The Kansas Adaptation to the Dutch Hoof Trimming Method

Ladd Siebert, DVM
Eureka, SD

This article proposes an adaptation to the Dutch Method. In this Kansas adaptation the soles are trimmed to a slope that is an inward and upward gradient. This differs from the conventional teaching of the Dutch Method where the soles are trimmed perpendicular to the long axis of the cannon bone.

Figures 1 and 2 show a side-by-side comparison of two trimmed hooves which illustrates the adaptation.

![Figure 1. Kansas Adaptation](image1.png)  ![Figure 2. Dutch Method](image2.png)

(Soles trimmed to normal gradient.) (Soles trimmed perpendicular to long axis of cannon bone.)

Normal Sole Gradient Definition

Normal sole gradient defined - the plane of the distal surface of the trimmed toe is sloped proximally from abaxial to axial at an angle that is normally 3 to 4 degrees below a line perpendicular to the long axis of the cannon bone. For any individual toe, its specific normal angle of sole gradient will be parallel to its normal sole surface.

Objectives of This Article

For reasons that are given in the body of this article I seldom use the Dutch Method. But, in those circumstances where I am required to, the soles are trimmed to normal gradient according to the Kansas Adaptation. This is done because a critical examination of the reasons given for trimming soles perpendicular reveals that there is no coherent justification for the use of this practice on free-stall cows. This will be explained in the article. It will also be explained why trimming the soles to normal gradient is beneficial, while trimming the soles perpendicular may actually do harm.
**Other Useful Definitions** (Many of these terms are technical; their use is helpful because they increase the precision and conciseness of a description.)

normal sole surface – the sole surface when the sole is at normal thickness.

abaxial – the outer or lateral aspect, examples: the abaxial wall (outer wall, lateral wall), the abaxial sole (this would refer to that portion of the sole that is located along the outer margin of the sole).

axial – the inner or medial aspect, examples: the axial wall (inner wall, medial wall), the axial sole (this would refer to that portion of the sole that is located along the inner margin of the sole).

abaxial toe rotation – where the direction of long axis rotation is lateral (toward the outside of the hoof).

axial toe rotation – where the direction of long axis rotation is medial (toward the inside of the hoof, an example of this type of toe rotation is seen in the corkscrew claw hoof deformity).

axial tilt – a description used by Dr. Toussaint Raven for a toe that leans in (medially) on its dorsal-ventral axis, on its long axis this would constitute an abaxial toe rotation.

proximal – closer to any point of reference, (in hoof anatomy the implied point of reference is always the main part of the cow), example: the dew claws are proximal to the hoof because they are closer to the main part of the cow than is the hoof.

distal – remote, farther from any point of reference, example: the sole surface is distal to the pedal bone, (same implied point of reference), another example; the sole is on the distal surface of the hoof.

dorsal – meaning on top or above, example: the dorsal hoof wall is that portion of the wall that comprises the top aspect of the hoof.

ventral – meaning bottom, below, or underneath, example: the sole is on the ventral (bottom) surface of the hoof.

hoof capsule- the horn covering of the hoof composed of the walls, heels, and soles.

typical site – the area of the sole surface that is directly below the axial prominence on the heel of the pedal bone, this is the place where sole ulcers typically occur.

etiology – the sum of the causes of any disease, example: the etiology of the sole ulcer would refer to the chain of events that cause the development of an ulcer.
Disclaimer

There are conclusions in this article that are based on a combination of formal education, logic, Rex Siebert’s teachings, and the personal observations I have made while trimming what now (2005) totals over 136,000 head of cattle. Most of these being dairy cows. I believe these conclusions are correct, but in the strictest sense they have not all been documented by research. Cited publications and research are foot noted.

The main topic of this article is normal sole gradient and while this has not been formally documented as being the normal state of the lifted hoof, it is, because by definition normal means the ‘usual state’ and sole gradient is the usual state for the normal bovine hoof when it is lifted and not bearing weight. The authenticity of this statement on normality should be self-evident to you from your own observations of normal hooves.

