

**Lameness: Its Role in the Productivity of Farm Animals and Its Management**

Amna Shakoor<sup>1</sup>, Tehreem Rana<sup>2</sup>, Furqan Munir<sup>3\*</sup>, Zia ud Din Sindhu<sup>3</sup>

<sup>1</sup>Department of Anatomy, Faculty of Veterinary Science, University of Agriculture, Faisalabad

<sup>2</sup>Institute of Microbiology, Faculty of Veterinary Science, University of Agriculture, Faisalabad

<sup>3</sup>Department of Parasitology, Faculty of Veterinary Science, University of Agriculture, Faisalabad

\*Corresponding Author: [vetfurqan@gmail.com](mailto:vetfurqan@gmail.com)

**ABSTRACT**

Ruminants are the source of income for resource-poor people in developing countries. Lameness affects the production of farm animals including decreased milk and meat production, delayed estrus and conception, and other indirect problems. It is characterized by abnormal gait or posture of animals and pain. Therefore, the timely diagnosis and management of this disease are crucial to ensure the maximum production of animals. Mostly the foot of the hind limb is affected by this issue. Laminitis, abscess of the white line, metabolic acidosis, or double sole could lead to lameness. The visual gait scoring and examination of the foot are necessary to approach the clinical diagnosis of the disease. The purpose of this article is to highlight the problem of lameness that decreases the productivity of dairy animals, the anatomical structures of the bovine hoof, its pathology, and managerial practices.

**Introduction**

In rural areas, cows and buffalo are the main source of economy for resource-poor people. Livestock has a share of 60% in agriculture and 11.53% in the gross domestic product (GDP) of Pakistan [1]. Therefore, the health and optimum production of animals is very crucial to maintaining the livelihood of people living in developing countries. The economy of the farm and the welfare of cattle is affected by lameness which is associated with a decrease in production, pain, and discomfort. Some studies indicated that lameness is also responsible for delayed estrus and conception of animals, and other indirect losses [2]. In dairy cattle, most cases of lameness occur due to the presence of subclinical laminitis of the hoof instead of trauma. Double sole and white line abscesses slowly develop and lead to lameness which further disrupts the locomotion of animals and is diagnosed as a clinical case. The consumption of highly fermentable carbohydrates led to metabolic acidosis that results in the secretion of vasoactive molecules and ultimately blood flow decreased to hoof. Studies showed that this could disrupt the germinal epithelial cells for the formation of a new wall of the hoof and sole. Early detection could be beneficial to limit production losses. In dairy cattle, the production includes milk and calf, both are affected by subclinical diseases. Correct posture and normal locomotion of the cow could be useful for the early detection of the disease. About 90% of cases of lameness involve the foot (mostly the hind limb). Visual lameness scoring, examination of the foot, pedometer, infrared thermography, and accelerometer could be employed to detect the defect. Proper managerial practices decrease the chances of occurrence of disease and analgesia could be used for the management of pain [3].

**Anatomical Structure of Bovine Hoof**

The bovine hoof is made up of bones, joints, ligaments, tendons, hoof wall, and the outer protective Corium (refer to Figure 1). It has three digits and two sesamoid bones namely the proximal phalanx, middle phalanx, distal phalanx, and proximal and distal sesamoid bones. There is also a supporting structure present under the distal phalanx, a shock absorber digital cushion on the posterior side of the hoof. It also has three joints viz the metacarpophalangeal joint between the metatarsus and proximal phalanx, the proximal interdigital joint between the proximal and middle phalanx, and the distal interdigital joint between the middle and distal phalanx. The lateral digital extensor tendon, common digital extensor tendon, and deep digital flexor tendon attach to the middle phalanx, distal interdigital ligament, and sesamoid ligament. Each side of the superficial digital flexor tendon covers its correspondent deep digital flexor tendon and forms a structure called manica flexoria. The insertion point of the flexor and extensor muscles is 1 cm below the distal interphalangeal joint [4].

The anatomical features of the hoof from the dorsal aspect are the hoof periphery, hoof coronal, and hoof wall and from the palmar aspect is the hoof sole and hoof sphere. The hoof periphery is made of soft white epithelium and separates the glabrous and pileous skin. The hoof coronal is softer and darker than the hoof periphery and has coronary tori, a groove that separates the hoof periphery and coronal. The hardest anterior part from the dorsal aspect is the hoof wall, made of an enamel layer, and has axial and abaxial sides. At the planter aspect, there is a hoof sole, and a white line separates the hoof wall and sole. The hoof sphere is torus-shaped at the posterior side of the hoof. There are three major arteries of the bovine forelimb namely palmer common digital artery III, abaxial palmar digital

artery III, and IV. Palmer digital common artery III is the extension of arteria mediana and is further divided into two branches digital arteries II and IV, which supplies the interphalangeal joint at the posterior end of the proximal phalanx. The palmer common digital artery is further divided into two branches arteriae Palmares propriae III and IV, supplies the pars axialis. Digital arteries II and IV form the network of vessels in the hoof sphere where it unites with the abaxial palmar digital artery III and IV and with the branches of arteriae Palmares propriae III and IV [5].



