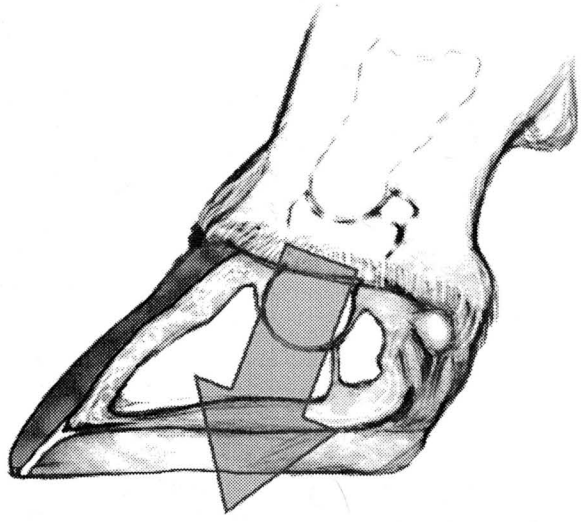

Figure 9.

In this way the impact of the foot with each stride is evenly cushioned.[6] When the toe becomes long the weight bearing axis is shifted caudally concentrating more of the weight bearing forces towards the heel.[6] An increased weight bearing force is now exerted on the corium through the flexor tuberosity of the third phalanx leading to damage of the corium as indicated by hemorrhage in that area.[6] See Figure 10.

This sole lesion (typical sole lesion) occurs in the typical site for sole ulcer development. Similarly in-

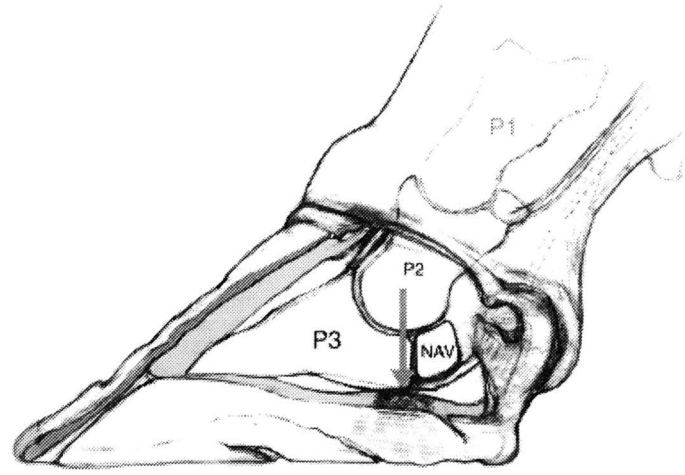

Figure 10.

creased weight bearing force exerted on the back portion of the abaxial white line when the toe is long, increases cellular turnover rate, in the white line of this area. Because of the high turnover rate, horn cells of the white line in this area are more immature.[1] This increases their susceptibility to the mechanical shearing effect of concrete and the chemical eroding effect of manure. The result is a greater risk of white line separation and disease.

On the other hand, if the dorsal wall is short and the sole is thin, more of the weight bearing forces will be shifted towards the toe. This will increase the shearing effect of weight bearing on the sensitive laminae and pressure of the tip of the third phalanx on the corium at the toe.[6] Thin soles which lead to disruption and separation at the abaxial white line/sole junction of the toe and which in turn predisposes to toe abscess (toe ulcer) formation, has become a major problem in the U.S. dairy and beef industry. In dairy cattle the main predisposing causes are: (a) the long distances cows have to walk to be milked; (b) new or abrasive concrete; (c) poor cow comfort; (d) poor stockmanship; (e) over trimming; (f) temperament and co-mingling of animals and; (g) laminitis.

Weight distribution between claws is related to several factors, which include the cows' anatomical structure, udder size and normal gait. Anatomically the cow does not equalize weight bearing between claws because of lateral movement through the hips. This displaces more weight onto the outside claw.[6] A large udder size will further aggravate the lateral weight distribution. It appears that the cows' normal gait also increases weight bearing onto the lateral claw. The response of a lateral claw to this unequal and increased weight bearing is excessive horn production and this is particularly emphasized at the heel of the outside claw.[6] See Figure 11.

