

Epidermolysis bullosa dystrophica in a goat kid

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Epidermolysis bullosa dystrophica bei einem Zicklein

In einer Milchherde aus Thüringer Waldziegen wurden bei einem etwa drei Wochen alten Bocklamm Hautläsionen festgestellt, insbesondere an den distalen Gliedmassen, dem Thorax und den Ohren. Diese Hautläsionen waren durch Alopezie, eitrige Blasen, Krustenbildung und Erosionen gekennzeichnet. Das Bocklamm wurde zur Behandlung an die Klinik überwiesen, musste jedoch trotz intensiver Behandlung aufgrund einer zunehmenden Verschlechterung des Allgemeinzustands euthanasiert werden. Die anschließende pathohistologische Untersuchung der veränderten Haut- und Schleimhautbereiche ergab eine Ablösung des Epithels von der darunterliegenden Dermis und/oder *Lamina propria* auf der Ebene unterhalb der Basalmembran. Die Transmissionselektronenmikroskopie bestätigte die Lokalisation der subepidermalen Spaltbildung, was zur Diagnose einer Epidermolysis bullosa dystrophica (EBD) führte. EBD ist eine sowohl beim Menschen als auch bei verschiedenen Haus- und Nutztierarten bekannte Erkrankung, deren Ursache bei einigen dieser Arten bis auf molekular-genetischer Ebene aufgeklärt wurde. Bei Ziegen gab es bislang jedoch keine genetischen Untersuchungen zur Epidermolysis bullosa dystrophica, was den nächsten Schritt der Analyse im hier beschriebenen Fall darstellen wird.

Schlüsselwörter: Hauterkrankung, genetischer Defekt, Ziege, Thüringer Waldziege

Summary

In a dairy herd of Thuringian Forest goats, a male goat kid of around three weeks of age was detected with skin lesions, particularly on the distal limbs, chest and ears. These skin lesions were characterized by alopecia, pus-filled blisters, incrustations and erosions. The goat kid was referred to the clinic for treatment but had to be euthanized despite intensive treatment due to increasing deterioration in its general condition and was subsequently referred to necropsy. Histologic investigation of the altered areas of skin and mucosa revealed a separation of epithelium from the underlying dermis and/or *lamina propria* at the level below the basement membrane. Transmission electron microscopy confirmed the localization of the subepidermal cleft formation, leading to the diagnosis of epidermolysis bullosa dystrophica (EBD). EBD is a well-known disease in humans as well as in various domestic and farm animal species, and the cause has been elucidated up to the molecular genetic level in some of these. In goats, however, there has been no genetic investigation in epidermolysis bullosa dystrophica so far, which will be the next step of the analysis in the here described case.

Keywords: dermatological disease, genetic defect, goat, Thuringian Forest goat

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Epidermolysis bullosa dystrophica in a goat kid

N. Ossowski et al.

Introduction

Epidermolysis bullosa (EB) is a disease caused by several genetic defects, and has been already described in humans, cattle, horses, dogs and cats, but also in sheep and goats.² The disease is characterized by marked blistering as well as erosions and ulcerations induced by minimal mechanical trauma due to detachment of the epidermis from the dermis. Blisters and ulcers occur particularly in areas exposed to mechanic friction, such as the gums, hard and soft palate, lips, tongue and distal limbs. EB can also be present with deformations of the claws. In veterinary medicine, a distinction is only made between three main forms of EB.⁹ EB simplex is characterized by cleft formation within the basal keratinocytes of the epidermis. EB junctionalis (EBJ) is characterized by clefts along the lamina lucida of the basal membrane. EB dystrophica (EBD) is characterized by clefting below the basal membrane and the upper dermis. In

humans, these main forms are further subdivided into numerous subtypes. In sheep, autosomal recessive inherited EBJ was observed in different breeds and shown to be caused by variants in different genes (OMIA database, <https://www.omia.org/>).^{1,2} In contrast, only a single publication on EBD in sheep appeared since nearly 35 years, and the only published case of EB in goats, also the dystrophic form, dates back to the year 2013.⁹ In both species, the mode of inheritance of EBD was described to be autosomal recessive, but no causal variant has been identified so far.

