



Bovine Laminitis–Its Clinico-Pathogenesis and Management

Strong Hooves, Sound Herds

Dear Vets,

Dairy industry is continuously striving to improve animal health, welfare, productivity and farm profitability. Among the various health challenges encountered in modern dairy production systems, locomotor disorders remain a major concern due to their direct impact on animal comfort, feed intake, reproductive efficiency and milk production. Hoof health plays a critical role in ensuring optimal performance and longevity of dairy animals.

Bovine laminitis is recognized as one of the most important underlying cause of lameness and claw lesions. Although often overlooked during its early stages, laminitis can substantially reduce productivity through decreased milk yield, impaired reproductive performance and increased treatment costs.

Bovine laminitis is a complex multifactorial disease that develops through interaction of nutritional, metabolic, infectious and managemental factors. The multifactorial nature of laminitis makes it a challenging condition to understand and control.

Effective management depends on a clear understanding of factors involved in disease development, underlying pathological mechanisms and influence of nutrition, housing and herd management practices on hoof health. Greater awareness of these aspects can help Veterinarians and dairy producers adopt more informed strategies to support long-term hoof health and herd productivity.

This issue of Face2Vet provides a comprehensive review of bovine laminitis. We invite you to read this issue and share your valuable feedback/thoughts by scanning the QR code below or by reaching us via email at face2vet@intaspharma.com.

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Introduction

Bovine laminitis is a complex, multifactorial disease characterized by inflammation, vascular dysfunction and degeneration of sensitive claw corium, resulting in defective hoof horn production, claw lesions and subsequent lameness. It is recognized as one of the most important cause of lameness and is associated with substantial economic losses due to reduced milk yield, poor reproductive performance and increased treatment costs. The disease is particularly prevalent in high producing dairy animals, especially during transition period and early lactation when animals experience considerable metabolic and nutritional stress.

Laminitis is generally regarded as a systemic metabolic disorder that manifests locally within the hoof. Various predisposing factors, including ruminal acidosis, endotoxemia, nutritional imbalances, housing conditions and management practices, contribute to the development of disease by disrupting normal blood circulation within the claw. These disturbances result in vascular and structural damage to the corium, leading to impaired horn production and increased susceptibility to claw lesions. The disease may occur in acute, sub-acute, sub-clinical and chronic forms, each differing in severity and clinical presentation.

A thorough understanding of etiology and pathophysiology of bovine laminitis is essential for development of effective prevention, management and treatment strategies. A better understanding of laminitis not only facilitates early diagnosis and effective treatment but also contributes to improved hoof health, enhanced animal welfare and increased productivity and longevity in dairy herds.

Predisposing Factors

Bovine laminitis develops due to combined effects of various predisposing factors, including systemic diseases, nutritional and management factors. These factors interact and disrupt normal blood circulation and horn production within the hoof, contributing to development of laminitis.

Systemic Diseases

- Certain metabolic and infectious diseases (mastitis, metritis, ketosis and retained placenta) trigger the release of inflammatory mediators (histamine and endotoxins) into bloodstream.
- These inflammatory mediators disrupt normal blood circulation and vascular function, particularly within the sensitive tissues of hoof.

Nutritional Factors

The increasing occurrence of laminitis has mainly been attributed to changes in feeding practices.

High Carbohydrate Diet

- Feeding excessive amounts of rapidly fermentable carbohydrates (e.g., grains such as corn, wheat and barley) can cause ruminal acidosis due to accumulation of lactic acid.
- Acidic environment causes lysis of Gram-negative bacteria, resulting in release of endotoxins and histamine.
- These endotoxins and histamine may enter the bloodstream and disrupt microcirculation in hoof, causing inflammation and increasing the risk of laminitis.

High Protein Diet

- Excessive dietary protein intake can lead to increased production of ammonia and other nitrogenous metabolites in rumen.
- These metabolites may exert toxic effects or induce histamine mediated inflammatory responses, contributing to hoof tissue damage and increasing susceptibility to laminitis.

