Beef Cattle Metatarsal Growth Plate Lesions

Subjects: Agriculture, Dairy & Animal Science

Contributor: Giorgia Fabbri

Young beef bulls are predisposed to develop diseases of the growing skeleton, especially growth plate lesions. These lesions jeopardize both welfare and production, often leading to anticipated culling and reduced weight gain. However, beef cattle are prey animals and do not exhibit signs of pain and lameness until the disease becomes extensive and severe. Fast methods to screen for growth plate lesions' presence could lead to prompt treatment of the affected animals, enhancing recovery and diminishing losses.

beef cattle growth plate lesions infrared thermography physitis

1. Introduction

Lameness is a major problem affecting cattle, it has a significant impact on health and welfare, and has been proven to cause about 16% of the health problems of feedlot cattle [1]. Lameness also leads to a range of production losses [2], often resulting in earlier culling of animals and decreasing the economic value of carcasses. It reduces the time animals spend feeding and leads to lower carcass weight, conformation class, and fat cover class [2][3][4].

Young beef bulls selected for rapid weight gain are particularly susceptible to developing lesions in the growing skeleton, particularly physeal (growth plate) lesions such as physitis [5][6][7]. Physitis is characterized by inflammation of the growth plates and mostly has a multifactorial origin, such as feed pushing for rapid growth, direct trauma to the ossification centers, infection, nutritional imbalances, and housing on slatted floors [8][9][10][11][12]. A critical aspect when dealing with lameness is early detection and diagnosis. Detecting lameness efficiently allows for early intervention, enhancing recovery chances, and minimizing losses. Thus, early diagnosis of physitis cases allows for better farm management decision-making processes [13][14]. Physitis can represent a confusing picture with significant lameness and often moderate swelling and pain [12][15][16], and when dealing with growth plate lesions, ruling out other causes for lameness such as arthritis and claw affections is important [3].

Radiography (associated with clinical examination) is generally the most used method to identify and confirm growth plate lesions [6][7][12][17][18]. However, the disadvantages associated with radiographic imaging remain important. Besides the well-known issues related to X-ray emissions, costly equipment can represent a limitation for many freelance professionals. The use of radiography, although highly reliable, is both logistically and economically challenging on a large scale and at pen level when dealing with beef animals.

Among the innovative techniques in diagnostic imaging, infrared thermography (IRT) is experiencing a spike of interest amidst practitioners both in human and veterinary medicine [19]. The perks of IRT are that it is low cost, fast and efficient [20]. Moreover, thermal images can be taken at a distance from the subject, avoiding issues associated with capture and confinement [21]. Infrared thermography (IRT) is a non-invasive, quantitative assessment of temperature, producing a pictorial representation of the surface temperature of an object. The color gradient reflects differences in emitted heat [20][21][22]. Numerous studies in animal sciences have been conducted using thermography as a tool to obtain thermal responses in a rapid and non-invasive manner [23][24]. IRT permits the detection of even small changes in temperature with precision [25], and as heat is a cardinal sign of inflammation, caused by an increase in circulation and tissue metabolism [26], this technique has been used both on humans and animals to detect local inflammation due to disease conditions and injury [19].

2. Current Insights

The present study represents a pilot investigation in screening for beef bull’s growth plate lesions using IRT diagnostic imaging. IRT images from 20 animals radiographically diagnosed with a metatarsal growth plate lesion on one of their hindlimbs were analyzed for temperature differences between the affected and healthy limbs.

IRT was proven useful in detecting changes in blood flow and localized inflammatory conditions [19][27]. Growth plate lesions, such as physitis, are a common issue of young beef bulls, especially those selected for rapid weight gain [5][6][7]. Physitis is characterized by inflammation of the growth plate, and it affects mainly the immature long bones of both fore and hindlimbs [8][16]. As the intensity of infrared radiation emitted by the skin was proven to be directly proportional to the metabolic processes occurring in related surfaces and is associated with a simultaneous increase in blood supply to a given area [28], the inflammatory condition that characterizes growth plate areas during physitis would result in an increase in blood flow, and therefore emitted heat. The presence of growth plate lesions was found to be associated with a significant increase in skin temperatures both for AR01-N against AR01-A, and for AR02-N against AR02-A. Significative differences were found for maximum, mean, and minimum temperatures in AR01, and for mean and maximum temperatures in AR02. Moreover, the affected limbs showed a higher mean when compared to the healthy ones for the parameters with significative *p*-values.

When assessing temperature differences between areas, the most reliable factors in the present study were the maximum and mean temperatures. These parameters showed differences in both AR01 and AR02 areas. When examining the AR02 area, the mean temperature showed significant *p*-values ($p < 0.0001$) when used to screen for growth plate lesions. Maximum temperature, although having a lower *p*-value than mean temperature, was significant ($p < 0.005$) too. Minimum temperature, however, was found to be significant only when examining the lesion area (AR01) specifically, and not the whole metatarsus area (AR02).