Case report

History

During a routine visit by the herd health service for small ruminants of the University of Veterinary Medicine Hannover in March 2023, a male, three weeks old goat kid was presented. The farm of origin was a dairy goat farm milking around 45 Thuringian Forest goats. Since birth, the goat kid has been affected with skin irritations on the distal limbs, accompanied by redness, blistering and intermittent lameness. Food intake was not affected, the goat kid was reared by its mother. Compared to other goat kids of the same age, the affected animal was developmentally delayed. In recent years, goat kids with identical clinical signs were born sporadically in the herd. Most of these individuals died within the first days or were euthanized due to their severe symptoms. Some of the affected kids were presented to the local vet and treated symptomatically. No further diagnostics were initiated. The male goat kid presented in March 2023 was already pre-treated by the local vet with non-steroidal anti-inflammatory drugs and antibiotics, but its condition worsened progressively despite treatment. The goat kid was referred to the clinic for small ruminants for further diagnostics.

Clinical examination

On clinical examination, the goat kid showed a curved dorsal line when standing, a marked relief posture of the right hind limb, with moderate lameness and intermittent bruxism. In both eyes there was opacity of the corneas, on the left side approximately 2 × 2 mm, on the right side approximately 4 × 5 mm (Figure 1). Sight was not impaired. Lung auscultation revealed a moderate inspiratory sound on both trachea-bronchial and broncho-bronchial areas. The *Lymphonodii* (*Lnn.*) *cervicales superficiales* were enlarged on both sides to approximately 2 × 2 × 1 cm. Both *Lnn. subiliaci* had the same dimensions and were also enlarged on both sides. The fur was dry and brittle over the entire body and the skin was scaly and crusty, especially on the ears, the sternum and distal limbs. Alopecia was present on the coronet band and fetlock joints of all four limbs. There were purulent blisters and ulcerations of approximately 0,5 cm in diameter, as well as slight swelling and marked redness, particularly at the coronet band (Figure 2). The goat kid showed clear signs of pain when the affected areas were touched (bruxism, defense moves).



Figure 1: Corneal opacity of the right eye (arrow) in a three weeks old Thuringian Forest goat with Epidermolysis bullosa



Figure 2: Alopecia, purulent blisters, crusts at the distal left hind limb (arrow) of the three weeks old Thuringian Forest goat with Epidermolysis bullosa

Further diagnostics and treatment

As part of the initial clinical examination, a venous blood sample was collected for hematology. Fecal samples were also collected for parasitological examination, and crust material for examination for ectoparasites.

Hematology revealed only a slight reduction in PCV (packed cell volume) of 0,20 l/l (reference range 0,22 - 0,38 l/l). No gastrointestinal parasites were detected in the fecal sample. The examination of the crust material for ectoparasites was also negative.

In the clinic, the goat kid was treated daily with Meloxicam (Melosolute 20 mg/ml, CP Handelsgesellschaft GmbH, Ostlandring 13, 31303 Burgdorf, Germany, 0,5 mg/kg s.c.), a non-steroidal anti-inflammatory drug to reduce pain and inflammation. In addition, it was treated with Amoxicillin (Duphamox LA 150 mg/ml, Zoetis Deutschland GmbH, Schellingstraße 1, 10785 Berlin, Germany, 20 mg/kg s.c.) every 48 hours to contain the secondary bacterial infections in the conspicuous areas of skin. Regular local wound care with zinc oxide spray (Livisto Zinkoxid-Salben-Spray, ani-Medica GmbH a Livisto company, Im Südfeld 9, 48308 Senden-Bösensell, Germany, local application) was also carried out.

As the kid was weaned from its mother when it was brought in, it was bottle-fed in the clinic. Hay, concentrate and fresh water were available at all times. Drinking and feed intake were very variable and predominantly moderate to poor.

As the skin lesions did not improve despite antibiotic treatment and wound care, a biopsy was taken from the fetlock area one week after admission to the clinic and examined histopathologically. It revealed a pustular and purulent dermatitis suggestive of bacterial infection.

Three weeks after the beginning of treatment, a swollen tongue and erosions on the palate, gums and tongue were noticed in the kid. Purulent plaques were found in the area of the erosions and a swab sample was examined microbiologically. A moderate infestation with *Fusobacterium necrophorum*, *Mannheimia haemolytica*, coagulase-negative staphylococci and *Streptococcus pluranimalium* was detected, as well as a severe infestation with alpha-hemolytic streptococci. According to the resistance test, the antibiotic treatment was switched to Tulathromycin (Draxxin 100 mg/ml, solution for injection for cattle, pigs and sheep, Zoetis Deutschland GmbH, Schellingstraße 1, 10785 Berlin, Germany, 2,5 mg/kg s.c.).

