

The Role of Superficial Lymph Nodes of Cattle in the Diagnosis of Infectious Diseases

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Abstract

The superficial lymph nodes of cattle represent important diagnostic markers for the early detection and monitoring of infectious diseases. The lymphatic system is functionally linked to both innate and acquired immunity and constitutes the first barrier upon pathogen entry into the organism. Palpation, visual assessment, and continuous monitoring of superficial lymph nodes-such as the submandibular, supramammary, and others-often provide valuable information regarding the localization, generalization, and intensity of infectious processes.

In diseases caused by infectious agents, including bacteria, viruses, and parasites, lymph nodes exhibit early reactive changes such as hyperplasia, inflammation, swelling, and pain. Evaluation of lymph nodes is particularly important in the diagnosis of tuberculosis and listeriosis, where local lymphadenitis represents one of the earliest clinical signs. In addition, superficial lymph nodes play a significant role in assessing the epizootic situation, as their pathological changes may indicate the spread of infection throughout an entire farm.

Clinical assessment of lymph nodes is recommended in combination with additional diagnostic methods, including serological tests, bacteriological examinations, and molecular studies.

Keywords: lymphadenitis, infectious diseases, superficial lymph nodes.

Introduction

The lymphatic system was known to the ancient Greek philosopher Hippocrates, who referred to lymphatic vessels as “white vessels” and lymph as “white blood” although he did not attribute particular significance to them. Approximately 2,500 years after Hippocrates, the lymphatic system was rediscovered in 1626 by the Milanese surgeon Gaspare Aselli during demonstrations involving the recurrent nerve.

In recent years, the study of lymph node structure and function has attracted increasing scientific attention due to advances in immunology and the growing demands of practical medicine. Lymph nodes play a crucial role in the formation of both humoral and cellular immunity, interacting closely with systems such as the sympatho-adrenal system and the hypothalamic–pituitary–adrenal axis.

In oncology, lymph nodes are regarded as primary targets for metastasis. In inflammatory processes occurring within the organism, lymph nodes are among the first structures to respond. Therefore, in veterinary practice, detailed examination of lymph nodes enables veterinarians to assess disease localization, which requires thorough knowledge of lymph node anatomy, size, and location.

Functions of Lymph Nodes

Lymph nodes perform the following functions:

1. Lymph nodes belong to the hematopoietic organs; lymphocyte transformation occurs in both the cortical and medullary layers.

2. They possess a barrier–filtration function.
3. Lymphocyte formation occurs in lymph nodes, as well as in:
 - I. lymphoid tissues of the digestive tract,
 - II. the spleen,
 - III. the thymus,
 - IV. the bone marrow.

The majority of lymphocytes develop in lymph nodes, lymphatic follicles, and the gastrointestinal tract.

4. Globulin synthesis occurs within lymph nodes.
5. Plasma cells and antibodies are produced in lymph nodes.
6. Lymph nodes ensure the formation of both humoral and cellular immunity.
7. Lymph nodes function primarily as biological rather than purely mechanical filters.
8. Lymph nodes have a reservoir function similar to lymphatic ducts, enabling lymph deposition and regulation of fluid distribution between blood and lymph under both physiological and pathological conditions. Smooth muscle elements located in lymph node trabeculae participate in lymph propulsion.
9. Lymph nodes actively participate in metabolism, including lipid, protein, vitamin, and other metabolic processes.
10. Lymph nodes produce leukocytic factors that stimulate proliferation of lymphocytes as well as cells of various tissues.

Morphological and Evolutionary Aspects

Lymph nodes are complex organs with rich blood supply, confirmed morphologically by numerous arteries, interarterial and arteriovenous anastomoses, and dense capillary networks that penetrate lymph nodes not only through the hilum but also through the capsule.

According to G. Khrushov, in phylogenesis the earliest signs of hematopoietic organs appear in cyclostomes within the intestinal wall. The spleen first appears in fish, bone marrow in amphibians, and lymph nodes in birds.

In birds and mammals, lymph flow is ensured by contraction of muscular elements within lymphatic vessel walls, while direction is regulated by valves. According to G. Iosifov, respiration plays a major role in rhythmic lymph transport, with arterial pulsation acting as an auxiliary driving force.

