

MORPHOLOGICAL CHARACTERISTICS OF INTERDIGITAL DIVERTICULUM (*sinus cutaneous interdigitalis*) OF DUBSKA PRAMENKA

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Abstract: Lameness in sheep, especially in semi-extensive breeding of Dubska pramenka, which starts in the interdigital region, was the motive of our morphological and histological research, in order to and in some way, bring the structure of the interdigital sinus in correlation with the appearance of this pathological state that causes extensive economical losses in the domestic sheep breeding. The anatomical location of the interdigital diverticulum, its histological structure, which point to abundance of sebaceous glands around the hair follicles surrounding the interdigital opening and interdigital glands in deeper layers, point to the suggestion that their secretion increases due to poor hygienic keeping conditions. Pathogens - anaerobic microorganisms, which are most commonly causing the contagious lameness find the ideal conditions for their growth and reproduction because the secretion of these glands is likely "to close" the only "air" communication - interdigital opening.

Key words: morphology, histology, interdigital sinus, Dubska pramenka

Introduction

Lameness in ungulates, in sheep in particular, is high on the list in terms of contemporary breeding, both in the sheep production and farming of dairy cows and, in terms of frequency, it comes right after mastitis and sterility. Significant economic losses reflected as high costs of treatment and therapy, loss of body weight, and drop in dairy production contribute to the size of this problem.

Contagious foot rot in small ruminants, sheep and goats, appears as a part of a so-called contagious foot rot caused by mixed infection with anaerobic bacteria such as *Fusobacterium necrophorum*, *Dichelobacter nososus*, *Spirocheta penortha*. All this is due to keeping the sheep in poor **zoo hygienic** conditions, irregular corrections of hooves and neglectedness of the flock in general. Due to specific anatomic and histological structure, *sinus cutaneus interdigitalis* is a place that most frequently, due to poor hygienic conditions and mechanical injuries, becomes an ideal place for development of inflammation processes, especially in spring and autumn, when the level of humidity in the air is extremely high. Contagious foot rot in sheep is rare during the dry period, i.e. during summer, and in our areas, it most often affects the front extremities. Histological assay of the interdigital sinus of the front and rear extremities of Dubska pramenka aims to determine the micro-structural matter, trying to bring the problem closer to easier prevention and therapy.

Materials and Methods

Samples for histological assay were taken from 60 distal parts, the front and rear extremities of the sheep Dubska pramenka - male, aged six (6) months to three (3) years. After the preparation of the interdigital sinus of the sheep, it was stored (the front and rear extremities) in plastic bottles containing 10% formalin, until the moment of moulding in the paraffin blocks. The complete procedure of processing the interdigital sinus, from the fixation to paraffin moulding, was performed using rotational tissue processor - MICROTOM model STP-120. Following the moulding, the material was incised using digital microtome, LEICA RM 125, several serial 0.5 -1.5 micrometer incisions. The incisions were placed on a glass surface, stained with haematoxylin eosin, covered with glass cover and glued with Canada balsam. Histological inspection of the preparations was performed using light microscope under magnification of 100 and 200 times, while some structures were observed under magnification of 400 times.

Results and Discussion

The hoofs are skin derivatives with a structure that is modified in relation to the skin covering the rest of the body. Accessory, (additional) toes have short chronic capsules that resemble those on the main toes, and they have a weak corium.

The interdigital skin sinus of the sheep is present in the interdigital space and it represents a tube-like invagination of the skin, which opens on the front part of the interdigital rupture. Morphological assay determined that, given the shape, the sinus may be differentiated as three parts: fundus, corpus and collum.

Fundus is the most proximal and the "blind" part of the sinus, located within distal endings of the first phalange. It builds into a distally and palmary directed corpus, i.e. plantary, creating a sharp bend in the half of the second phalange, then it narrows and goes into collum. The collum is proximally directed and it ends dorsally in a 1.5 to 1.8 mm opening above the start of interdigital rupture. The opening is about 2 cm wide. Macroscopically, the sinus is closed from all sides, and the opening, which is relatively large in diameter, represents the only communication with the environment and the only possible "entrance" for pathogen microorganisms, especially during autumn, when the concentration of humidity in air and air temperatures are high, which is favourable for thier reproduction. The sinuses on the front extremities are somewhat longer and wider in comparison with the rear ones.

Microscopic structure of the interdigital sinus of Dubska pramenka provided the insight into the general micro-structural matter and allowed for gaining an easier understanding of pathogenesis of the contagious lameness in sheep.