Normal Capsular Structure

The goal of hoof trimming is normal capsular hoof structure. The key to attaining this is trimming the sole to normal thickness. There is a hindrance that is holding back a better understanding, and better teaching of correct bovine hoof trimming. These are short-comings of a most fundamental nature. They are a general lack of recognition, and a lack of knowledge of two very basic elements of the normal sole and this includes how they react to different environments. These two elements are normal sole gradient and normal sole shedding. These are both basic to normal capsular structure.

Normal sole gradient should be evident to anyone who has several years of trimming experience. Normal sole shedding, once explained, would be evident to any experienced hoof trimmer who trims cows housed in a variety of different environments.

As hoof trimmers we are charged with restoring the overgrown hoof to normal. To accomplish this, the first requirement is a recognition of what normal is. It is self-evident that to understand and successfully deal with the abnormal, we must first know normal.

Toe Parameters

The normal capsular structure of the bovine toe includes four parameters that are important for hoof trimming. These are: 1) sole thickness, 2) heel height, 3) wall length, and 4) normal sole gradient.

The Importance of Recognizing the Non-weight Bearing Normal

The normal weight bearing function of the hoof is dependent on its having a normal capsular structure. The goal of hoof trimming is to return the hoof to its normal weight bearing function by restoring this normal structure. An important parameter of normal capsular structure is the orientation of the sole surfaces. When the hoof is weight-bearing the normal sole surfaces are parallel to the ground surface. This configuration is perpendicular to the long axis of the cannon bone and this is the weight bearing normal.
It is important to recognize that the normal configuration of hoof structure changes when the hoof is lifted for trimming, because of the removal of weight bearing. The obvious component of this change in normal is seen in the orientation of the surfaces of the soles. In the lifted non-weight bearing normal hoof the soles slope upward and inward. This is the non-weight bearing normal. As previously defined, this slope is proximal from abaxial to axial at a gradient that is normally 3 to 4 degrees below a line perpendicular to the cannon bone.\textsuperscript{3} For the remaining three parameters of wall length, heel height, and sole thickness, removing weight bearing has no effect on their normal magnitudes. If a lifted hoof is correctly trimmed to normal sole gradient these remaining three parameters will all be trimmed to their normal magnitudes. This restores the hoof to normal capsular structure and insures normal weight bearing forces across the sole surfaces when it again becomes weight bearing.

If soles are trimmed perpendicular to the cannon bone, instead of to normal gradient, they are being trimmed to the weight bearing normal, but this is being done during a time when the hoof is in a non-weight bearing state. The result leaves the walls, heels, and soles with abnormal magnitudes for length, height, and thickness, respectively. The most important of these are an over-shortened abaxial wall and an over-thinned abaxial sole. The end result will be a trimmed hoof with an abnormal capsular structure. This will inevitably cause an abnormal distribution of weight bearing forces across the ground surfaces of the toes when the hoof again becomes weight bearing. This is important because we know that abnormally distributing weight bearing forces across the sole surfaces will result in increased sole contusion and disease.

To summarize: Since all hoof trimming is done while the hoof is in a non-weight bearing state, i.e., when it is lifted, to successfully accomplish the goal of restoring the hoof to normal requires that we trim the hoof to the normal that exists during the time the hoof is lifted and we are working on it. This existing normal is the non-weight bearing normal which includes normal sole gradient.

Plate 1. Hoof Trimmed to Normal Sole Gradient

This was a “rim trim.” The fresh cut surfaces around the toe perimeters show where the overgrown walls and heels were trimmed away. The soles were not trimmed because normal sole shedding has maintained them at normal thickness. If this hoof would have been trimmed perpendicular, (thin dotted lines), an abaxial portion of the soles would have been over-thinned and a portion of the abaxial walls would have been over-shortened. This picture shows clearly that normal sole gradient is parallel to the normal sole surfaces. (This hoof is not completely trimmed. I use an electric sander to make minor final changes required to finish a hoof. I took this picture before sanding so the sole surfaces would be clearly demarcated from the cut ends of the walls and heels.)
The only way to negate the importance of recognizing and understanding the non-weight bearing normal would be to devise a technique to trim the hoof while the cow is standing on it. That way the existing normal would be the weight bearing normal. Since this is not likely to happen anytime soon, the important realities that the non-weight bearing normal have on the correct practice of hoof trimming will be explained throughout the remainder of this article. There will also be explanations of other differences between the Kansas and Dutch Methods.