Low Fiber Intake

- Feeding a low-fiber diet with insufficient roughage reduces rumination and saliva production, both of which are essential for maintaining normal rumen pH.
- The resulting low pH (ruminal acidosis) promotes the production and release of endotoxins and histamine, thereby increasing the risk of laminitis.

Mycotoxin Contamination in Feed

- Feeding mycotoxin contaminated feed can disrupt rumen function, reduce feed intake and increase the risk of subacute ruminal acidosis (SARA).
- Mycotoxin induced metabolic stress and systemic inflammation, can compromise the structural integrity of hoof, impair blood flow to hoof tissues and increase the risk of laminitis.

Managemental Factors

Housing Conditions

- Hard concrete floors increase the risk of laminitis, as heifers newly introduced to such surfaces are highly susceptible due to increased mechanical stress and pressure exerted on hooves.
- Poor housing design, including inadequate cubicle dimensions, uncomfortable flooring surfaces and overcrowding, forces animals to stand for longer periods, reduces resting time and increases pressure on claws, thereby predisposing them to laminitis.

Bedding

- Poor quality bedding compromises animal comfort, increases pressure on hooves and consequently increases the risk of laminitis.
- Soft bedding provides a comfortable resting surface, reduces pressure on hooves and promotes even weight distribution, thereby decreasing the risk of laminitis.

Exercise

- Limited or no exercise reduces blood circulation to hooves, impairing nutrient supply and increasing risk of laminitis.
- Excessive movement on hard surfaces causes mechanical stress and damage to hooves, thereby contributing to the laminitis development.
- A proper balance between movement and rest is essential for maintaining hoof health and preventing development of laminitis.

Pathophysiology

- Bovine laminitis is a multifactorial metabolic-vascular disorder triggered by various predisposing factors that act as initiating stimuli. These factors promote the systemic release of vasoactive substances, inflammatory mediators and bacterial endotoxins, which induce endothelial dysfunction and activate inflammatory cascades, resulting in altered vascular tone, endothelial injury and increased vascular reactivity within the hoof (Fig. 1).
- Endothelial injury leads to vasodilation, increased capillary permeability and leakage of plasma proteins, causing edema within the confined lamellar tissues of hoof.
- Simultaneous activation of platelets and coagulation cascade results in formation of microthrombi and capillary obstruction, further reducing tissue perfusion and leading to ischaemia. As the disease progresses, sustained ischaemia and hypoxia impairs the function of keratin producing epidermal cells, resulting in cellular degeneration, necrosis and production of structurally weak horn.
- In chronic cases, prolonged vascular injury may lead to arteriosclerosis, fibrosis and persistent thrombosis, further disrupting the lamellar architecture and promoting hyperkeratosis and parakeratosis.
- These structural alterations weaken the suspensory apparatus of distal phalanx, resulting in sole hemorrhages, hoof deformities and in severe cases, displacement or rotation of distal phalanx.

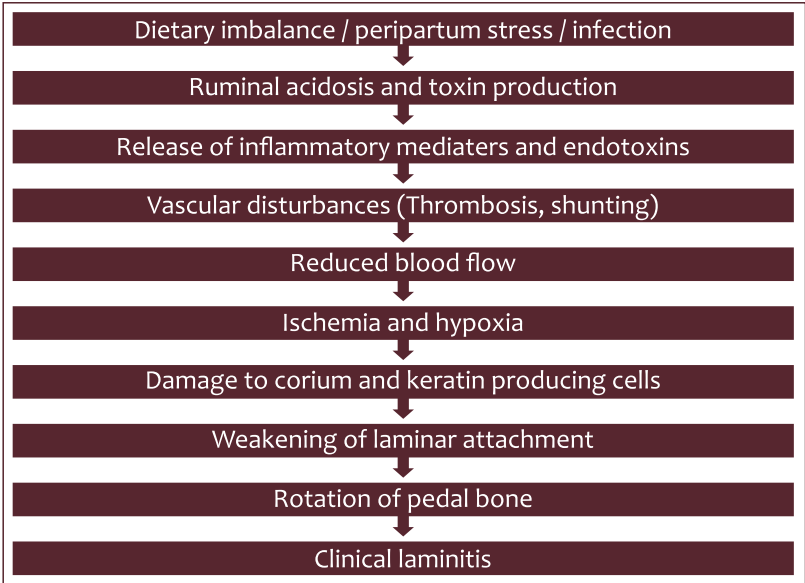
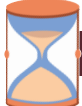


