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PATHOMORPHOLOGICAL CHANGES IN ORGANS IN SHEEP ECHINOCOCCOSIS

ANNOTATION

Echinococcosis is a widespread parasitic disease caused by the larval stages of cestodes of the genus Echinococcus. In sheep, as intermediate hosts, the larvae form echinococcal cysts that affect internal organs and cause severe morphological disorders. The liver and lungs are most commonly affected, but lesions can also be observed in other organs, including the kidneys, spleen, muscles, and brain.

To study macro- and microscopic changes in the organs of sheep infected with Echinococcus in order to clarify the pathogenesis and expand the morphological criteria for diagnosing the disease.

The work was carried out in the West Kazakhstan region. The carcasses of sheep infected with echinococcus were examined. Pathological autopsy was performed using standard methods. Organ material was subjected to histological processing and staining using standard protocols. Macro- and micro-preparations were analyzed using light microscopy. In 70-72 % of sheep, cysts were localized in the liver, and in 26-28 % simultaneously in the liver and lungs. In isolated cases, multiple lesions involving the spleen, kidneys, muscles, and brain were detected. Macroscopically, the affected organs were enlarged, with pronounced deformities and the presence of bubbles up to 8 cm in size. Histologically, dystrophy, necrosis, chronic inflammation, perivascular infiltration, and the formation of giant cells were noted. Particularly pronounced changes were recorded in the liver and lungs, including fibrosis and cirrhotic transformation.

Echinococcosis in sheep is characterized by organ specificity and causes a complex of destructive and productive processes in tissues. Understanding the pathomorphology of the disease is important for diagnosis and prevention in veterinary practice.

Key words: *Echinococcosis, pathomorphology, organ changes, parasitic diseases, light microscopy, histopathology*.

Introduction. Echinococcosis is one of the most widespread natural focal parasitic diseases, caused by the larval stages of cestodes of the genus *Echinococcus*, primarily *E. granulosus sensu lato* [1]. The disease poses a serious challenge to both veterinary medicine and public health, especially in livestock-rearing countries, including Kazakhstan, where the infection rate in sheep can exceed 30% [2]. The main intermediate hosts of the parasite are herbivorous farm animals, particularly sheep, in which the larvae form echinococcal cysts in various internal organs [3].

In the life cycle of the parasite, dogs and wild canids act as definitive hosts, while sheep serve as intermediate hosts. Infection in sheep occurs through ingestion of eggs found on contaminated pastures, in water, or in feed. After ingestion, the eggs hatch into oncospheres in the small intestine, which penetrate the intestinal wall and migrate via the bloodstream to various organs, where they develop into echinococcal cysts. This parasitic infection significantly impacts the health of sheep and meat quality and represents a public health concern due to its zoonotic nature [4].

Pathomorphological changes associated with echinococcosis in sheep are complex and multifaceted, involving both gross anatomical and microscopic tissue alterations. These changes vary depending on the localization, size, and fertility of the cysts, as well as the host's immune response. Understanding these pathological manifestations is critical for accurate diagnosis, effective treatment strategies, and the implementation of control measures in veterinary practice [5].

The disease progresses gradually: cyst formation initially does not cause clinical signs, but as they grow, mechanical compression and tissue destruction occur. The liver and lungs are the most frequently affected organs in sheep, which is attributed to their vascular anatomy and filtration function [6]. However, cases involving the kidneys, spleen, muscles, and central nervous system have also been reported [7].

The number of cysts in individual animals can reach up to 1000, and they may attain considerable sizes, negatively affecting both the involved and adjacent organs due to pressure on their stroma and parenchyma, disrupting function and causing atrophy. The larvae of *Echinococcus* exert not only mechanical but also toxic effects, causing allergic reactions. Rupture of hepatic echinococcal cysts can lead to inflammatory processes in the serous cavities, often resulting in the death of the intermediate host [8,9].

Macroscopically, the affected organs are enlarged, with visible round, fluid-filled structures surrounded by dense fibrous capsules [10]. As parasitic cysts grow, they compress surrounding parenchyma, leading to atrophy of functional structures and replacement with connective tissue [11].