“What is Normal?” – The Problem of Normal Variation

In cattle there are normal variations in the magnitude of the toe parameters. This variation occurs between cattle groups that differ by age, breed, or sex, and between individuals who are of the same age, breed, and sex. It also occurs between the toes on a same animal. Normal variation presents a problem during hoof trimming, where the goal is to restore the hoof to normal, because the range in normal magnitudes means that what is ‘normal’ varies from animal to animal, and from toe to toe on the same animal. Dutch Method teachings are inadequate to accomplish the comprehensive goal of normal capsular structure because average values are a ‘one size fits all’ approach that will never solve the problems posed by the range of normal variation. The following examples will illustrate this:

Heel height – We have all seen adult Holsteins that are naturally shallow heeled and some that have naturally deeper heels. This is determined by inheritance and is an example of the normal range in heel heights. When trimming these cows, if we assume an average heel height of 1½ inches\(^4\), (Dutch Method teaching), and trim all heels to this height, the posterior sole of a naturally shallow heeled cow will be under-trimmed, leaving it thicker than normal, and for a naturally deep heeled cow, it will be over-trimmed, leaving it thinner than normal.

Dorsal wall length – The same can be said for dorsal wall length because some cows naturally have a longer toe, and some a shorter toe. If we assume an average dorsal wall length of 7.5 cm (3 in)\(^5\), (Dutch Method teaching), trimming all toes to this length, and then trim the soles to leave a 5 mm (1/4 in)\(^6\) step at the toe end-cut, (Dutch Method teaching), the result will be an over-thinning of the anterior sole in the naturally long toed cows, and it will be left thicker than normal in the naturally short toed.

The problems posed by normal variation are made more severe for the Dutch Method when animals from different groups are included:

Age – Mature Holstein average values for dorsal wall length and heel height, for obvious reasons, will cause even larger errors when applied to a group of Holsteins that are younger because this group as a whole will have smaller feet. These would include freshening and pre-freshening Holstein heifers.

Breed – Again, and for the same reasons, using average mature Holstein values for breeds that naturally have smaller feet, such as Jersey cows, is unworkable.

Normal variation also causes differences between the toes on a same animal. We have all seen this. These would include normal front toes being generally wider than normal back toes; this is especially the case in bulls. Another would be the differences in the back toes. These include a difference in size where the medial rear toe is normally smaller than the lateral. Recent research has revealed another difference. It is now known that the lateral epicondyle of the metatarsal bone is normally longer than the medial...
epicondyle. This causes the lateral toe of the rear leg to extend further distally than the medial toe. Because of this variation, if the lateral sole is trimmed down to the level of the medial sole, (Dutch Method teaching), the result will be the lateral sole being thinned to less than normal thickness. In the research on this, in several of the hooves the lateral sole was so over-thinned that it almost caused exposure of the corium.

Subjective and Objective Hoof Trimming Methods

There are two basic types of hoof trimming methods: subjective and objective.

The Dutch and White Line Methods are subjective methods where the determination of normal sole thickness, from anterior to posterior, is based on using average values for dorsal wall length and heel height, respectively, (these teachings were explained above). As a result, both of these subjective hoof trimming methods are inherently weak at overcoming the problems posed by normal variation because average values do not adequately define the normal range of individual variation. We also now know that using the medial toe as a guide for trimming the lateral toe results in over-trimming the lateral sole. Research has proven the error of this practice. In addition, both methods teach that the correct plane of the trimmed soles is perpendicular to the cannon bone. A critical look at this teaching will show that it is also subjective because it is based only on opinion; there is no empirical research showing that this results in normal sole thickness across the width of the sole.