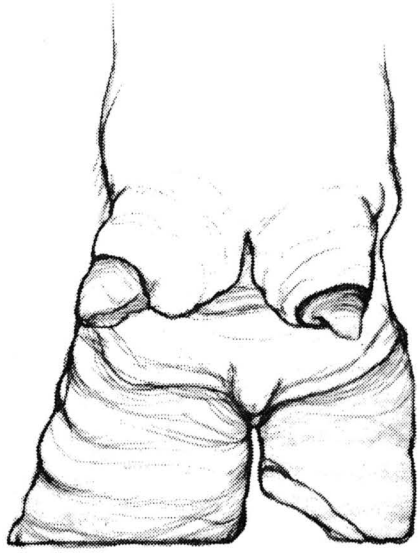

Figure 11.

The cow tries to adjust for this unequal weight bearing between claws by outward rotation of the toe in an effort to displace more weight onto the medial claw. This can be seen by the fact that the cow becomes progressively more cow hocked. See Figure 12a.

This biomechanical alteration however is not entirely successful since a big ledge of overgrowth occurs on the inside of the lateral heel at the interdigital space corresponding to the typical place of sole ulcer development.[6] See Figure 12b.

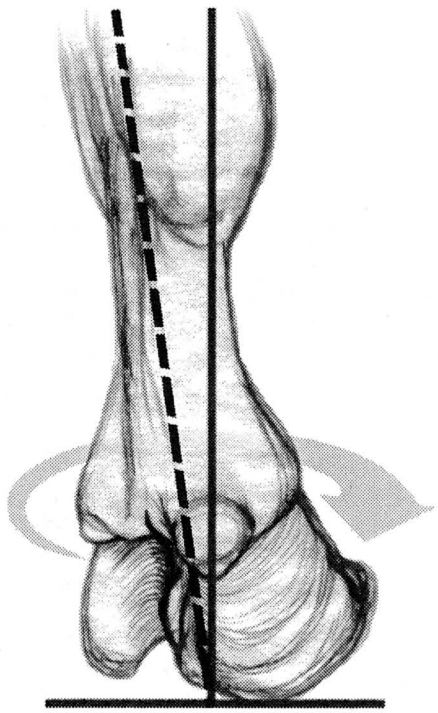

Figure 12a.

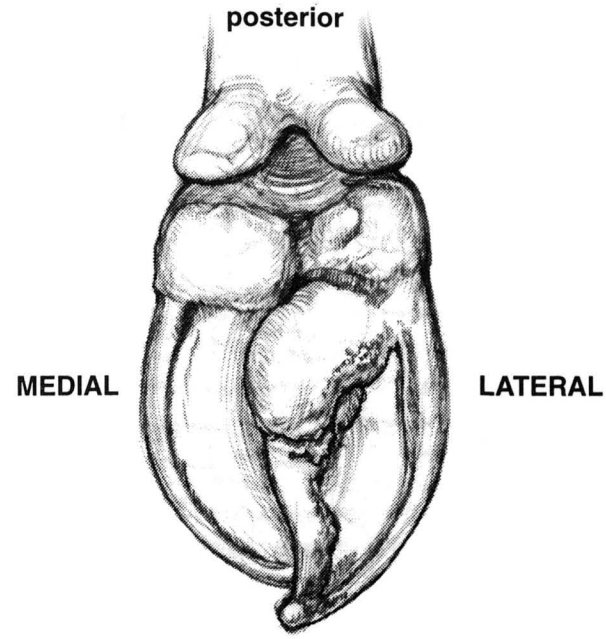

Figure 12b.

Areas of overgrowth which thus commonly occur in dairy cattle include the following: 1) overgrowth of the dorsal wall at the toe; 2) overgrowth of the sole; 3) overgrowth of the heel (lateral heel of the hind leg in the majority of cases); 4) overgrowth of the heel and sole in the "typical place" (abaxial heel/sole junction at the interdigital space).

Thin soles commonly occur in first lactation heifers and are often associated with separation of the abaxial white line/sole junction at the toe. Thin soles are often associated with low and thin heels (except where the animal is deliberately placing more weight on the toe). Low heels, however will often remain unbalanced with the outside heel (hindleg) being higher than the inside heel.

The objectives of functional claw trimming for routine maintenance are: [1] correction of the relative overgrowth that leads to overburdening of the claw (overgrowth is most significant for the outside claw of the rear feet and the inside claw of the front feet); [2] restoration of the appropriate weight bearing surface within each claw, an equal weight distribution between claws; [3] correction of claw lesions at an early stage.[6] Since the inner hind and outer front claws represent the more normal claws of the feet, these claws are used as a model for trimming of the more abnormal outer hind claw and inner front claw. Since 90% of lameness occurs in the outer hind claw, the following six step work plan for trimming feet pertains mainly to the hind feet. However, the same principles will apply for the front feet.