Fig. 1: Pathophysiology of Bovine Laminitis

Types of Laminitis

Laminitis is categorised into acute, sub-acute, sub-clinical and chronic forms based on clinical severity and duration.

	Acute	• Characterized by sudden onset of inflammation within the hoof tissues, with clinical signs typically lasting from few days up to two weeks. • Commonly associated with mastitis, metritis and ruminal acidosis.
	Sub-Acute	• Characterized by mild inflammation of hoof tissues, typically developing over a period of 2 to 6 weeks, often during the transition period around calving. • Clinical signs are mild and may go unnoticed until lameness becomes evident several weeks later.
	Sub-Clinical	• Occurs without obvious clinical signs of lameness and may persist for weeks to months before becoming clinically apparent. • Causes internal hoof tissue damage that predisposes animals to secondary lesions such as sole hemorrhages and white line disease.
	Chronic	• Develops following repeated or unresolved laminitic episodes and may persist for more than 6 to 8 weeks or several months. • Characterized by permanent structural changes in hoof, including abnormal hoof growth, sole ulcers and hoof deformities.

Clinical Signs and Lesions

Acute Laminitis (🚒)

- Acute laminitis is characterized by lameness, stiffness and tender gait.
- Affected animals commonly exhibit arched back posture (Fig. 2b) due to pain.
- Hind limbs and occasionally front limbs are placed well under the body to reduce weight bearing on painful claws.

- The lateral claws of hind limbs and medial claws of fore limbs are more frequently affected than other claws.
- In severe cases, animal may adopt a cross-legged stance of fore limbs and keep the hind limbs wide apart to relieve pressure on affected claws.
- Muscle fasciculations (muscle tremors) may occasionally be observed.
- Animals often experience difficulty in rising and show a preference for remaining recumbent (lying down).
- Profuse sweating, accompanied by increased pulse and respiratory rates, may be observed.
- A reduction in feed intake and milk yield is observed.

