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РЕЗЮМЕ

Авторами статьи проведено генотипирования коров голштинской породы по локусам генов: MX1 g.143182088, CXCR1 c.+291C>T, CXCR1 +1093C>T, ассоцированных с резистентностью к маститам у коров, выявление животных с желательным генотипом, с минимальным риском заболеваемости субклиническим маститом. По локусам генов MX1 c.567 T>C, CXCR1 c.+291C>T, CXCR1 +1093C>T наблюдается генетический полиморфизм, распространенность генетических вариантов была: MX1 - TT –0,12, CT – 0,30, CC – 0,58, CXCR1 c.+291C>T - TT - 0,12, CT – 0,33, CC – 0,55, CXCR1 +1093C>T - TT - 0,47, CT – 0,51, CC – 0,02. По двум локусам генов, MX1 g.143182088 и CXCR1 +1093C>T выявлен факт нарушения генного равновесия и вследствие чего, установлено увеличение значения $\chi 2$ до 10,6261 и 9,7137, соответственно. Методом ПЦР-ПДРФ анализа были идентифицированы комбинированные генотипы 40 коров голштинской породы ТОО «Амиран» и в течение года ежеквартально проводилась диагностика на субклинический мастит, у животных с комбинированным CCCCCT генотипом по локусам генов MX1 c.567 T>C, CXCR1 c.+291C>T, CXCR1 +1093C>T обнаружен высокий риск заболеваемости субклиническим маститом. Таким образом, локусы генов MX1, CXCR1 являются потенциальными ДНК маркерами устойчивости к субклиническим маститам у коров голштинской породы.

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PATHOMORPHOLOGICAL CHANGES IN ECHINOCOCCOSIS OF THE LIVER OF SAIGAS FROM THE URAL POPULATION

ANNOTATION

This article presents a pathomorphological study of the livers of 3-year-old 5 saigas that died in the Zhanibek district.

Pathomorphological changes in the structure of the liver were characterized by changes in the colour of the organ to a reddish-brown colour; the liver was divided into two lobes with pronounced outgrowths in the right lobe. Pathomorphological changes in echinococcosis lesions of the liver were studied, characterised by mechanical compression of the organ tissues, dystrophy and atrophy of hepatocytes, and the development of inflammatory processes. Microscopic studies showed that in healthy animals, the liver is covered with a capsule consisting of collagen fibres, and the lobular structure of the organ is clearly expressed. In the liver affected by echinococcosis, significant immunomorphologic changes were observed in the form of compression of hepatic plates, increase of sinusoidal cells, accumulation of inflammatory cells and blood stasis in the central vein. A fibrous capsule develops around the parasitic cysts, possibly leading to cirrhosis.

Histologic examination confirmed the presence of parenchyma atrophy and structural changes in liver cells. It also revealed perivascular infiltrates and erythrocyte stasis in capillaries. The study results have implications for understanding morphologic changes in the liver during echinococcal invasion.

Thus, in severe liver damage by echinococcosis, there is mainly a disturbance of the structure of the liver beams, enlargement of the gallbladder and dilatation of biliary capillaries. At weak invasive process around the focal cyst, chronic reactive hepatitis with accumulation of lymphoid-histiocytic cells with expressed fibroblastic reaction is detected.

Key words: *Saiga, Ural population, pathomorphology, echinococcosis, liver.*

Introduction. Echinococcus species, particularly Echinococcus granulosus and Echinococcus multilocularis, are significant zoonotic parasites affecting wild ruminants and their ecosystems. The transmission dynamics of these parasites are influenced by various ecological and biological factors, including the interactions between wild ruminants and their definitive hosts, typically canids. Understanding the epidemiology of Echinococcus in wild ruminants is crucial for managing the health of wildlife populations and mitigating zoonotic risks to humans. Echinococcus granulosus is primarily associated with domestic livestock, but its presence in wild ruminants has been documented in various regions. For instance, a study in Italy highlighted the prevalence of E. granulosus in sheep and goats, indicating that these animals serve as significant intermediate hosts in the parasite's life cycle [1].