The inflammatory process that characterizes physitis is mainly localized to the area corresponding to the growth plate, thus AR01. It is possible that when the limb is screened broadly (area AR02), echoes of the inflammation can determine an elevation in maximum and mean temperatures. The infrared radiation emitted by the lesion area will be higher than the healthy one because of the inflammatory process, and will therefore be registered by IRT, thus influencing maximum and mean temperatures. However, the minimum temperature will be the similar to the one emitted by the healthy limb, because the baseline is not affected. It is therefore observable how minimum temperature is a parameter that is less subjected to variation caused by an inflammatory status than the other two. Moreover, when dealing with minimum temperatures, there could be other confounding factors present on the limb that are not presently being taken into account, such as the presence of dirt or manure on the limb, which could create areas of reduced minimum temperature. However, such different outcomes for the various considered parameters could be of interest in future studies to see whether an interaction between the three parameters (Tmax, Tmean, and Tmin) could be capable of predicting with even higher reliability whether a limb is subjected to localized inflammation due to growth plate lesions.

The capability of IRT in distinguishing between healthy limbs and diseased ones was not diminished by the lack of intervention on the animals, such as the necessity to clean the limbs prior to investigation. In other studies, cleaning of the limbs was suspected to be necessary because of the influence of dirt on the reliability of thermography by affecting the surface's ability to radiate absorbed energy (emissivity) and to conduct heat (conductivity) [21]. However, in the present study, differences between the affected and healthy limbs could be detected in an on-farm setting without the need to restrain the animals that were free in their boxes, and without cleaning the examined limbs before IRT imaging, thus indicating IRT as a reliable and fast on-field method.

Currently, the recognized standard measure to assess lameness in cattle is locomotion scoring [29]. However, routinely locomotion scoring an entire herd is both lengthy and an inherently subjective process [21][29][30][31]. Moreover, this technique requires the regular observation of the animals, which is both logistically and economically challenging in practice. An automated IRT imaging system, placed in an area of the barn with a high daily influx of animals (e.g., near drinking troughs/feeders) and connected to a remote ear tag detection system, could represent an aiding tool for the detection of locomotory apparatus diseases in the herd. The development of a computerized system screening bovine limbs on a regular basis could represent an innovative approach for detecting lameness problems. This automatic detection system could signal animals that are developing pathologies of the musculoskeletal system, allowing for rapid intervention for closer inspection and treatment.

However, one of the limits of IRT is in distinguishing between different lesion etiologies such as aseptic epiphysitis [6][7] and septic osteitis and osteomyelitis [8][14], and lesion severity. IRT was seen effective as a detection tool for unspecified lesions, but its potential as a diagnostic test has yet to be proven. The surface skin temperature is likely to vary with the stage and severity of disease, and with different types of disease, a subject that warrants further investigation. Future research following the development of lesion cases longitudinally may establish temperature thresholds for early treatment interventions, and IRT could be used also to quantify treatment effectiveness, following recovery and recurrence.

References

1. Griffin, D.; Perino, L.; Hudson, D. Feedlot lameness. In Neb-Guide; University of Nebraska-Lincoln: Lincoln, NE, USA, 1993.
2. Huxley, J.N. Impact of lameness and claw lesions in cows on health and production. Livest. Sci. 2013, 156, 64–70.
3. Fjeldaas, T.; Nafstad, O.; Fredriksen, B.; Ringdal, G.; Sogstad, A.M. Claw and limb disorders in 12 Norwegian beef-cow herds. Acta Vet. Scand. 2007, 49, 24–35.
4. Bicalho, R.C.; Machado, V.S.; Caixeta, L.S. Lameness in dairy cattle: A debilitating disease or a disease of debilitated cattle? A cross-sectional study of lameness prevalence and thickness of the digital cushion. J. Dairy Sci. 2009, 92, 3175–3184.
5. Levi, M.; Dittmer, K.E.; Gentile, A.; Beltrame, A.; Bolcato, M.; Morgante, M.; Fiore, E.; Benazzi, C. Growth plate lesions of fattening bulls. Vet. Pathol. 2017, 54, 437–444.
6. Bernath, C.; Nuss, K.; Dennler, M.; Counotte, M.; Geyer, H.; Devaux, D. Prevalence of metatarsal growth plate lesions in Swiss fattening bulls. Schweiz. Arch. Tierheilkd. 2021, 163, 709–720.
7. Steiner, S.; Gelfert, C.C.; Kofler, J. Herd problem ‘epiphysitis’ in fattening bulls—A case report . Klauentierpraxis 2009, 17, 48–55.
8. Barneveld, A. Cancellous bone grafting in the treatment of bovine septic physitis. Vet. Q. 1994, 16, 104–107.
9. Fiore, E.; Levi, M.; Gianesella, M.; Benazzi, C.; Morgante, M.; Beltrame, A.; Vaccaro, C.; Gentile, A. Epiphysitis in fattening bulls: Radiological and pathologic findings. Large Anim. Rev. 2016, 22, 43–45.
10. Houlihan, M.G.; Veenstra, B.; Christian, M.K.; Nicholas, R.; Ayling, R. Mastitis and arthritis in two dairy herds caused by Mycoplasma bovis. Vet. Rec. 2007, 160, 126–127.
11. Davies, I.H.; Munro, R. Osteochondrosis in bull beef cattle following lack of dietary mineral and vitamin supplementation. Vet. Rec. 1999, 145, 232–233.
12. Rizk, A.; El-Shafaey, E. Clinical and radiographic evaluation of distal cannon bone physitis in cattle. J. Anim. Vet. Adv. 2015, 14, 205–210.
13. Fiore, E.; Perillo, L.; Marchesini, G.; Piccione, G.; Giudice, E.; Zumbo, A.; Armato, L.; Fabbri, G.; Gianesella, M. Effect of parity on claw horn lesions in Holstein dairy cows: Clinical and radiological study. Ann. Anim. Sci. 2019, 19, 147–158.
14. Verschooten, F.; Vermeiren, D.; Devriese, L. Bone infection in the bovine appendicular skeleton: A clinical, radiographic, and experimental study. Vet. Radiol. Ultrasound. 2000, 41, 250–260.
15. Enting, H.; Kooij, D.; Dijkhuizen, A.A.; Huirne, R.B.M.; Noordhuizen-Stassen, E.N. Economic losses due to clinical lameness in dairy cattle. Livest. Prod. Sci. 1997, 49, 259–267.