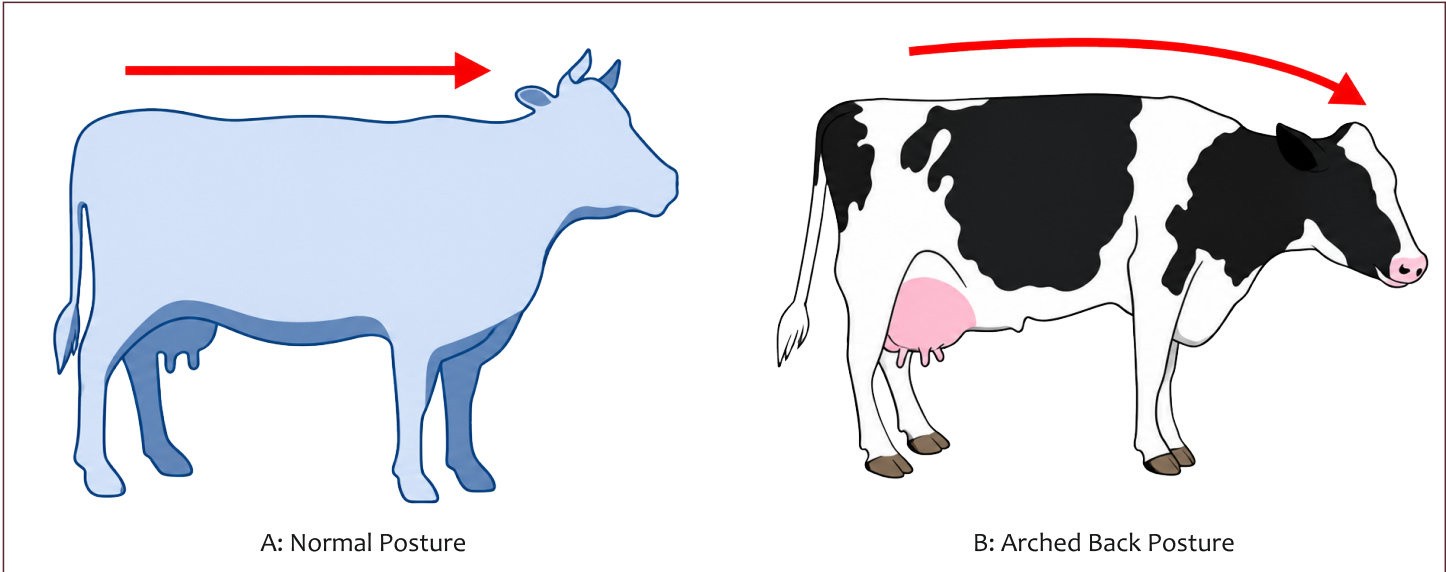


Fig. 2 (a and b): Normal and Laminitic Standing Postures (Rojas *et al.*, 2025)

Sub-Acute Laminitis (🕒)

- This is the most common form of laminitis, particularly around calving.
- Affected animals often show reluctance to move and may exhibit an abnormal gait.
- Frequent shifting of weight from one limb to another is a common clinical sign, reflecting an attempt to reduce pressure on painful claws.

Sub-Clinical Laminitis (🔍)

- Sub-clinical laminitis occurs without obvious clinical signs and is commonly detected during routine claw trimming.
- The condition is characterized by sole hemorrhages (Fig. 3a), yellowish discoloration of sole horn (Fig. 3b), white line separation (Fig. 3c) and heel erosions (Fig. 3d).
- Diagnosis is primarily based on hoof examination and findings observed during claw trimming.
- Absence of dorsal wall ridges (laminitic rings) helps distinguish sub-clinical laminitis from chronic laminitis.
- In advanced cases, separation of horn at abaxial wall may occur, predisposing claw to further damage and secondary infection.