By inspecting the histological preparation of the interdigital diverticulum of the sheep using light microscope, under small magnification, we actually get what at first sight is a typical preparation of the skin (Image 1). Hence, epidermis, dermis are present, however, by looking more closely, we see that the surface contains a thick network of connective tissue, which, in some way, is a type of a capsule - capsule fibrosis. Hair follicles and hairs around which one can observe *m. arrector pili* are clearly seen in dermis, while, the present sebaceous glands, lightly coloured, are in the form of bubbly conglomerate masses.

The sebaceous glands are well developed and clearly shown, quite large, especially around the external opening of the interdigital sinus, in fact, around hair follicles that are more numerous around the mentioned opening (Image 4 and 5). Directly in the vicinity of the sebaceous glands, there are muscle fibres. Between muscle fibres there are also connective tissue fibres. In individual hair follicles, we noticed keratin cells and even some circular keratin fibres (Image 2).

Next to the sebaceous glands, on the border between subcutis and dermis, there are interdigital glands, which, in thier appearance, point to the apocrine type of secretion, around which we noticed connective tissue and muscle fibres. They are found in smaller accumulations and in the form of ring formations - acini with visible lumen, and, in thier appearance, they remind of sweat glands that are present on the skin of other domestic animals. The draining ducts of these acini are not observed. The glands are built like glomerate, with clearly observable low-prismatic cells and large round nuclei leaning on the basal membrane (Image 3). We did not notice secretion in the interior of these gland formations, or secretory drops. Histological assay determined that the interdigital glands are on the border between subcutis and dermis, in deeper layers of sinus interdigitalis, i.e. in its extended part. Also, on the histological preparations, in the assayed part of the

interdigital sinus, there are clearly observable intersections of blood vessels, capillary, and somewhat thinner muscle fibres around the glands.

Considering that the samples came from the front and rear extremities of the sheep, we did not observe any significant histological discrepancies in the matter, as it is the case with macroscopic matter.

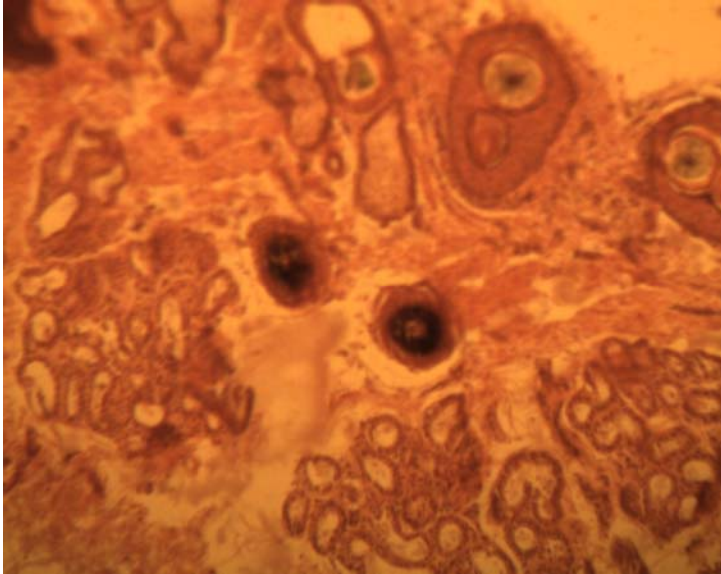


Image 1. Histological view of interdigital sinus of the sheep with clearly observable hair follicles and sebaceous glands, haematoxylin eosin (oc.10x, ob. 25x)

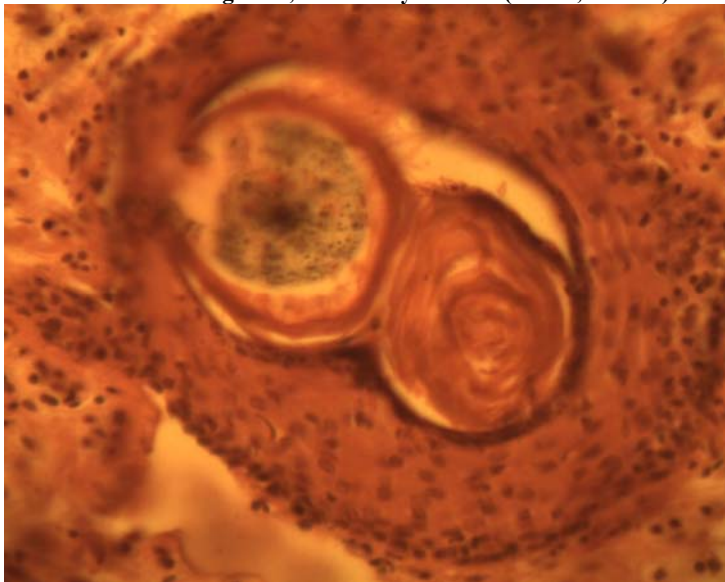


Image 2. Hair follicle with fibres and keratin cells, haematoxylin eosin (ob.10x, ob.40x)