Microscopic changes include dystrophic and necrotic tissue processes, development of chronic productive inflammation, bile duct proliferation (in the liver), and pronounced fibrosis with perivascular infiltration [12]. In chronic cases, cirrhotic changes develop, microcirculation is disrupted, and profound structural alterations occur in the organs [13]. The host's immunomorphological response is characterized by the formation of giant cells, accumulation of eosinophils, lymphocytes, and macrophages around the cysts, especially in cases of suppuration or parasite death [14].

To date, the scientific literature lacks sufficient information on the pathomorphological alterations of liver tissues under the influence of echinococcal larval cysts [15,16,17]. Furthermore, important questions remain regarding the progression of echinococcosis in internal organs depending on the intensity of infection, which hampers a comprehensive understanding of the morphopathogenesis of this parasitic disease.

Despite the availability of extensive data on the epizootiology of echinococcosis, morphological studies aimed at systematically analyzing organ lesions in sheep remain limited. This hinders early diagnosis and timely assessment of lesion severity. The present study aims to describe the characteristic macro- and microscopic changes in the liver, lungs, spleen, kidneys, muscles, and brain of sheep infected with *Echinococcus*, with the goal of clarifying disease pathogenesis and expanding morphological diagnostic criteria.

Materials and methods. The study was conducted in the city of Uralsk, the administrative center of the West Kazakhstan Region, Republic of Kazakhstan. The geographical coordinates of the research site are 51.2272° N latitude and 51.3865° E longitude (Figure 1).

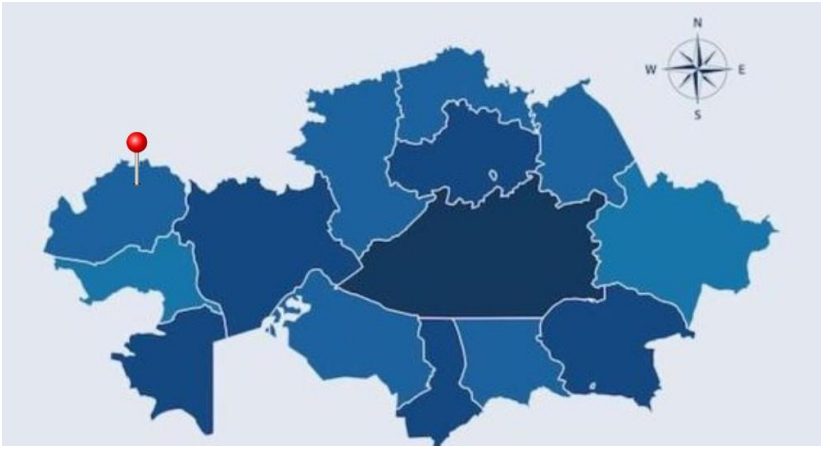

Figure 1 - Geographical location of the study area in the West Kazakhstan region

Pathological necropsies and sample collection were carried out on deceased sheep received from various farms in the region (Figure 2). The work was conducted during the spring-summer period. All

procedures were performed in accordance with veterinary and sanitary regulations, followed by fixation of the material for histological analysis.

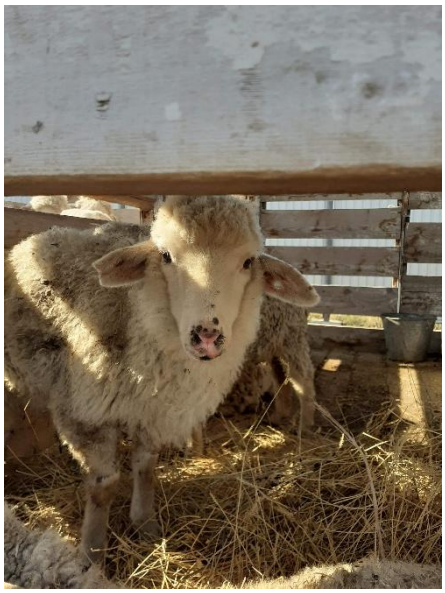

Figure 2 - Experimental animal (sheep) included in the pathomorphological study

Pathological necropsy was performed according to the Shor method [18] using standard instruments, with data recorded in autopsy protocols. Examination of internal organs was carried out under both natural and artificial lighting. Particular attention was given to the liver, lungs, spleen, kidneys, muscle tissue, and brain. Macroscopic changes were documented visually and by palpation; the sizes of echinococcal cysts were measured with a ruler and recorded in the protocols.