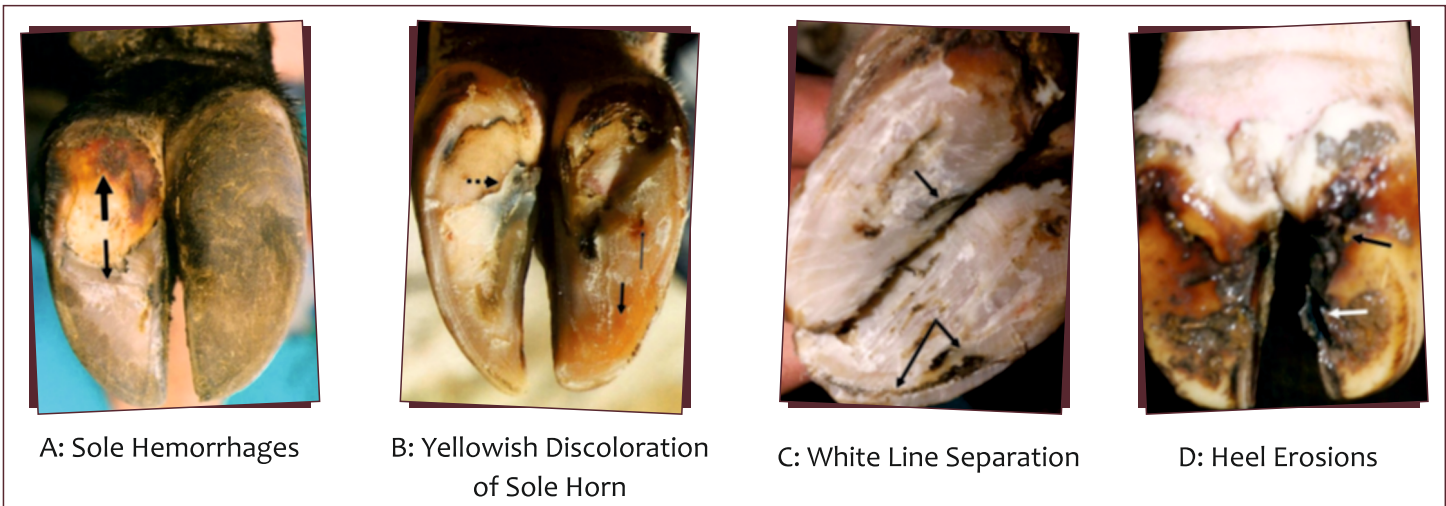


Fig. 3 (a, b, c and d): Lesions of Sub-Clinical Laminitis (Sagliyan and Han, 2010)

Chronic Laminitis (🔴🔴)

- Most prominent feature of chronic laminitis is permanent alteration of claw shape and structure.
- Dorsal claw wall becomes buckled and concave, resulting in a characteristic deformity known as buckled toe (Fig. 4a).
- Sole becomes flattened, broadened and abnormally shaped compared to a healthy claw.
- Lesions are especially prominent in white line zone and at the typical site of sole ulcer formation.
- Sole horn is frequently softer and of poorer quality than normal.
- Chronic laminitis predisposes the claw to white line disease (Fig. 4b) and sole ulceration (Fig. 4c) due to weakening of horn structures.
- Excessive horn growth may occur, resulting in overgrown claws.
- Uneven weight distribution caused by claw deformities further contributes to lameness and development of secondary claw lesions.



Fig. 4 (a, b and c): Lesions of Chronic Laminitis (Kloosterman, 2007)

Diagnosis

- Diagnosis of bovine laminitis is primarily based on clinical examination, evaluation of herd history, feeding practices and observation of locomotion abnormalities.
- Seven gait based indicators for lameness assessment (Fig. 5 and Table 1) are commonly used to assess the severity of condition and monitor its progression over time.
- Careful visual examination of claws may reveal abnormal claw shape, uneven wear patterns and characteristic hoof lesions.
- Palpation of claws and distal limbs may reveal increased hoof temperature, pain on pressure and prominent digital arterial pulsation.
- The use of hoof testers can help identify painful areas and assess sensitivity within the affected claws.
- Functional hoof trimming is an important diagnostic procedure that allows examination of the internal claw structures and identification of lesions associated with laminitis.
- Radiographic examination may be used in chronic or advanced cases to identify structural changes, including rotation or sinking of pedal bone and alterations in claw conformation.

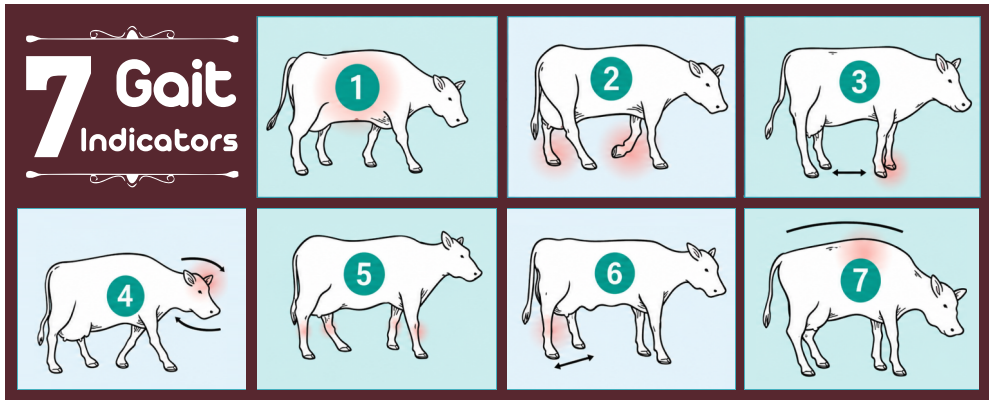


Fig. 5: Seven Point Gait Based Indicators for Lameness Assessment (Macdonald, 2023)