The Kansas Method is an objective method for determining normal sole thickness. This is based on using ‘pith’ as the depth of trimming guide for removing the overgrown sole horn down to the level of the normal sole surface (the surface of the sole at normal thickness). Pith is a white powdery substance. It is the product of sole horn dehydration. It is produced by specific capacities of the process of normal sole shedding. Pith only occurs in overgrown sole horn, and is interspersed in pockets within this overgrown horn. It is never found in normal sole horn. This characteristic of pith, that it is only found in overgrown sole horn and is never in normal sole horn, is used to differentiate these two types of horn during the trimming process, and this is used to objectively determine when the normal sole surface has been reached. This is accomplished by trimming the overgrown sole to just short of the complete disappearance of pith across the plane of the trimmed surface. This disappearance indicates the transition from overgrown sole horn to normal sole horn and the plane of this interface is the normal sole surface. When this plane of trim is extended across the entire distal surface of the toe, this objectively yields normal sole thickness across the complete expanse of the sole. This also objectively yields normal wall length and normal heel height because when these are at their normal magnitudes their ground surfaces are always flush to the normal sole surface. This plane of trim also objectively yields normal sole gradient because this slope is always parallel to the normal sole surface. Since normal is determined objectively for all four hoof parameters, (sole thickness, dorsal wall length, heel height, and sole gradient), the Kansas Method overcomes the problem of normal variation because each toe is trimmed to its own specific normal. Thus, this method can be used to accurately restore the overgrown bovine hoof to normal capsular structure for any age, breed, or sex as long as sufficient sole drying is occurring to result in the production of pith.
The majority of the cattle I trim are free-stall cows with at least some seasonal access to dirt. In these housing environments, there is enough sole drying to allow the use of the Kansas Method on almost all of the cows. This varies a little depending on the amount of access to dirt. The amount of access to sun-dried concrete also affects this.

I also trim in free-stall herds where the lactating cows are totally confined, but in all of these the dry cows have access to dirt. In these environments sole drying is insufficient to allow the use of the Kansas Method on many animals. This varies from herd to herd. In most of these herds the Kansas Method can be used on many to most of the cows, but in several a majority of the cows cannot be trimmed with this method. For the lactating cows this is mainly determined by how long they have been fresh.

I prefer the Kansas Method because it provides a more accurate way to determine where I am at in the hoof than is possible with the subjective methods. If insufficient sole drying requires the use of a subjective method my preference is the Dutch Method because it is less likely to result in over-thinning the anterior sole than is the White Line Method. When using the Dutch Method it is applied according to some, but not all of its teachings. One very important exception is the practice of trimming the soles perpendicular to the cannon bone. Instead, I substitute the adaptation from the Kansas Method where the sole surfaces are trimmed to the average gradient of the lifted non-weight bearing hoof. This average is the 3 to 4 degree value. An average value must be used, because with the Dutch Method the normal sole surface is not determined objectively. This means it is impossible to determine the actual normal for sole gradient for the toe being trimmed. The average value is used with the hope that it will be close to the normal.

Justifications for the Kansas Adaptation

Fig 3 shows a normal bovine hoof that has been lifted for examination or trimming. There is no, or only very slight overgrowth. As can be seen the soles slope proximally from abaxial to axial to the 3 to 4 degree gradient below a line perpendicular to the long axis of the cannon bone, (on a live animal this is best seen by looking at the heels directly from behind). As previously noted, sole gradient is normal because it is the overwhelmingly consistent finding when the normal bovine hoof is removed from weight bearing.

Fig 3. Non-weight Bearing Normal

For readers that have not noted this gradient the next time you lift a normal hoof, or one that is very near-normal, look for it, it will be there.