Step 1.[1]

Judge the size of the cow and the length of the claws. The front wall of the medial claw should be 3"

long from the skin horn junction to the tip of the toe. This length of 3" or 7.25 cm is taken as the correct front wall length for the average sized Holstein Friesian cow. Thickness of the sole at the toe should be a minimum of .25" or 5 to 7 mm. Since disease is more commonly associated with the outer claw, one should spare as much of the heel on the medial claw as possible.

Reduce the length of the inner claw to this required length using one or two cuts. See Figure 13.

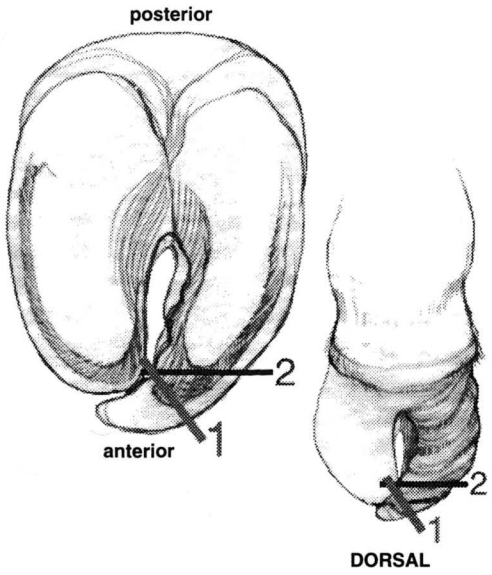

Figure 13.

Next the bearing surface (sole and wall, but not the heel) is stabilized on the inner hind claw. In other words, the bearing surface of the wall and sole is pared flat so that it will be at right angles to the long axis of the metatarsus in the standing position. This will insure that the cow has a flat and stable supporting weight bearing surface. See Figure 14.

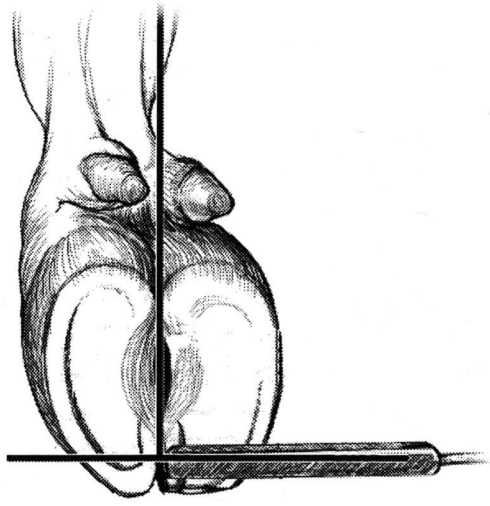

Figure 14.

Height of the heel of the inner claw is not reduced down unless overgrown. The abaxial groove denotes the heel wall junction and trimming of the wall should start immediately in front of the abaxial groove. In this way the heel will be spared. Furthermore, since claw lesions in the outer claw are the more frequent circumstance, preservation of the heel on the inner claw is desired in the event that it is necessary to provide rest to the outer claw by increasing weight bearing on the inside claw heel.

A dorsal wall length of at least 3" will insure adequate sole thickness particularly at the toe where a sole thickness of at least .25" or 5 to 7 mm is required. See Figure 15.

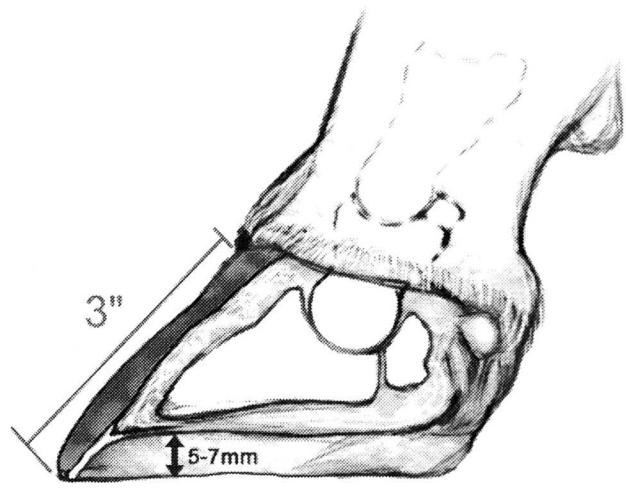

Figure 15.