For histological analysis, tissue fragments measuring 1×1×0.5 cm were collected from the affected organs. Samples were fixed in four parts of IsoPrep histological solution (BioVitrum, Russia) and two parts of BioClear (BioOptica, Italy). Following fixation, the tissues were dehydrated, embedded in three parts of HistoMix paraffin (BioVitrum, Russia), and mounted into histological blocks. Sections with a thickness of 5 μm were prepared using an Orion Medic Rotmik 2M microtome (Russia).

The obtained sections were deparaffinized in two parts of BioClear and sequentially processed in descending concentrations of ethanol. Standard staining was performed using hematoxylin and eosin [19], followed by processing in ascending concentrations of ethanol and mounting in a synthetic preserving medium, BioMount (BioOptica, Italy).

Special attention was paid to alterations in parenchymal and connective tissue components, the presence of inflammatory cell infiltration, fibrous capsule formation, vascular reactions, and signs of tissue dystrophy [21].

Results. Pathological examination of sheep infected with *Echinococcus* revealed that in the vast majority of cases (approximately 70-72 %), cysts were predominantly localized in the liver. Combined liver and lung involvement was observed in 26-28 % of cases. Multiple organ involvement affecting three organs simultaneously was recorded in less than 2 % of cases. The rarest combinations included concurrent lesions in the liver, lungs, and kidneys or spleen.

The affected organs exhibited marked deformation, enlargement, and the presence of cysts of various sizes (ranging from 1 to 8 cm), filled with clear fluid containing small inclusions (scoleces). The echinococcal cysts were surrounded by a dense connective tissue capsule.

In the liver, the right lobe was most frequently affected. Superficial cysts were detectable both visually and by palpation. Histological examination of liver tissue revealed pronounced hepatocyte atrophy, fibrosis, and dystrophic changes, with areas of necrosis observed in some cases. The fibrous capsule varied in thickness from 0.5 to 4 cm and contained perivascular infiltrates and multinucleated giant cells (Figure 4).

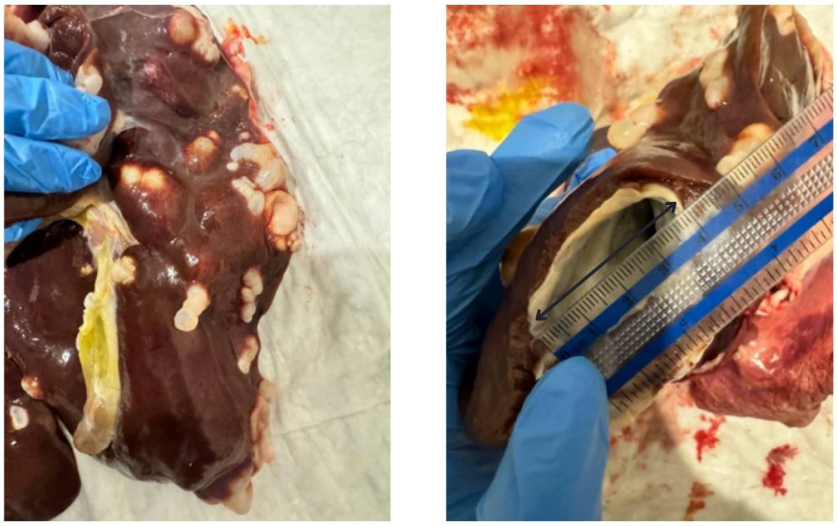

Figure 4 - Infected liver

Single and multiple echinococcal cysts were identified in the lung tissue, predominantly in the right lung. The cysts caused bronchial compression and, in some cases, segmental atelectasis. Histological examination revealed eosinophilic interstitial pneumonia, perivascular edema, lymphoid infiltration, areas of necrosis, and granulation tissue with a predominance of macrophages and eosinophils (Figure 5).