As the kid's condition increasingly deteriorated despite intensive care and treatment during the hospital stay and it almost completely stopped eating, the animal was euthanized three and a half weeks after referral to the clinic and was sent to the Department of Pathology at the University of Veterinary Medicine Hannover for necropsy.

Pathological examination

The necropsy confirmed the poor nutritional status of the goat kid. Moderate to severe crusty, vesicular to erosive-ulcerative skin lesions were found on the base of the ear, the chest and in the distal area of all four limbs (Figure 3). Hind limbs were more severely affected than fore limbs and showed onset of declawing. Mucosa on the hard and soft palate, gums and tongue showed marked vesicular to erosive-ulcerative lesions (Figure 4). Redness and multifocal

Epidermolysis bullosa dystrophica in a goat kid

N. Ossowski et al.

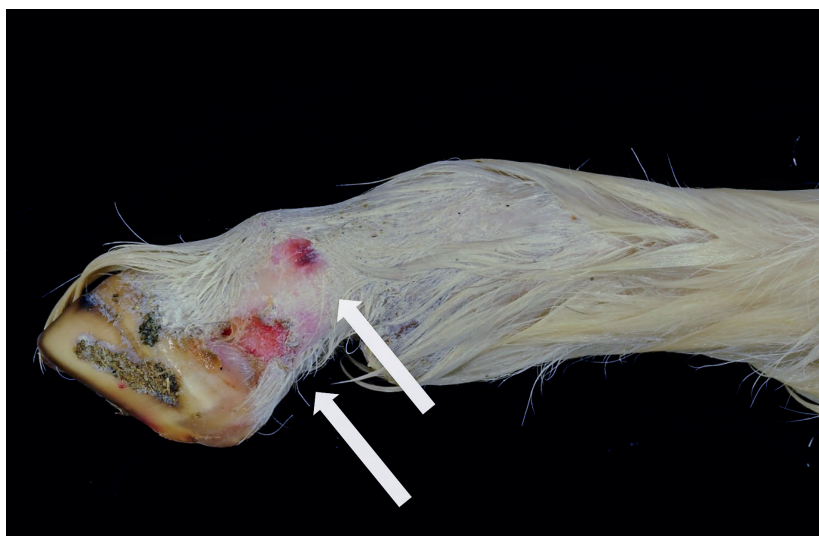


Figure 3: Ulcerative lesions (arrows) on the right forelimb of the two-month-old Thuringian Forest goat with Epidermolysis bullosa



Figure 4: Ulcerative lesions on the palate (arrows) of the two-month-old Thuringian Forest goat with Epidermolysis bullosa

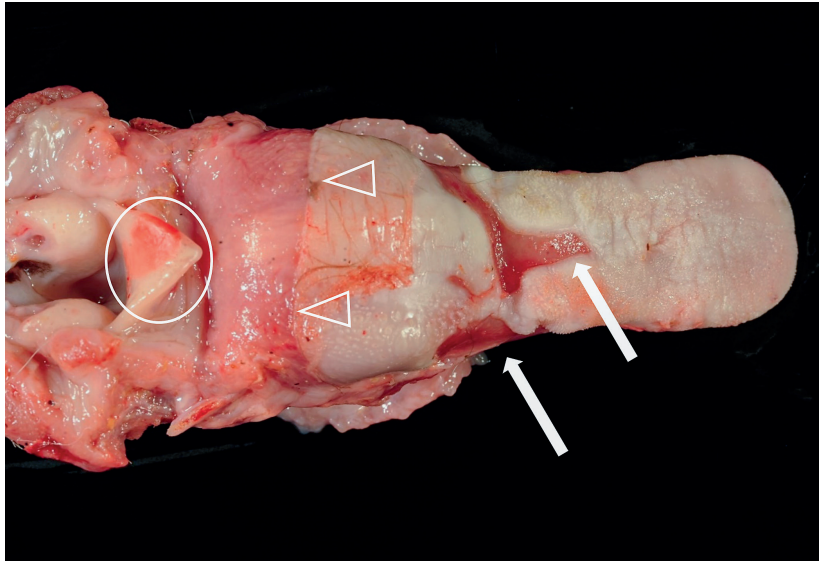


Figure 5: Ulcerative lesions on the tongue (arrows) and pharynx (arrowheads), redness of the epiglottis (circle) in the two-month-old Thuringian Forest goat with Epidermolysis bullosa