As in all things biological, there is a range in normal. Some hooves will slope more and some less. The three to four degrees is my estimate of the normal range. For any individual toe, the specific normal will be parallel to its normal sole surface. What you will almost never see is a lifted normal hoof that has perpendicular soles, i.e., no sole gradient.
Preliminary calculations show that in a toe that is 5 cm (2 in) in width, a gradient of 4 degrees will result in the mid-abaxial outer margin of the sole surface extending distally 3 mm further than its mid-axial inner margin. Considering that normal sole thickness is approximately 7 mm, it would seem that 3 mm would be a significant quantity. And it follows, that if this toe is trimmed axially to normal sole thickness, and then perpendicular across the remaining sole surface, the mid-abaxial outer margin of the sole, including the white line joint, would be over-thinned by this 3 mm. This would over-thin the white line joint in zone three to a little more than half of its normal thickness. This would weaken the white line joint in zone three where most penetrating white line infections occur. White line infections are the second leading cause of lameness in dairy cows due to toe disease. This is an important reason for trimming to normal gradient instead of perpendicular.

The cause of sole gradient is not documented but is probably due to some elasticity in the cruciate ligament configuration. These ligaments criss-cross between the two phalangeal arrays and keep the toes from splaying excessively when the hoof is under a weight-bearing load. When the load is removed, by lifting the hoof, this elasticity would pull the soles together which results in normal sole gradient. This would be analogous to the way an independent suspension cants the wheels of a car inwardly when it is raised on a lift.

The essential justification for trimming the soles to normal gradient is: it is normal.

Normal is the end result of eons of time and thousands of generations of use. It is unwise to ignore this.

This discussion of the reasons for trimming to normal gradient would be incomplete without an examination of the reasons given for not trimming to normal slope, in other words, the reasons given for trimming the soles perpendicular to the cannon bone. This practice is always referenced back to the book, Cattle Footcare and Claw Trimming, authored by the late Dr. E. Toussaint Raven who developed the Dutch Method. This book, which is well written and illustrated, is indeed a classic in the literature on hoof trimming. I am glad to have a copy of it in my library, and I honor the memory of Dr. Raven with an appreciation for the amount of time, work, and research it took to compile and write this book. However, the fact remains that a critical reading of his reasons for trimming the soles perpendicular reveals that this practice should not be applied to all cattle, all the time, as is commonly taught today. Dr. Raven, himself, cautioned against this kind of a mind set, explaining that what is written in the book must be adjusted to local circumstances (different housing systems, climates, feeding regimes, etc. etc.). It is important to recognize that the majority of his clinical experience was with the tie stall or stanchion cow. What might seem to be correct for the hooves of these cows can not always be directly applied to the hoof of the free-stall cow. This would include the teaching that soles should be trimmed perpendicular to the cannon bone. It will be explained why this practice should not be applied to free-stall cows. This would also include cows confined in a dry lot setting.

Dr. Raven believed that toe instability was the primary cause of sole contusion and ulceration at the typical site. He defined instability as a claw which tilts over axially
and backwards on its dorsal ventral axis.\textsuperscript{16} Another way to describe this would be to say that \textit{the toe rotates abaxially on its long axis}. He concluded that when this occurs the effect within the hoof is to focus an increased weight-bearing load on the axial prominence located on the ventral-axial aspect of the heel of the pedal bone. The result of this abnormal point load is bruising of the sole corium located directly below this prominence.\textsuperscript{17} If this loading is severe and long standing the sole contusion progresses to an open lesion, a sole ulcer. Probably because sole ulcers are such a common and serious lesion, Dr. Raven devotes several pages in the book to discussions that pertain to their cause and prevention. Many of these discussions focus on the role that hoof overgrowth plays in the development of this lesion, specifically, \textit{long abaxial wall overgrowth}. As stated above, he believed that toe instability was a primary cause of the lesion. He also believed that the root cause of this instability was long abaxial wall overgrowth because this type of overgrowth was the direct cause of the \textit{axial tilt}\textsuperscript{18} (abaxial rotation) which he believed starts the whole pathological process.