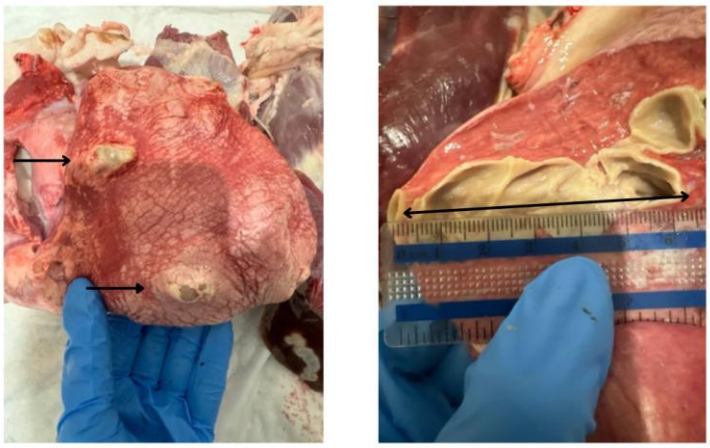

Figure 5 - Infected lungs

Echinococcal lesions in the spleen were observed in 7-9 % of cases, typically in the form of solitary large cysts. In all instances, significant parenchymal atrophy was noted due to pressure exerted by the expanding cysts. The capsule was thickened and dense, with no signs of perforation or rupture of the contents.

Changes in muscle tissue were dystrophic in nature, characterized by granular degeneration of muscle fibers. In nervous tissue, signs of neuronal degeneration were identified, including vacuolization, chromatolysis, and pyknosis. The kidneys exhibited signs of protein dystrophy of the tubular epithelium, parenchymal edema, and blurring of the boundaries between the cortical and medullary layers.

Table 1 – Pathomorphological changes in organs affected by echinococcosis

Organ	**Macroscopic Changes**	**Microscopic Changes**
Kidneys	Enlargement, blurring of cortico-medullary boundary	Protein dystrophy of tubules, edema, nuclear lysis
Brain	Mild changes, edema, softening	Chromatolysis, vacuolization, pyknosis, neuronal death
Muscle tissue	Discoloration, dull surface, increased density	Granular dystrophy, disruption of striations, nuclear alterations

Table 1 presents the pathomorphological changes in organs affected by echinococcosis, characterizing both macroscopic and microscopic alterations in various organs.

Discussion. The results of our study confirm that echinococcosis in sheep is characterized by pronounced organotropism, primarily affecting the liver and lungs, which is consistent with findings reported by other authors [22, 23]. The localization of the parasite in the liver is explained by the specifics of hemocirculation, in which *Echinococcus* larvae predominantly settle in the capillary system of the portal vein [24]. The increased frequency of lesions in the right hepatic lobe observed in our study correlates with reports of more intensive blood flow in this anatomical region [25].

Fibrosis and inflammatory reactions around the parasitic cysts confirm the presence of chronic productive inflammation [26, 27]. The giant cells and lymphoid infiltrates detected in the fibrous capsule also indicate the activation of an immune response resembling a foreign body reaction [28].

Pulmonary lesions were mainly interstitial in nature. Chronic eosinophilic pneumonia diagnosed in a subset of animals is typical for parasitic etiology and aligns with the findings on the pathogenesis of pulmonary echinococcosis [29]. Mechanical compression of the bronchi and blood vessels by large cysts led to secondary changes such as atelectasis, focal emphysema, and impaired ventilation [30].

Spleen and kidney involvement was rare, as also reported in other epizootiological studies [31]. However, even in isolated cases, we observed significant parenchymal destruction and disruption of microarchitecture, indicating the high pathogenic potential of the parasite.

Histopathological changes in the brain and muscles revealed in our study reflect the toxic effects of *Echinococcus* metabolic products [32]. The observed signs of neuronal degeneration and granular muscle dystrophy are particularly important, as they point to the systemic nature of parasitic intoxication.

Thus, the combination of macroscopic and microscopic alterations reflects a complex pathogenic process involving mechanical compression by cysts, inflammation, tissue destruction, and fibrosis. The obtained results expand current understanding of the pathomorphology of echinococcosis and confirm the importance of early diagnosis and prevention of this invasion in farm animals.

Conclusion. Based on the results obtained, it was established that liver and lung involvement predominates in sheep with echinococcosis. The pathological changes are of a chronic destructive-productive nature, manifested by atrophy, fibrosis, and inflammation. The histological findings confirm the high invasive and toxic activity of the larval forms of *Echinococcus*, which cause profound morphofunctional disturbances in the host's tissues.