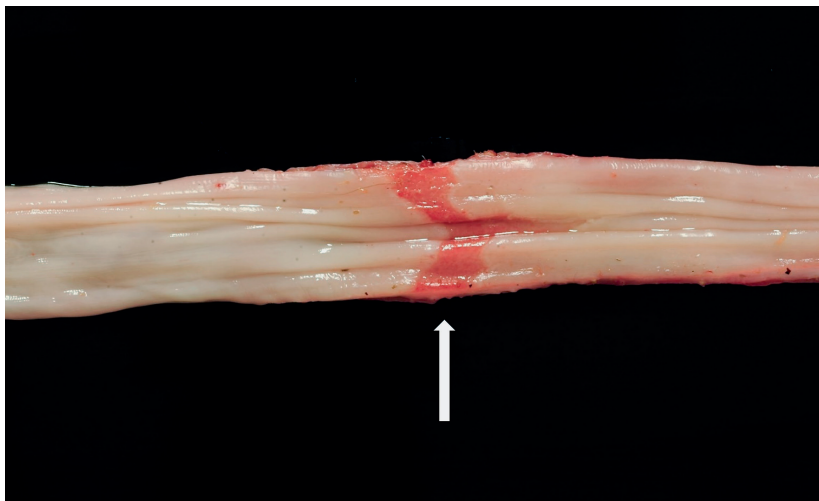


Figure 6: Ulcerative lesion of the esophagus (arrow) in the two-month-old Thuringian Forest goat with Epidermolysis bullosa

vesicles were also present on the epiglottis (Figure 5). The esophagus showed a focal, marked ulceration (Figure 6). Neighboring mucosal areas detached with slight manipulation.

Lnn. mandibulares were moderately enlarged. The left *Musculus quadriceps femoris* showed marked hemorrhages.

Histologic examination showed a multifocal to coalescing, marked erosive-ulcerative dermatitis with associated purulent inflammation with serocellular crusts, intracorneal pustules, and superficial bacteria and fungi in the skin of the back, chest, and distal limbs. Subepidermal clefting, associated with accumulation of protein-rich exudate and

few macrophages and neutrophils was multifocally found in less affected areas. Periodic acid–Schiff (PAS)-reaction revealed the basement membrane localized above the cleft formation (Figure 7). The tongue, gingiva and esophagus showed marked ulceration with associated neutrophilic inflammation and multifocal subepithelial clefting in the adjacent tissue. In addition, the gingiva showed granulation tissue. The reticulum showed multifocal subepithelial clefting with evidence of intralesional bacteria. There was moderate follicular hyperplasia and mild neutrophilic lymphadenitis in the *Lnn. mandibulares*. Oligofocally, mild to moderate purulent hepatitis was present in the liver.

To confirm the diagnosis of EBD, transmission electron microscopy (TEM) was performed as described by Baumgärtner et al. 1987.⁵ After dehydration in graded series of alcohol, samples were embedded in epoxid resin. Ultrathin sections cut from representative areas were stained using uranyl acetate and lead citrate and evaluated on a TEM (EM 10C, Carl Zeiss Microscopy GmbH, Jena, Germany). The sections investigated using TEM revealed the basal membrane clearly visible above the cleft formation in both locations (Figure 8).

Discussion

The case history as well as clinical, macroscopic and histologic findings are consistent with the diagnosis of epidermolysis bullosa. Detection of the basement membrane above the cleft formation, as shown in PAS-reaction and TEM, indicates EBD (Figure 9). This form of EB is caused by a mutation of the *COL7A1* gene, which codes for collagen type VII.⁶ Collagen type VII is the main component of the anchoring fibrils that form the connection between the basement membrane and the dermis.⁸ As a result of the defect, this connection is disrupted by minimal mechanical trauma, leading to blistering and ulceration and possible secondary bacterial and fungal infection.⁷ In goats, EBD has already been described as an autosomal recessive gene defect in a flock of Anglo-Nubian goats.⁸ There is some evidence that the disorder was caused by a spontaneous mutation in a founder animal, but no molecular genetic studies were carried out. In contrast to EBD, affected genes are known for EBJ in small ruminants, specifically in sheep. For example, in the German Black-Headed Mouton, EBJ is caused by a variation in the gene *LAMC2* which codes for laminin C2.¹

In individual cases, EBD lesions can heal, as the blisters are located below the lamina densa of the basal membrane and thus stimulate the mesenchymal wound healing response of the dermis. Skin becomes scarred and is often significantly restricted in its flexibility.⁶ In the other forms of EB, affected individuals usually die shortly after birth or need to be euthanized due to severe symptoms.²