**Pathological Changes**

Many factors can affect the healthy cattle hoof and lead to laminitis and different hoof-related infection. The main pathological issue of the hoof is laminitis, which can be clinical and subclinical laminitis depending on the extent of the infection. Laminitis makes the animal walk with unease, staggering gait and bowed back. In subacute and chronic cases, the signs are less severe than the acute cases. Severe laminitis tends to be in the ulceration form and necrosis. Moreover, white zone lesions are also observed in laminitis pathology. In acute cases, the signs and symptoms of hemorrhages, edema, hyperemia, and pigmentation are observed. Inflammatory responses have been observed in the hoof of animals suffering from laminitis and other welfare problems related to dairy cattle hoofs. Inflammation is considered the landmark sign of hoof laminitis, the most prominent and easy to diagnose. Sole ulcers if developed lead to long-lasting chronic inflammatory responses in the dairy cattle hoof [6]. Different microscopic and macroscopic lesions have been observed in the hoof regarding pathology. Degenerative changes in the hoof tend towards laminitis by changing its anatomy. Hyper and parakeratosis are one of the main signs observed in the lamellae epidermal. Different environmental conditions lean towards the diseases like sole ulcers, white line disease, and digital dermatitis. The hoof structure has different bones and muscles that are affected by the compression and weaken the collagen layers of the hoof. Animals with damaged locomotor systems survive with pain, inflammation, and swollen and damaged tissues, which ultimately affect the circulation of the hoof and hemostasis happens [7]. Considering the pathology of the healthy hoof, the main concern is different sole and hoof infections, that can affect its normal anatomy and physiology for proper functioning. Bacterial infections are the major concern for hoof laminitis. Digital dermatitis is another pathological disorder that is a contagious bacterial infection causing laminitis. The lame cow is examined with different body parameters including the rectal temperature that is

observed in a higher range and ultimately affects the efficiency of an animal. Other parameters show that they have a high serum cortisol level which is an indicator of inflammation and is also in the higher range [8]. Diseases like sole ulcers, dermatitis, and white line diseases altered the normal gait of cattle but it is mostly affected in the case of sole ulcers. We can conclude that sole ulcer is one of the most painful lesions than other hoof anomalies. As it is obvious that there is a consistent release of cytokines like IL-6 that are the major factors in the initiation of pain and other pathological factors.

### Management of Hoof Health

The methods to conserve hoof health requires maintaining an aseptic environment, timely hoof trimming, arrangement of foot dips, regular thorough checkups, preventing the herds from metabolic insults, reducing corium pressures, and arrangements to balance the temperature alterations. Providing the animals a diet with a balanced ratio of proteins, vitamins including vitamin A,  $\beta$ -carotene involved in the growth and repair of the digital cushion and epithelial layer of the corium, and minerals such as copper being responsible for the production of a healthy claw horn, gradual switching of animals from low fiber to high metabolic content, ensuring the lie down resting period of dairy cows for at least 10-14 hours a day, avoiding overcrowding and providing a good stall space are some of the major factors to conserve the hoof health of the herd [9].

### Conclusion

This article demonstrates the causes, structure, and circulation of the bovine foot, pathology, and managerial approaches to cure lameness. Rural people keep about 5-6 animals per family in the subcontinent and rely on the economy generated by the production of milk and calves. Therefore, the health of animals is necessary. When blood circulation to the foot of animals becomes decreased due to metabolic acidosis, the problem of laminitis begins. It is due to the not proper formation of a new wall of the hoof which ultimately exposes the foot to disease-causing microbes.

### References

- [1] Pakistan Economy Survey, 2020-21. Ministry of Finance, Government of Pakistan; 2021.
- [2] Coetzee JF, Chp C, Shearer JK. An Update on the Assessment and Management of Pain Associated with Lameness in Cattle. *Vet Clinics Food Animal*; 2017. 33, 389-411. <https://doi.org/10.1016/j.cvfa.2017.02.009>
- [3] Shearer JK, Stock ML, Amstel SR. Assessment and Management of Pain Associated with Lameness in Cattle. *Veterinary Clinics Food Animal*; 2013. 29, 135-156. <https://doi.org/10.1016/j.cvfa.2012.11.012>
- [4] Abdellatif AM. Normal magnetic resonance anatomy of the hind foot of Egyptian buffalo Normal magnetic resonance anatomy of the hind foot of Egyptian buffalo (*Bubalus bubalis*): A correlative low-field T1 - and T2 - weighted MRI and sectional anatomy atlas. *Anatomia, Histologia, Embryologia*; 2018. 9, 1-10. <https://doi.org/10.1111/ahc.12402>
- [5] Yang X, Ren X, Yu S, Cui Y. Morphological study of the hoof in yalk. *Via Medici*; 2016. 75(3), 400-408. <https://doi.org/10.5603/FM.a2015.0132>
- [6] Pirkkalainen H, Talvio I, Kujala-Wirth M, Soveri T, Orro T. Acute phase response of sole ulcer, white line disease and digital dermatitis in dairy cows. *Veterinary and Animal Science*; 2022. 17, 100253.
- [7] Tothov C, Nagy O, Seidel H, Paulíkov I, Kov G. The influence of hoof diseases on the concentrations of some acute phase proteins and other variables of the protein profile in heifers. *Acta Veterinaria*; 2011. 61, 141-150. <https://doi.org/10.2298/AVB1103141T>
- [8] Kontturi M, Junni R, Kujala-Wirth M, Malinen E, Seuna E, Pelkonen S, Soveri T, Simojoki H. Acute phase response and clinical manifestation in outbreaks of interdigital phlegmon in dairy herds. *Comparative Immunology, Microbiology and Infectious Diseases*; 2020. 68, Article 101375. <https://doi.org/10.1016/j.cimid.2019.101375>
- [9] Sadiq B, Ramanoon M, Shaik Mossadeq SZ, Mansor WM, Syed-Hussain SS. Association between Lameness and Indicators of Dairy Cow Welfare Based on Locomotion Scoring, Body and Hock Condition, Leg Hygiene and Lying Behavior. *Animals: An Open Access Journal from MDPI*; 2017. 7(11). <https://doi.org/10.3390/ani7110079>