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ТҮЙІН

Эхинококкоз - кең таралған паразиттік аурулардың бірі, оның қоздырғышы *Echinococcus* туысына жататын цестодтардың дернәсілдік сатылары болып табылады. Қойлар аралық иесі ретінде эхинококк личинкалары әртүрлі ішкі ағзаларда эхинококк көпіршіктерін (цисталарын) түзеді және оларда айқын морфологиялық өзгерістер туғызады. Ең жиі зақымданатын ағзалар бауыр мен өкпе, дегенмен бүйрек, көкбауыр, бұлшықет және ми тіндері де патологиялық процеске тартылуы мүмкін.

Осы зерттеудің мақсаты - эхинококкпен зақымданған қойлардың ағзаларында макро- және микроскопиялық деңгейде орын алатын өзгерістерді сипаттап, аурудың патогенезін нақтылау және морфологиялық диагностика критерийлерін кеңейту.

Зерттеу жұмысы Батыс Қазақстан облысында жүргізілді. Эхинококкпен зарарланған қойлардың өлекселері тексерілді. Патологоанатомиялық ашу стандартты әдістер бойынша жүргізілді. Ағзалық материалдар гистологиялық өңдеуден өтіп, стандартты бояу әдістері қолданылды. Макро және микропрепараттар жарық микроскопы арқылы талданды. Қойлардың 70-72 %-ында эхинококк цисталары бауырда, ал 26-28 %-ында бауыр мен өкпеде бір мезгілде анықталды. Сирек жағдайларда көкбауыр, бүйрек, бұлшықет және ми қатар зақымданған. Макроскопиялық тұрғыдан зақымданған ағзаларда көлем ұлғаюы, деформация және мөлшері 8 см-ге дейін жететін көпіршіктер байқалды. Микроскопиялық зерттеуде дистрофия, некроз, созылмалы қабыну, периваскулярлы инфильтрация және алып жасушалардың түзілуі тіркелді. Ең айқын өзгерістер бауыр мен өкпеде фиброз және цирротикалық қайта құрылу түрінде байқалды.

Қойлардағы эхинококкоз ағзалық ерекшелікпен сипатталады және тіндерде деструктивті-продуктивті өзгерістер кешенін туғызады. Бұл аурудың патоморфологиясын терең түсіну ветеринариялық тәжірибеде дер кезінде диагностика жасау және алдын алу шараларын жүргізу үшін маңызды.

РЕЗЮМЕ

Эхинококкоз является широко распространённым паразитарным заболеванием, вызываемым личиночными стадиями цестод рода *Echinococcus*. У овец, как промежуточных хозяев, личинки формируют эхинококковые цисты, поражающие внутренние органы и вызывающие тяжёлые морфологические нарушения. Наиболее часто страдают печень и лёгкие, однако поражения могут наблюдаться и в других органах, включая почки, селезёнку, мышцы и головной мозг.

Изучение макро- и микроскопических изменений в органах овец, инфицированных эхинококком, с целью уточнения патогенеза и расширения морфологических критериев диагностики заболевания.

Работа проведена в Западно-Казахстанской области. Обследованию подверглись трупы овец, заражённых эхинококком. Патологоанатомическое вскрытие проводилось по стандартным методикам. Органный материал подвергали гистологической обработке и окрашиванию с использованием стандартных протоколов. Макро- и микропрепараты анализировались с применением световой микроскопии. У 70–72% овец цисты локализовались в печени, у 26–28% — одновременно в печени и лёгких. В единичных случаях выявлено множественное поражение с вовлечением селезёнки, почек, мышц и

головного мозга. Макроскопически поражённые органы были увеличены в объёме, с выраженными деформациями и наличием пузырей размером до 8 см. Гистологически отмечены дистрофия, некроз, хроническое воспаление, периваскулярная инфильтрация и формирование гигантских клеток. Особенно выраженные изменения зафиксированы в печени и лёгких, включая фиброз и цирротическую трансформацию.

Эхинококкоз у овец характеризуется органоспецифичностью и вызывает комплекс деструктивно-продуктивных процессов в тканях. Понимание патоморфологии заболевания имеет важное значение для диагностики и профилактики в ветеринарной практике.