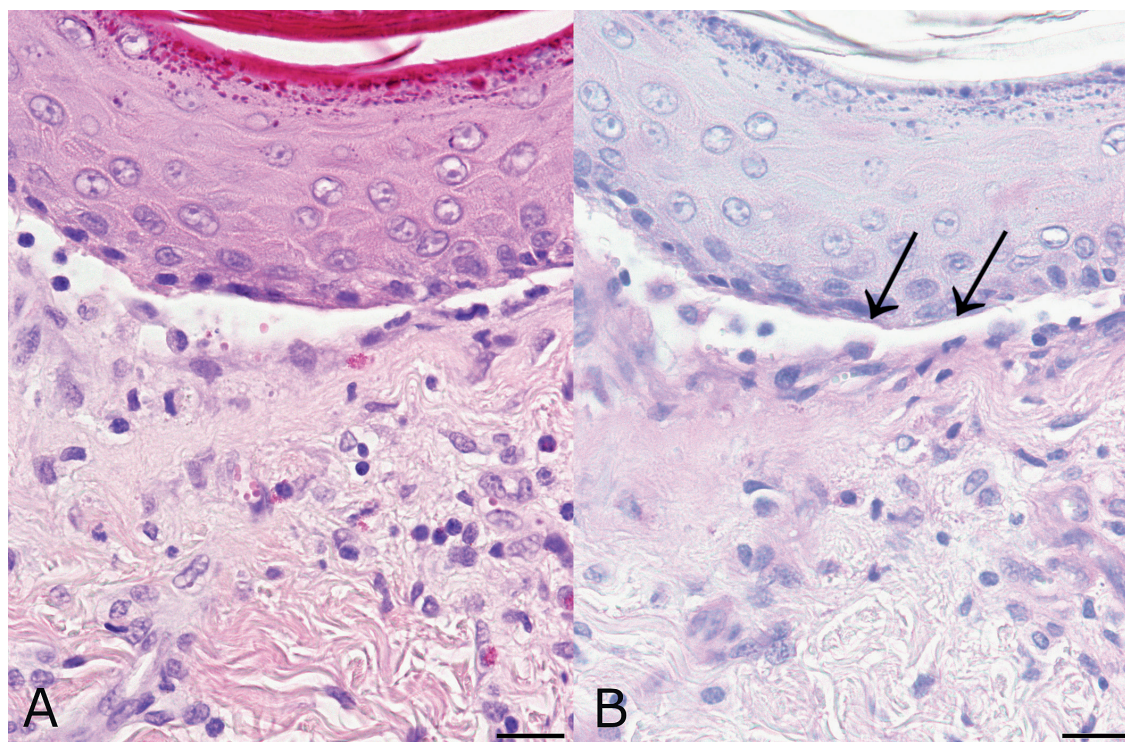


Figure 7: Histologic lesion in the two-month-old Thuringian Forest goat with Epidermolysis bullosa. Scale bars: 50 μ m, A) Clefting between the dermis and epidermis of the skin. (Hematoxylin and Eosin (HE), B) Clefting between the dermis and epidermis with basal membrane (basophilic line, arrows) localized above the cleft (PAS-reaction)

There is no specific treatment for any form of EB in human or veterinary medicine. The focus of treatment is on wound management, combating secondary infections and preserve quality of life, which contains mainly treatment of pain and itch. Depending on the form and subtype of EB, patients' life expectancy varies from a few months in severe cases of EBJ to nearly unchanged life expectancy in milder cases. In milder cases the impairment of life quality and the cancerogenicity of some forms of EB must be considered.⁶ There are approaches of systemic and cell therapy, including injecting mesenchymal stroma cells or allogenic fibroblasts, but no resolving treatment of the disease.³

In the presented case, the kids' parents were not reported to have been affected, fitting to an autosomal recessive modus of inheritance. Further molecular genetic analyses were initiated to identify a potential causal variant. This would enable genetic testing in the Thuringian Forest goat population, and a consecutive elimination of carriers of defect alleles, if present.