It is clear that Dr. Raven had very serious concerns about long abaxial wall overgrowth. In addition to the pages of written text that deal with this subject there are numerous drawings. Many of these show posterior views of splayed out axially tilting (abaxially rotating) hooves caused by long abaxial wall overgrowth with cut-aways to illustrate the pathological bio-mechanical effects this type of overgrowth has on the inner structures of the hoof. For all these reasons, I think he had a deeply held opinion that no hoof should ever be trimmed in any way that left the abaxial sole margin extending further distally than the axial sole margin. It would appear that he felt this so strongly that it allowed him to completely ignore normal sole gradient, because with this gradient, the abaxial sole margin \textit{does} extend further distally than the axial margin. These are the reasons I think he advocated trimming soles perpendicular, instead of to normal gradient. My reasoning on why he ignored normal gradient may be incorrect, but there is one thing that is obvious to anyone who critically reads his book; he thought strongly that trimming other than perpendicular would increase sole ulceration. However, for the free stall hoof this thinking is clearly wrong, because for all practical purposes, the type of pathology causing long abaxial wall overgrowth that Dr. Raven describes, \textit{does not typically occur in free-stall cows}.

It must be remembered that the \textit{defining component} of the type of hoof overgrowth described as typical by Dr. Raven is that it causes an \textit{abaxial rotation} of the toe and it is this that results in the instability and development of sole ulcer pathology. However, in free-stall hooves that have long abaxial wall overgrowth, if there is toe rotation, it is almost always in the opposite direction; \textit{it is axial}, not abaxial as described by Dr. Raven. (Axial is the typical direction of rotation in the rear outside toes and front inside toes of free-stall cows, and these are the toes where most sole ulcers occur.)

The second essential component of the type of hoof overgrowth described by Dr. Raven was an \textit{axially under-developed heel}.\textsuperscript{19} While not as significant as long abaxial wall overgrowth, a low axial heel is described as being a very important contributing factor to the abaxial and backward rotation that characterizes the toe instability which he believed caused the increased pressure on the sole corium at the typical site. However, and again, in free-stall hooves with long abaxial wall overgrowth, the development of the axial aspect of the heel is typically just the opposite; \textit{it is over-developed}, not under-developed as described by Dr. Raven.
Because the essential features of the two anatomical components of the etiology of sole ulcer formation in the overgrown hoof, as described by Toussaint Raven, are completely dissimilar to the features of the same anatomical components in the overgrown free-stall hoof, a different etiology for the sole ulcer in free-stall cows with hoof overgrowth is needed:

In free-stall hooves with long abaxial wall overgrowth the axial aspect of the heel is typically overdeveloped, not underdeveloped, (this is seen in corkscrew claws and pre-cork screw claws). When this overgrowth is severe, it is commonly seen as a ledge of combined overgrown heel and wall horn that extends distally and axially. This extends over the typical site and it is not unusual to discover sole bruising and/or ulceration underneath this overgrown horn when it is trimmed away. In many instances the segment of this axial overgrowth that is directly over the typical site extends distally beyond the remaining sole surface. This will cause an extreme point load at the typical site. It is most likely that the cause of the under-lying pathology would be the increased loading at this site due to the axially occurring overgrowth. To counter this loading would require trimming in a manner that leaves the axial aspect of the sole surface, proximal to the abaxial aspect. Logic teaches that this would be the most effective way of reducing the abnormal point load on the typical site. This would also give the sole a slope that is proximal from abaxial to axial. This slope is the same as normal sole gradient. Sole ulcers are the leading cause of dairy cow lameness due to toe disease. So, this is another important reason for trimming to normal gradient.

To summarize; the type of long abaxial wall overgrowth and its pathological effects, as described by Dr. Raven, is not typical for the free-stall hoof. His reason for trimming the soles perpendicular was to help nullify a backward and axial tilt (abaxial toe rotation) which he believed was the primary cause of sole ulcer pathology. However, in the free-stall hoof with long abaxial wall overgrowth the direction of rotation is the opposite, it is axial, not abaxial, and the axial heel is typically overdeveloped, not underdeveloped. Considering these facts, the teaching of trimming the soles perpendicular is not plausible for the treatment or prevention of sole ulcer formation in free-stall cows.