Table 1: Clinical Characteristics Associated with Seven Point Gait Based Indicators

Score	Locomotor Signs	Description
1	Reluctance to bear weight	Cows shift body weight away from a painful limb, resulting in an uneven gait and limping.
2	Asymmetrical/ Irregular stepping	Affected cows exhibit an irregular stride pattern due to reduced weight bearing on a painful limb.
3	Poor tracking	Rear feet fail to follow the tracks of front feet because of shortened strides.
4	Jerky head movement	Cows move their heads abruptly while walking to reduce weight bearing on painful limbs.
5	Joint stiffness	Limb and back movements become less flexible, resulting in a stiff gait.
6	Rear leg lateral movement	Hind limbs move outward in a semicircular motion to avoid flexion and pressure on painful claws.
7	Arched back	An upward arch of back is commonly observed in lame cows due to pain and discomfort.

Treatment

The primary objectives of treating bovine laminitis are to relieve pain and inflammation, restore normal hoof circulation, eliminate or correct the underlying predisposing factors and prevent the development of chronic claw lesions.

Pain Relief and Anti-inflammatory Therapy

Laminitis is an inflammatory condition of sensitive laminae of hoof, characterized by vascular dysfunction, pain, abnormal weight bearing and impaired locomotion. The condition is associated with the release of inflammatory mediators, which promote edema, tissue damage and sensitization of pain receptors within the hoof. Non-steroidal anti-inflammatory drugs (NSAIDs) are commonly used to manage laminitis by reducing pain and inflammation within the hoof.

Use of Tolfenamic Acid in Bovine Laminitis

- Tolfenamic acid exerts its therapeutic effect through inhibition of cyclooxygenase 2 (COX-2) and 5 lipoxygenase (5-LOX) enzymes, thereby preventing the conversion of arachidonic acid into pro-inflammatory prostaglandins, thromboxanes and leukotrienes. This suppression of the inflammatory cascade reduces the progression of laminar inflammation and tissue injury.
- By reducing the synthesis of prostaglandin E₂ (PGE₂), a key mediator of pain and inflammation, tolfenamic acid decreases vasodilation, edema and hypersensitivity within the laminar tissues.
- Tolfenamic acid provides significant analgesic activity by reducing peripheral sensitization of nociceptors and increasing the pain threshold.
- Reduction of pain promotes the weight distribution across the claws, minimizing compensatory postural changes and improving locomotion.
- Inj. Tolfenamic Acid (**Inj. Maxxtol**) can be administered @ 4 mg/kg body weight via IM/IV route as single dose, to reduce laminar inflammation and pain, improve weight bearing and locomotion and facilitate early recovery.
- **Maxxtol bolus** can be administered orally @ 2 boluses daily as follow-up therapy.
- Inj. Meloxicam (**Inj. Melonex XP**) can be administered @ 1 ml/100 kg body weight via IM/IV/ SC route.



- Topical analgesic spray (**Maxxtol QPR Spray**, containing tolfenamic acid, methyl salicylate, menthol, cinnamon oil and linseed oil) may be used as an adjunctive therapy to alleviate pain and support recovery in animal with painful claw lesions associated with laminitis. Tolfenamic acid reduces laminar inflammation and pain by inhibiting COX-2 and 5-LOX enzymes. Methyl salicylate provides local anti-inflammatory and mild analgesic effects, helping to relieve hoof discomfort. Menthol produces a cooling sensation that soothes pain and improves local comfort. Cinnamole oil helps reduce muscle stiffness and promotes better mobility. Linseed oil enhances the penetration and absorption of active ingredients.
- Application of topical analgesic gel (**Maxxtol Top Gel**) 2-3 times daily may help reduce local inflammation and provide pain relief.