16. Dutra, F.; Carlsten, J.; Ekman, S. Hind limb skeletal lesions in 12-month-old bulls of beef breeds. J. Vet. Med. Ser. A 1999, 46, 489–508.
17. Trostle, S.S.; Nicoll, R.G.; Forrest, L.J.; Markel, M.D. Clinical and radiographic findings, treatment, and outcome in cattle with osteochondrosis: 29 cases (1986–1996). J. Am. Vet. Med. Assoc. 1997, 211, 1566–1570.
18. Tryon, K.A.; Farrow, C.S. Osteochondrosis in cattle. Vet. Clin. N. Am. Food Anim. Pract. 1999, 15, 265–274.
19. Schaefer, A.L.; Cook, N.; Tessaro, S.V.; Deregt, D.; Desroches, G.; Dubeski, P.L.; Tong, A.; Godson, D.L. Early detection and prediction of infection using infrared thermography. Can. J. Anim. Sci. 2004, 84, 73–80.
20. McManus, C.; Tanure, C.B.; Peripolli, V.; Seixas, L.; Fischer, V.; Gabbi, A.M.; Menegassi, S.R.O.; Stumpf, M.T.; Kolling, G.J.; Dias, E.; et al. Infrared thermography in animal production: An overview. Comput. Electron. Agric. 2016, 123, 10–16.
21. Stokes, J.E.; Leach, K.A.; Main, D.C.; Whay, H.R. An investigation into the use of infrared thermography (IRT) as a rapid diagnostic tool for foot lesions in dairy cattle. Vet. J. 2012, 193, 674–678.
22. Turner, T.A.; Purohit, R.C.; Fessler, J.F. Thermography: A review in equine medicine. J. Equine Vet. Sci. 1986, 5, 8–10.
23. Phillips, P.K.; Heath, J.E. An infrared thermographic study of surface temperature in the euthermic woodchuckz (Marmota monax). Comp. Biochem. Physiol. 2001, 129, 557–562.
24. Fabbri, G.; Fiore, E.; Piccione, G.; Giudice, E.; Gianesella, M.; Morgante, M.; Armato, L.; Bonato, O.; Giambelluca, S.; Arfuso, F. Detection of digital and interdigital dermatitis in holstein friesian dairy cows by means of infrared thermography. Large Anim. Rev. 2020, 26, 113–116.
25. Bowers, S.; Gandy, S.; Anderson, B.; Ryan, P.; Willard, S. Assessment of pregnancy in the late-gestation mare using digital infrared thermography. Theriogenology 2009, 72, 372–377.
26. Head, M.J.; Dyson, S. Talking the temperature of equine thermography. Vet. J. 2001, 162, 166–167.
27. Heath, A.M.; Carson, R.L.; Purohit, R.C.; Sartin, E.M.; Wenzel, J.G.W.; Wolfe, D.F. Effects of testicular biopsy in clinically normal bulls. J. Am. Vet. Med. Assoc. 2001, 220, 507–512.
28. Fita, K.; Dobrzyński, M.; Całkosiński, I.; Dudek, K.; Bader-Orłowska, D. The usefulness of the thermography in medical-dental diagnostic—The author’s experiences. Ann. Acad. Med. Stetin. 2007, 53, 34–38.
29. Whay, H.R. Locomotion scoring and lameness detection in dairy cattle. Practice 2002, 24, 444–449.

30. Gianesella, M.; Arfuso, F.; Fiore, E.; Giambelluca, S.; Giudice, E.; Armato, L.; Piccione, G. Infrared thermography as a rapid and non-invasive diagnostic tool to detect inflammatory foot diseases in dairy cows. Polish J. Vet. Sci. 2018, 21, 299–305.
31. Telezhenko, E.; Bergsten, C. Influence of floor type on the locomotion of dairy cows. Appl. Anim. Behav. Sci. 2005, 93, 183–197.