Additional Justifications for Trimming to Normal Sole Gradient

Sole gradient is the existing normal for the lifted hoof, so when a sole is trimmed perpendicular it will be left with more thickness along the inner margin than it has along its outer margin. When the hoof is again returned to weight bearing it is likely that this increased axial thickness would increase the axial loading of the sole beyond normal due to increased counter pressure from the floor surface. We should all be able to agree, considering the etiology of sole ulcer formation, that it is not good to increase the load on the axial sole. This is another reason for trimming to normal gradient which leaves the sole with a uniform axial to abaxial thickness, i.e., no increased axial thickness.

In free-stall cows significant abaxial wall overgrowth usually results in some degree of axial toe rotation. The magnitude of this is almost always greatest in the lateral rear toes and medial front toes. If this rotation is severe enough the result is a corkscrew claw. The complete etiology of this hoof deformity is not documented but a hypothesis describing its growth and development is accepted by many. To paraphrase this
hypothesis, it appears that the aberrant axially twisting growth of the corkscrew claw is instigated when the pedal joint slants abnormally. (While there is disagreement as to whether this is the instigating cause, there is no disagreement that this hoof deformity causes an increase in tension on the lateral collateral ligaments of the pedal joint.) This slant is abaxial-ventral and it is severe enough to significantly increase the stretch and tension on the lateral collateral ligaments that cross the lateral side of this joint. This results in injury and tearing where the ligaments attach to the periosteum of the second phalanx and the pedal bone. This causes an exotosis reaction that consists of the development of bone spicules at the sites of the tearing injuries. The next tissue layer out is the lateral aspect of the coronary corium. This is located at the hair line. This corium secretes the hoof wall. The sharp bone spicules irritate this corium and its response is an increased rate of abaxial hoof wall production. Meanwhile, on the medial side of the pedal joint there is no stretching of the medial collateral ligaments, and thus no bone spicules. As a result, medial hoof wall production remains at its normal rate. To summarize; the effect of this sequence is a situation where the growth rate of the abaxial wall is increased while that of the axial wall is normal. The net effect of these unequal growth rates is the axially twisting lateral wall overgrowth that characterizes the corkscrew claw. The important thing to remember about this is that the immediate cause of the bone spicules is the increase in tension on the lateral collateral ligaments of the pedal joint.

As previously explained, when a sole is trimmed perpendicular, its axial aspect is left thicker than its abaxial aspect. When such a toe again becomes weight bearing this abnormal sole surface will result in an increased distil displacement of the lateral margin of the toe compared to its medial margin. It is inevitable that this will result in an increase in the tension on the lateral collateral ligaments. It is logical that this would predispose to the development of a corkscrew claw. This is another reason for trimming to normal gradient instead of perpendicular.

In free-stall cows the corkscrew claw is a common and debilitating hoof deformity. This problem is not a serious today as it was in the past because of widespread hoof trimming, but it is still too common. More than thirty years ago when I first started trimming there were not many hoof trimmers, and it was a common occurrence to trim a free-stall herd that had never been trimmed before. In these herds the level of hoof overgrowth was appalling, and if the lactating cows were totally confined, it was not uncommon to find a third or more affected with corkscrew claws. In some of these herds the level approached one half. I think that the lower incidence of this deformity, that we see today, is the direct result of the increase in hoof trimming, especially preventative trimming. Considering the etiology of the corkscrew claw, hoof trimming will be most successful at preventing the development of this hoof deformity when it is done in a manner that does not increase the tension on the lateral collateral ligaments. The only effective way to do this is trimming to normal gradient.

As noted above, though fewer, there are still too many corkscrew claws. When trimming an existing corkscrew claw, where we know the lateral collateral ligaments are already under increased tension, it would be adding insult to injury to trim the toe in a manner that maintains this increase. But, this is the inevitable result when the toes are trimmed perpendicular. This is a reason for trimming to gradient on corkscrew claws.
Before leaving the subject of additional justifications for trimming to normal gradient there is one more important point that, while seemingly obvious, needs to be made. This point is: in all instances, if the axial sole margin is left thicker than the abaxial this will cause the entire toe structure to rotate axially on its long axis when the toe again becomes weight bearing. This is abnormal and in the previous paragraphs some of the known consequences of this have been discussed. Are there any unknown consequences in other parts of the toe from abnormally rotating its entire structure? At this date, no one knows the answer to this, but we do know that the toe is, essentially, a weight-bearing structure. In these types of structures the correct spatial arrangement of the different parts to each other is important to their own integrity, and to the integrity of the entire structure. (This may be a good lesson on the importance of always respecting normal!)