The sole in this area should not give under digital pressure. If it does it may indicate that the sole has been trimmed too thin. Thin soles subject the underlying corium to bruising or a greater potential to wear through, particularly at the white line. Exposure of the corium often leads to grave consequences for the foot.

Step 2.[6]

Using the medial claw just trimmed as a guide, pare the weight bearing surface of the sole of the outside claw to the same level as that of the medial claw. The outer claw is trimmed to the same level as the inner claw both at the toe and at the heel. Again, the bearing surface should be flat and balanced with the inner claw. Leaving a damaged outer claw higher than the inner claw will probably lead to lameness. It is for this reason that the inner claw heel is preserved. At the end of Step 2 the bearing surface of the outside claw should balance with that of the inside claw particularly at the toe. This can be tested by laying the handle of a hoof knife across both toes whilst at the same time equalizing the level of both dorsal walls by laying an index finger across. The bearing surface of the sole at the toe

should be flat against the handle of the hoof knife and there should not be any gaps visible. See Figure 16.

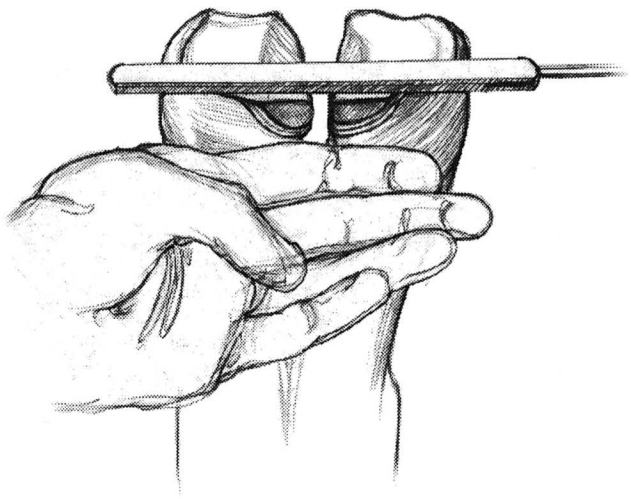

Figure 16.

The bearing surfaces should also be flat along the abaxial wall and sole. This can be tested by laying the handle of the hoof knife flat along the abaxial wall from just in front of the heel to the toe. The abaxial wall and sole should be flat with the surface of the hoof knife and no gap should be visible. See Figure 17.

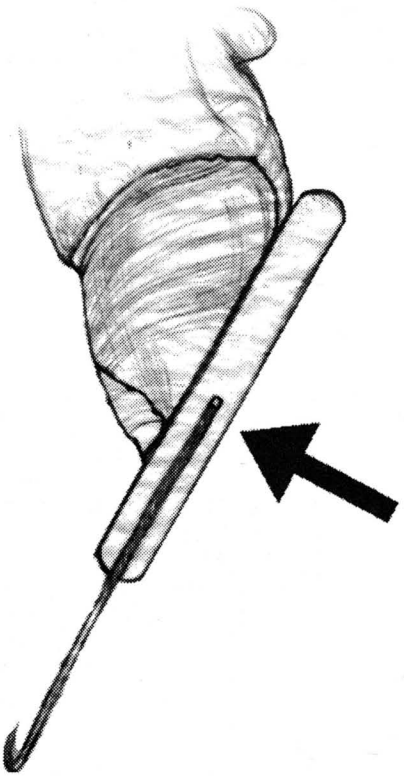

Figure 17.

Step 3.[6]

Slope the sole. This should be done from where the axial white line starts to diverge up the interdigital space to the back of the heel. The slope should be made at a 45° angle with the sole and no more than 1/3 of the width of the sole in that area (heel/sole junction and true sole) should be sloped. See Figure 1.

Excessive sloping of the sole should be avoided because it reduces the weight bearing surface area to the abaxial wall. This is a common error in foot trimming and predisposes to excessive splaying of the toes which can lead to weakening of the interdigital structures, interdigital dermatitis, corns, sole ulcer formation and white line disease. Proper sloping of the sole in this region is designed to reduce pressure in the sole ulcer site and open the interdigital space between claws. Overgrowth of the sole which normally occurs in this area predisposes the interdigital space to entrap dirt and manure between the claws thereby increasing the likelihood of digital disease. It will also cause increasing pressure of the corium between the flexor tuberosity of the third phalanx and the overgrown sole.

Step 4.[6]

Balance the heels. The weight bearing surfaces should be flat at the toes along the walls and across the heels. Heel balance can be evaluated by laying the handle of a hoof knife flat across both heels. The angle of the hoof knife should make a 90° intersect with a line running vertically down the back of the metatarsus. See Figure 18.