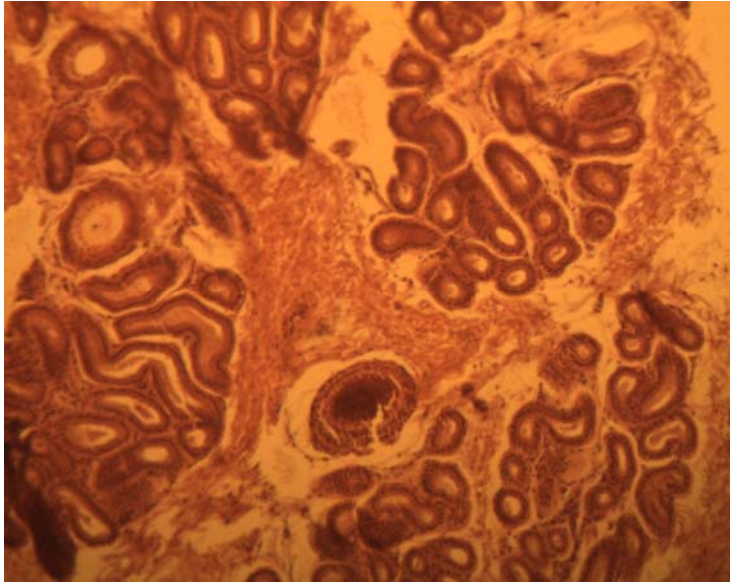


Image 3. the glands of the interdigital sinus of the sheep, haematoxylin eosin (oc.10x, ob.25x)

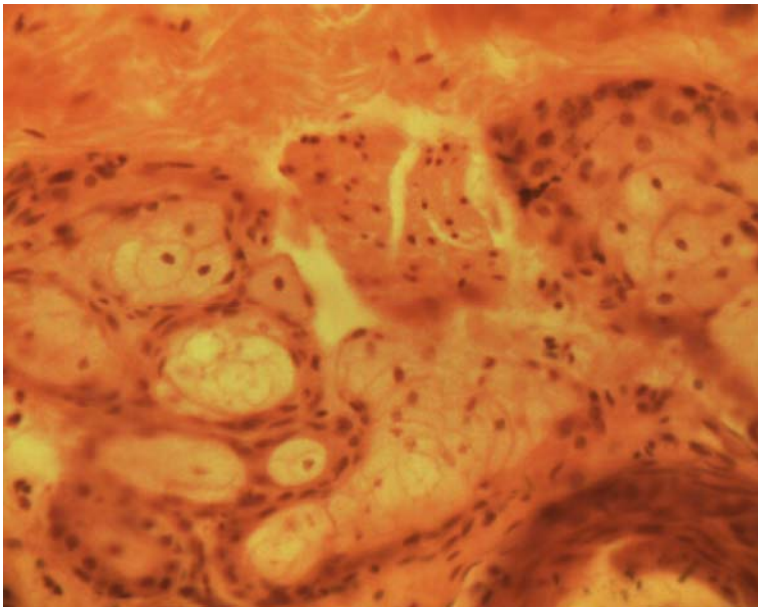


Image 4. Sebaceous glands around the external opening of the interdigital diverticulum, haematoxylin eosin, (oc.10x, ob.40x)

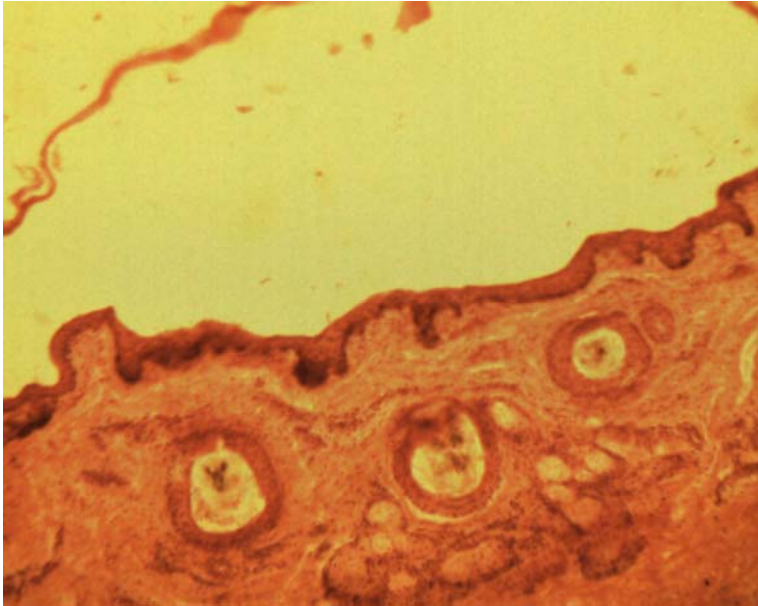


Image 5. Histological view of the external opening of interdigital diverticulum of the sheep, with many hair follicles and sebaceous glands, haematoxylin eosin (oc.10x, ob. 25x)