**Normal Weight Distribution across the Sole Surface**

Classically, it had been theorized for many years that the abaxial wall was the main weight-bearing structure of the hoof. Considering the design of the hoof, this makes sense because this wall is strong and anchored so well to the pedal bone by the extensive abaxial laminar corium. This theory was supported by Scott (1988)\(^2\)^ with his work showing that the abaxial wall of the claw carried the most weight. Also, Westerfeld (2004),\(^3\) in anatomical studies of the hoof under a weight-bearing load, came to the functional conclusion that the main part of force transformation is in the dorsal and apical third of the abaxial parietal area of the claw. This would tend to support the classical theory that the abaxial wall, by design, is supposed to carry the main weight-bearing load. However, van der Tol (2002)\(^4\) found that recently trimmed cows exert most of their weight on the sole and not on the wall when they are housed on a hard surface.

So, where does this leave us, what is normal weight-bearing? The Classical Theory, Scott, and Westerfeld teach that the abaxial wall is and should be, respectively, the main weight-bearing structure, but in van der Tol’s study it was actually the sole. However, he did qualify this by stating that the hard flooring surface and/or the recent hoof trimming may have affected his finding. Since the reason we trim hooves is to redistribute weight-bearing, (hopefully back to normal), it seems reasonable that a recent hoof trimming would unavoidably affect measured load distributions across the ground surfaces of the hoof. In other words, it is possible that what van der Tol (2002) actually discovered had as much to do with the effect of the hoof trimming, than what is necessarily normal weight distribution. As previously noted, the hooves in this study had been recently trimmed. The Dutch Method was used which means the soles were trimmed perpendicular. While there is conflicting research, I think that the prevailing opinion is still with the theory that the abaxial wall would normally be the primary weight-bearing structure. Future research may resolve these conflicts.

So, the question remains: How do we trim the confined dairy cow’s hoof to help insure normal weight bearing? This question is addressed further in two very recent studies. These trials were reported in 2004 and were on the effect that preventative trimming (Dutch Method) had on force and pressure distributions between the lateral and medial claws of the hind leg. One, (Kehler, 2004),\(^5\) concluded that functional trimming corrected, at least for a time, the unbalanced vertical loading of the hind claws. The other, (van der Tol, 2004),\(^6\) concluded that the vertical loading of the hind claws remained unbalanced after trimming, (Dutch Method). Due to this result, and his previous trial,
(van der Tol, 2002), which showed that the main weight bearing force was on the softer parts of the claw capsule (sole, proper), van der Tol (2004) concluded that, “force balance should not be the main focus of claw trimming. Instead the focus should be on finding a way to trim the hoof where the strongest part of the claw capsule would be the primary weight-bearing structure.” (The strongest part of the claw capsule is the abaxial wall.)

As I see it, as hoof trimmers we may have a choice that could effect whether the sole, proper, or the wall, becomes the primary weight bearing structure. This choice is whether we trim the soles perpendicular, or to gradient. On this subject I am biased, having never agreed with the idea that by trimming perpendicular you are stabilizing the toe and that this creates a more normal weight-bearing distribution. My opinion is that when the sole is trimmed perpendicular to ‘stabilize’ the toe, the actual effect is to stabilize the main weight bearing load on to the sole, proper, and I do not believe this is the type of stability that we are seeking.

I would suggest that trimming the soles to normal gradient may result in shifting some of the weight-bearing load away from the sole and toward the abaxial wall. It will not be proven which is best, sole gradient or perpendicular, until this is further researched. In the mean time I will continue to trim soles to normal gradient for all the reasons stated in this article, the most important of which is; it is normal.

I would invite your comments and criticisms, my email address is: laddsiebert@valleytel.net

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