Research has highlighted that *Echinococcus multilocularis* is particularly concerning due to its role in causing alveolar echinococcosis, a severe infection that can lead to fatal outcomes for humans. Wild carnivores, such as red foxes (*Vulpes vulpes*) and coyotes (*Canis latrans*), serve as primary hosts for this pathogen, facilitating the continuation of its lifecycle and elevating risks of transmission to humans and domestic animals. Moreover, studies documenting the presence of *Echinococcus* species in various wildlife populations, including wolves and wild felids, emphasize the need for ongoing monitoring and control measures to mitigate infection risks in both wildlife and human populations.

The diversity of *Echinococcus* species highlights the intricate ecological interactions within their respective environments. For instance, recent phylogenetic studies have illustrated close genetic relationships among *Echinococcus* species, indicating rapid speciation and adaptation processes that reflect changes in habitat and host availability. This adaptability poses challenges for the control of echinococcosis, necessitating robust strategies for diagnosis and management that consider the different species and their transmission dynamics.

Echinococcus is a genus of parasitic tapeworms that pose significant zoonotic risks and impact both wildlife and domestic animals globally. The most notable species include Echinococcus granulosus, Echinococcus multilocularis, and Echinococcus shiquicus, each presenting unique epidemiological challenges and varying host dynamics. A comprehensive investigation into the epidemiology of Echinococcus in various animal populations is critical for developing effective control measures for echinococcosis, a disease that bears significant public health implications. This review highlights the prevalence of Echinococcus infections across a range of animal hosts, including domestic livestock and wildlife, underscoring the ecological interactions that facilitate transmission.

Current research indicates that Echinococcus species have adapted to a diverse array of animal hosts, demonstrating a complex interplay within different ecosystems. For instance, a systematic review of domestic and wild animals indicates that Echinococcus granulosus is predominantly transmitted between canines and livestock. Meanwhile, Echinococcus multilocularis and Echinococcus shiquicus are more entrenched in wildlife transmission cycles, including rodents and canids. In regions such as the Qinghai-Tibetan Plateau, multiple Echinococcus species coexist within wildlife populations, illustrating the dynamic relationship between host species and the evolutionary pressures exerted by parasitism [2].

Moreover, emerging data indicate that even in developed regions, Echinococcus infections persist among wild canids, raising concerns about the potential consequences for livestock health and food security. Reports of Echinococcus ortleppi infections in wild boars further highlight the expanding host range of Echinococcus species and the need for heightened surveillance. The geographical distribution of Echinococcus spp. is also subject to variations influenced by environmental and anthropogenic factors, demonstrating the intricate balance between wildlife, livestock, and human health interactions.

The challenge posed by Echinococcus infections in animals worldwide requires a multifaceted approach to mitigate its impact on animal health and prevent zoonotic transmission. Understanding the ecology of Echinococcus spp. across diverse environments will be key in designing preventive strategies and effectively controlling echinococcosis for the well-being of both animals and humans [3].

Furthermore, the prevalence of hydatidosis in wild ruminants can lead to considerable economic losses, as evidenced by findings in Turkey, where significant monetary losses were attributed to hydatidosis in slaughtered ruminants [4]. This financial impact underscores the importance of monitoring Echinococcus infections in wild populations, as they can serve as reservoirs for the parasite, potentially affecting livestock health and productivity. The distribution of Echinococcus species in wild ruminants is not uniform and varies geographically. In Slovenia, a survey of wild carnivores revealed the presence of Echinococcus species, suggesting that wild ruminants like deer may play a role in the transmission cycle of these parasites [5]. Similarly, a study in Mongolia identified wolves as primary definitive hosts for E. canadensis, indicating that the dynamics of Echinococcus transmission are closely linked to the ecological interactions between wild ruminants and their predators [6, 7]. These findings highlight the complex interplay between wildlife and parasite life cycles, emphasising the need for integrated wildlife management strategies that consider the role of wild ruminants in the epidemiology of Echinococcus.