Lymphatic System in Mammals

The mammalian lymphatic system consists of lymph, lymphatic vessels, lymph nodes, and lymphoid formations. Lymph is a transparent, yellowish fluid that permeates tissues and lymphatic vessels. Lymphatic vessels are divided into capillaries, intraorgan and extraorgan vessels, and lymphatic ducts.

Species-specific differences exist in lymphatic system structure and lymph node numbers. For example, dogs possess approximately 60 lymph nodes, pigs 190, cattle 300, horses about 8,000, and humans approximately 460 (H. Baum, A. Trautmann).

Lymph nodes may be arranged singly or in groups, typically located along the convex surfaces of major lymphatic ducts.

Lymph nodes are divided into two major groups:

- **Somatic lymph nodes** (associated with the locomotor apparatus, head, and neck),
- **Visceral lymph nodes** (associated with the thoracic and abdominal cavities).

Some lymph nodes receive lymph from both somatic and visceral regions and are classified as mixed lymph nodes (e.g., cervical lymph nodes).

Lymph Nodes in Hoofed Animals and Cattle

Hoofed animals possess highly developed lymph nodes characterized by a clear distinction between cortical and medullary layers and a well-developed capsule. Smooth muscle cells within the trabecular apparatus facilitate lymph outflow, serving as an important mechanism of lymph circulation. Cellular structure of lymph nodes in various hoofed animals was studied by K. Florensov in 1964.

In cattle, lymph nodes may reach considerable size (up to 25×33 mm). Structural elements are relatively evenly developed compared to other mammals. Lymph node composition varies by group, particularly regarding granulocytic and erythroblastic elements, while reticular cells, plasma cells, and lymphocytic elements remain relatively stable.

Measured lymph node sizes in cattle:

- 4 years: 7×3.1 cm
- 6 years: 6.8×2.6 cm
- 7 years: 8.2×3.0 cm
- Diseased nodes (dark red): 9.6×2.3 cm

In infectious and invasive diseases, lymph nodes enlarge 2–3 times, may become dense or softened, and often exhibit petechial hemorrhages, necrotic foci, and abundant exudate on cut surface.

Immunological Significance

Along with the spleen, thymus, and bone marrow, lymph nodes belong to the organs of the immune system, which protects the organism from microorganisms and other harmful agents. However, some authors (Lol H., Soni I.L., 1985) reported autoimmune reactions during pathological–histological studies of cattle with piroplasmid infections (theileriosis), where activated lymphocytes and macrophages phagocytosed not only infected but also healthy erythrocytes.

The immune system distinguishes between “self” and “non-self,” enabling elimination of foreign bodies and tumor cells. Lymphocytes are the main specialized immune cells and function in cooperation with granulocytes, macrophages, and monocytes.

Lymphocytes are classified into three functional types: T, B, and NK cells.

Two types of specific immune defense have evolved: cellular and humoral immunity. Cellular immunity involves direct destruction of pathogens by immunocompetent cells, while humoral immunity is mediated by antibodies produced by activated B lymphocytes. Antibodies are immunoglobulins synthesized in plasma cells. In most cases, immune responses are combined.

Cytoarchitecture and Diagnostic Importance

The cytoarchitecture of lymph nodes includes:

1. Capsule
2. Trabeculae
3. Cortex
4. Paracortical zone
5. Medulla
6. Medullary cords
7. Marginal sinus
8. Intermediate cortical sinus
9. Intermediate medullary sinus
10. Hilar sinus
11. Lymphatic follicle
12. Germinal center
13. Reticular cell
14. Afferent lymphatic vessels
15. Efferent lymphatic vessels

Different functional zones are characterized by distinct cellular populations. Lymphatic follicles are predominantly populated by B lymphocytes, while the paracortical zone is rich

in T lymphocytes. The medulla contains both B and T cells, with B cells predominating.

In infectious and invasive diseases, cytological composition of lymph nodes changes significantly, which has diagnostic value. In invasions, eosinophilia is pronounced, accompanied by a decrease in T lymphocytes and an increase in B lymphocytes. Infectious diseases are associated with increased basophils and altered T/B lymphocyte ratios.

Pathohistological studies of cattle affected by theileriosis revealed marked eosinophilia in lymph nodes and peripheral blood, facilitating neutralization of toxins produced by Theileria. At the same time, a sharp decrease in T lymphocytes was observed, with complete destruction of lymphocytes in the peripheral regions of lymphoid follicles of lymph nodes, thymus, and spleen.

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