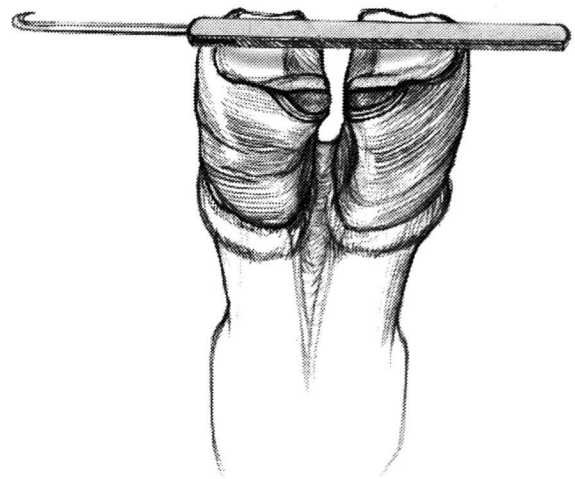

Figure 18.

Steps 1 through 4 insure appropriate distribution of weight bearing within and between the claws and complete the trimming process unless further corrective trimming procedures are necessary.

Steps 5 and 6 are characterized as therapeutic or corrective trimming procedures and are applied as needed.

Step 5.[6]

Pare the damaged claw lower from the toe toward the heel and including the heel to increase weight bearing on the healthy claw. See Figure 19.

In most cases the damaged claw will be the outside claw of rear and the medial claw of front feet. Specific indications for this trimming procedure would include conditions in which overgrowth has led to overloading which is usually seen as hemorrhage at the sole ulcer site. Lowering the damaged claw reduces weight bearing and thereby permits recovery and eventual return to normal function and health. In some cases it is necessary to apply a foot block to the healthy claw in order to reduce weight bearing in the damaged claw.

Step 6.

In the presence of hoof horn lesions characterized by loose and undermined horn, further corrective trimming is necessary. Remove all loose horn irrespective of how extensive it is until re-attachment between horn and the corium is evident. Paring should be done carefully in order not to remove any normal horn or damage the underlying corium.

Never dig holes. Always slope the horn towards the lesion. For example, remove the lateral wall adjacent to the lesion when trimming white line lesions. Do not trim horn with superficial cracks or hemorrhage particularly those associated with the inner claw of the hind leg and the outer claw of the front leg. If in doubt, make use of a hoof tester to evaluate the presence of pain and observe for swelling in any part of the soft tissue of the foot. After the initial corrective trimming procedure has been accomplished, avoid removing any more horn at each examination unless specifically indicated such as additional loose or damaged horn. When treating lame cows the maintenance trimming procedure should be carried out prior to corrective trimming procedures. The benefits from corrective trimming procedures will be short-lived unless the overgrowth that created the problem is corrected. Finally, the Dutch trimming method has been successfully applied over a long period in Europe and other countries. The principles of this method facilitates functional weight bearing which offers the foot maximum protection in the sometimes harsh environment of today's modern dairy operations.

Acknowledgements

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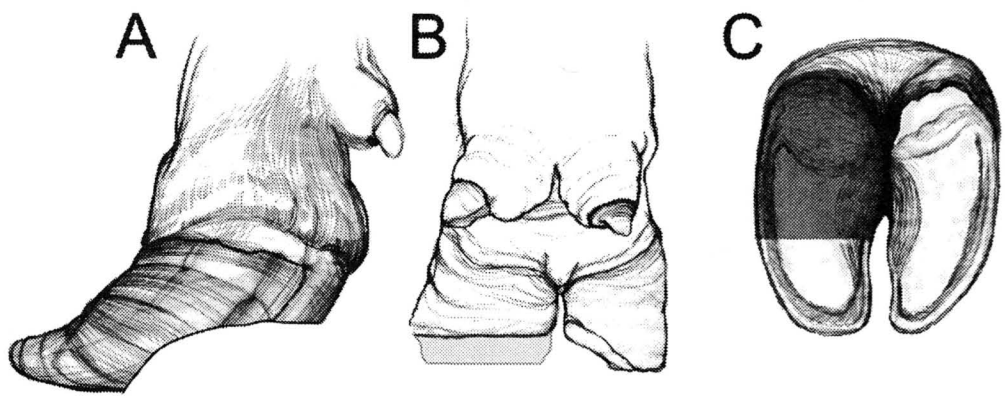

Figure 19.