Moreover, the prevalence of Echinococcus infections in wild ruminants can be influenced by environmental factors and host density. Research conducted in Southern Africa indicated that various species of Echinococcus circulate among wild and domestic animals, with significant implications for public health [8]. Recent studies have highlighted the diversity of Echinococcus species in wild mammals, particularly in regions like Namibia, where a comprehensive molecular survey identified multiple species in both carnivores and ungulates [9]. This study underscores the ecological complexity of Echinococcus transmission, as wild ruminants serve as potential intermediate hosts, facilitating the life cycle of these parasites. Similarly, research has shown that wild canids, such as wolves and foxes, are primary definitive hosts for Echinococcus species, further emphasising the role of wildlife in the epidemiology of these parasites [10-13]. The interaction between wild and domestic ruminants is another critical aspect of Echinococcus transmission dynamics. For instance, studies have indicated that wild ruminants can act as reservoirs for various pathogens, including Echinococcus, which can spill over into domestic livestock populations [13-16]. This is particularly concerning in regions where wild and domestic animals share habitats, as it increases the risk of zoonotic transmission to humans. The presence of Echinococcus granulosus in sheep, a typical intermediate host, has been well-documented, with studies indicating high prevalence rates in various regions, including Turkey [17].

Moreover, the ecological and environmental factors influencing Echinococcus transmission are significant. In regions where wild and domestic ruminants coexist, the risk of transmission increases, necessitating targeted surveillance and control measures to prevent outbreaks of echinococcosis in humans and livestock. In conclusion, studying Echinococcus in wild ruminants is essential for understanding the epidemiology of these parasites and their impact on wildlife health, livestock economics, and public health. Continued research is necessary to fill knowledge gaps regarding the transmission dynamics of Echinococcus species in wild populations, particularly in regions where interactions between wild and domestic animals are prevalent.

The article aims to describe pathomorphological changes in the liver of saigas affected by echinococcosis and histological changes in the liver structure.

Materials and Methods. The research was conducted in the Zhanibek district of the West Kazakhstan Region. Coordinates of Zhanibek district: Latitude: 49°25'20"N; Longitude: 46°50'49"E. Altitude: 29 meters above sea level (figure 1).

Five saigas were dissected and examined. Pathological necropsies were performed according to the Shor method [18], and visual inspection was conducted under natural and artificial light. The results were recorded in necropsy reports.

The samples were dehydrated in 4 portions of histological wiring solution (IsoPrep, BioVitrum, Russia) and two portions of BioClear (BioOptica, Italy), paraffinised in three portions of paraffin (HistoMix, BioVitrum, Russia) and cast into blocks. Slices with a thickness of 5 μm were obtained on the MZP-01 "Tekhnom" microtome. After their deparaffinisation in two portions of BioClear and three portions of ethanol of decreasing concentration, staining with hematoxylin and eosin [19] and Van Gieson [20] clarification in three portions of ethanol of increasing concentration and two portions of BioClear, and encapsulation with synthetic preserving medium BioMount (BioOptica, Italy) were performed.

Standard recommendations and algorithms for the study of histologic preparations were used for description [21].