Authors' contributions

The manuscript was written by N. Ossowski and I. M. Nägler with contributions from the other authors. Clinical investigation was performed by N. Ossowski and M. Ganter. Pathological investigation and transmission electron microscopy were performed by I. M. Nägler under supervision of A. Beineke and M. Ciurkiewicz. Sample analysis for subsequent molecular biological processing by G. Lühken. M. Ganter supervised the project. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

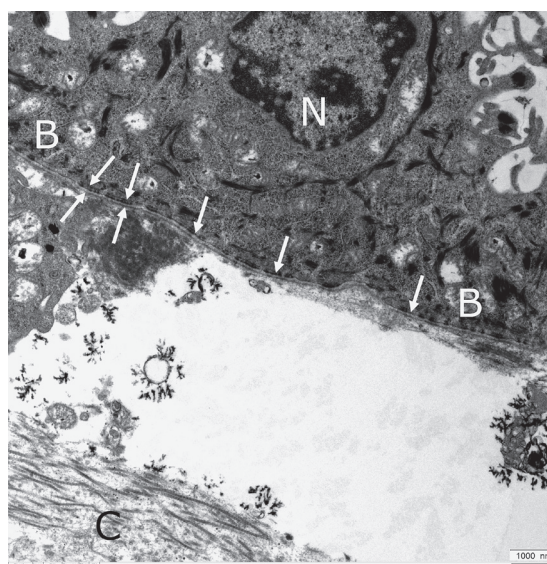


Figure 8: Subepidermal cleft formation in the two-month-old Thuringian Forest goat with Epidermolysis bullosa. Scale bar: 1000 nm. The basal membrane is clearly visible above the clefting (arrows). Transmission electron microscopy. N, nucleus; C, corium; B, basal cell

Epidermolysis bullosa
dystrophica in a goat kid

N. Ossowski et al.

Épidermolyse bulleuse dystrophique chez un chevreau

Au sein d'un troupeau laitier de chèvres de Thuringe, un chevreau mâle âgé d'environ trois semaines a présenté des lésions cutanées, notamment au niveau des membres distaux, du thorax et des oreilles. Ces lésions cutanées se caractérisaient par une alopecie, des cloques purulentes, des croûtes et des érosions. Le chevreau a été orienté vers la clinique pour y être soigné, mais a dû être euthanasié malgré un traitement intensif en raison de la détérioration croissante de son état général; il a ensuite fait l'objet d'une autopsie. L'examen histologique des zones altérées de la peau et des muqueuses a révélé une séparation de l'épithélium d'avec le derme sous-jacent et/ou de la *lamina propria* au niveau situé sous la membrane basale. La microscopie électronique en transmission a confirmé la localisation de la formation d'une fente sous-épidermique, ce qui a conduit au diagnostic d'épidermolyse bulleuse dystrophique (EBD). L'EBD est une maladie bien connue chez l'homme ainsi que chez diverses espèces d'animaux domestiques et d'élevage et sa cause a été élucidée jusqu'au niveau de la génétique moléculaire chez certaines d'entre elles. Chez les chèvres, cependant, aucune étude génétique n'a encore été menée sur l'épidermolyse bulleuse dystrophique, ce qui constituera la prochaine étape de l'analyse du cas décrit ici.

Mots clés: maladie dermatologique, anomalie génétique, chèvre, chèvre de Thuringe

Epidermolisi bollosa distrofica in un capretto

In un allevamento da latte di capre della Foresta di Turingia, sono state riscontrate lesioni cutanee in un capretto maschio di circa tre settimane, in particolare alle estremità distali degli arti, al torace e alle orecchie. Tali lesioni erano caratterizzate da alopecia, vescicole purulente, croste ed erosioni. Il capretto è stato ricoverato in clinica per essere sottoposto a trattamento, ma, nonostante le cure intensive, si è reso necessario procedere all'eutanasia a causa del progressivo peggioramento delle sue condizioni generali. Successivamente, l'animale è stato sottoposto a esame necroscopico. L'esame istologico delle aree cutanee e mucose alterate ha evidenziato una separazione dell'epitelio dal derma sottostante e/o dalla *lamina propria*, a un livello situato al di sotto della membrana basale. La microscopia elettronica a trasmissione ha confermato la localizzazione della formazione delle fessurazioni subepidermiche, consentendo di formulare la diagnosi di epidermolisi bollosa distrofica (EBD). L'EBD è una patologia ben conosciuta nell'uomo, così come in diverse specie di animali domestici e da allevamento. In alcune di queste specie, la causa è stata chiarita fino al livello genetico-molecolare. Nelle capre, tuttavia, finora non è stata condotta alcuna indagine genetica sull'epidermolisi bollosa distrofica. Tale indagine rappresenterà la fase successiva dell'analisi del caso qui descritto.

Parole chiave: patologia dermatologica, difetto genetico, capra, capra della Foresta di Turingia

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