It is generally known in the world that different types of ungulates were put in economical exploitation in a wider sense of the word. Lameness - contagious foot rot as a dysfunctional use of the extremities appears in all kinds of animals, but in terms of the domestic animals from the group of ungulates in the countries with developed or less developed economies, in intensive and nomadic cattle breeding, we particularly refer to the sheep, goats and cows. Interdigital skin sinus (*Sinus cutaneus interdigitalis*) in sheep is present in the interdigital space (Koch T. et al., 1993). Interdigital sacks in the sheep are shaped like a pipe that starts with a 2-4 mm wide opening and continues with a 18-20 mm long and 3-4 mm wide tube, which then creates a crescent-like bend and expands into a blind sack, 8- 10 mm wide and 15 mm long (Nickel et al., 1973). Our assays showed that the skin of the sack is rather thin, light coloured and surrounded with fine, non-pigmented light hairs, which corresponds to the findings of other authors (Ellenberger W., et al. 1943., Janicki et al., 2003). The assays showed that the sinus cavity is filled with fatty, thick, colourless secretion, odourless, and the complete insight showed that the larger amounts of secretion are found in sinuses of the front extremities, and that these findings correspond to those of other authors (Kadir Aslan et al., 2010). Our histological assays determined more specific structure of interdigital sinus, and special attention was given to the findings of a larger number of well developed sebaceous glands in the direct vicinity of hair follicles and around the external opening of the interdigital sack, both on the front and rear extremities.

Ultra-structural assay, scanning with electronic microscopy (Karahan S. et al., 2007., Abbasi M. et al., 2009) defined the specific matter of the interdigital sack, which is made of a base, a body and a neck, with plenty glandular formations, which, due to thier appearance, pointed to the glands of the apocrine type of secretion. The interior of these glandular formations is filled with secretory vesicles. Light-microscopic assays of interdigital sacks points to a clearly visible external opening that communicates with its environment and it has typical histological characteristics of the skin, because there is a multilayered, laminated, hardened epithelium, with noticeable hair and hair follicles surrounded with the prominent sebaceous glands, which is correspondent to the findings of other authors (Nickel R. et al., 1981., Atoji Y. et al., 1995). The interdigital glands are seen on sections of subcutis into dermis, hence in the deeper layers of interdigital sinus, whose cross sections provide ring-like appearance, appearance of acini surrounded with prismatic cells of large ball-like nuclei (Wood WF, 2003., Eurell JA et al., 2006), which corresponds with our assays.

Conclusions

Morphohistological assay of interdigital sinus of Dubska pramenka determined the following:

- Interdigital sinuses of the front extremities of Dubska pramenka are somewhat longer than those of the rear extremities, and they begin with a small opening that communicates with external environment
- Histological assays shows that around the external opening, which is 2 cm wide in diameter, there is skin with all of the building elements, and that there are well developed sebaceous glands around hair follicles
- In deeper layers, we noticed well developed glomerate-shaped interdigital glands, which, with thier structure, remind of sweat glands

Morfohistološke karakteristike interdigitalnog divertikula (*sinus cutaneus interdigitalis*) dubske pramenke

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Rezime

Zarazna šepavost ovaca, pogotovo u poluekstenzivnom uzgoju dubske pramenke, a čiji je početak u interdigitalnoj regiji, bio je povod naših morfoloških i histoloških istraživanja, kako bi na neki način doveli u korelaciju građu interdigitalnog sinusa sa nastankom ovog patološkog stanja, koje u domaćoj ovčarskoj proizvodnji izaziva velike ekonomske gubitke. Sam anatomski smeštaj

interdigitalnog divertikula, histološka građa, koja ukazuje na obilje lojnih žlezda oko dlačnih folikula oko interdigitalnog otvora, te interdigitalnih žlezda u dubljim slojevima, ukazuju na sumnju da usled nehigijenskih uslova držanja, njihova sekrecija se povećava. Potogeni - anaerobni mikroorganizmi, koji su najčešći uzročnici zarazne šepavosti tu pronalaze idealne uslove za svoj rast i razmnožavanje, jer sekret ovih žlezda verovatno „zatvori“ jedinu „zračnu“ komunikaciju – interdigitalni otvor.

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