Antihistamine Therapy

- Antihistamine (**Inj. Anistamin** @ 5-10 ml administered via IM route) may be beneficial when given during the early stage of laminitis.
- These drugs help counteract the effects of inflammatory mediators, thereby reducing vascular disturbances, minimizing tissue damage and supporting recovery of affected hoof tissues.

Use of Buffers

Use of dietary buffers (**Bufzone** can be supplemented @ 200 g daily for 3-4 days orally) helps maintain normal rumen pH, thereby promoting rumen health and facilitating early recovery from laminitis.

Supportive Therapy

- The immediate correction of the underlying cause is essential for successful treatment. Conditions such as grain overload, ruminal acidosis, endotoxemia, or nutritional imbalances should be identified and managed promptly to prevent further damage to hoof tissues.
- Cold therapy (cooling of claws and distal limbs) is recommended, particularly during the acute phase, as it helps reduce inflammation, pain, edema and tissue damage within the hoof.
- Provision of comfortable housing with soft bedding (e.g., sand, straw or rubber flooring) helps reduce pressure on affected claws, improves animal comfort and minimizes further hoof injury.

Prevention and control

- Laminitis is a multifactorial disease; therefore, proper management of nutrition, housing, hoof care and animal comfort is essential to reduce its incidence.
- Provide adequate fiber in diet to stimulate chewing, saliva production and rumination, which helps maintain normal ruminal pH and reduces the risk of ruminal acidosis.
- Introduce highconcentrate diets gradually, especially during the transition period and early lactation, to allow proper adaptation of rumen microflora.
- Avoid sudden dietary changes from forage based diets to concentrate rich diets.
- Minimize prolonged exposure to hard concrete surfaces and provide an adequate adaptation period when animals are moved from pasture systems to concrete flooring.
- Use rubber mats or rubber covered walkways to reduce claw trauma and lower the risk of laminitis.
- Provide soft, dry and comfortable bedding to encourage lying behaviour and reduce pressure on claws.
- Reduce prolonged standing, minimize waiting times before milking and avoid excessive walking distances between feeding, resting and milking areas.
- Implement routine preventive hoof trimming to maintain proper claw balance and hoof health.
- Early detection and treatment of claw lesions help prevent the development of severe laminitis.
- Regular locomotion scoring helps identify affected animals before clinical lameness becomes severe.



Conclusion

Bovine laminitis is a multifactorial disease. The high grain feeding, inadequate fiber diet, ruminal acidosis, endotoxemia, systemic diseases, prolonged standing on hard concrete floors and poor housing conditions are among the major predisposing factors contributing to its development. These factors promote the release of inflammatory mediators and endotoxins, leading to vascular disturbances, edema, impaired blood flow, ischemia and progressive damage to hoof. Laminitis may occur in acute, sub-acute, sub-clinical and chronic forms. Treatment of bovine laminitis primarily focuses on relieving pain and inflammation through the use of NSAIDs such as tolfenamic acid and meloxicam. Tolfenamic acid exerts its effect by inhibiting COX 2 and 5-LOX enzymes and suppressing prostaglandin and Leukotrienes synthesis, thereby reducing laminar inflammation and pain. Supportive measures, including topical analgesic sprays, cold therapy, correction of underlying causes and dietary buffer supplementation to maintain normal rumen pH and promote early recovery. Prevention remains the most effective strategy and relies on balanced carbohydrate feeding, adequate fiber intake, gradual introduction of concentrate diets, comfortable bedding, rubber covered flooring, reduced waiting times before milking, routine hoof trimming and regular lameness monitoring play a crucial role in maintaining hoof health and preventing laminitis.

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