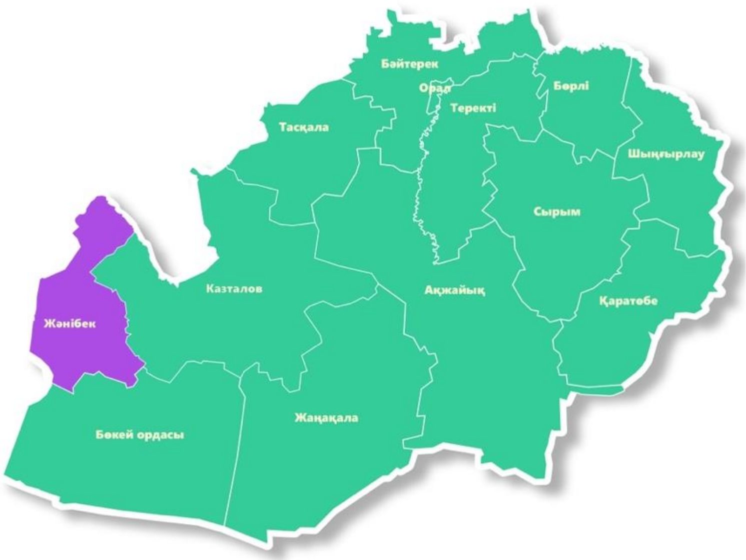

Figure 1 - Map of the Zhanibek district (study area)

Results. Data analysis in table 1 shows that from 2021 to 2024, there has been an increase in the number of studied saigas, as well as an increase in the percentage of infected individuals. In 2021, 15 saigas were examined, of which 7 (46.7%) were infected.

Table 1 - The number of saigas tested for echinococcosis in the West Kazakhstan region in 2021-2024

Year	Number of studied saigas	Number of infected saigas	Percentage of infected (%)
2021	15	7	46.7%
2022	18	9	50.0%
2023	20	11	55.0%
2024	22	13	59.1%

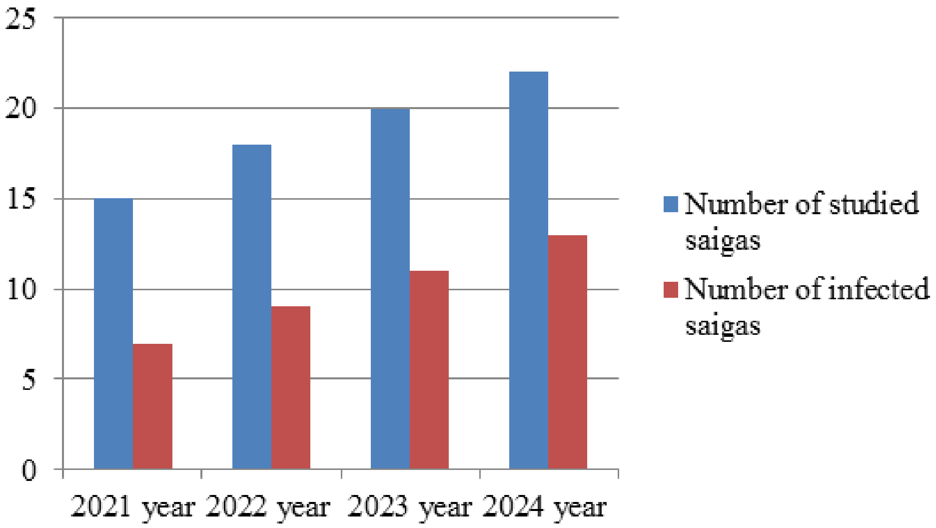

Figure 2 - Diagram of studied saigas for echinococcosis in West Kazakhstan region in 2021-2024

In 2024, the number of individuals studied increased to 22, and the percentage of infected reached 59.1%, indicating an increase in the incidence (figure 2).

Figure 3 shows a 3-year-old saiga body with clinical signs of echinococcosis, which was diagnosed by pathoanatomic necropsy, showing focal echinococcal lesions in the liver.

Figure 3 - Saiga body in Zhanibek district

Shallow notches were expressed on the blunt edge of the organ: oesophageal and notch for the caudal vena cava. The acute part of the liver is divided by notches into two lobes - left and right. The right lobe, the caudate lobe, the caudate and mastoid processes, and the quadrate lobe are distinguishable. The mastoid process noticeably overhangs the liver gate.

Figure 4 - Liver affected by echinococcosis

In saigas, an echinococcal cyst, up to 1 cm in diameter, was found in the right lobe of the liver; changes in the microstructure of the liver are associated with mechanical compression of the organ tissues, including parenchyma, blood vessels, and bile ducts, by the cyst (figure 4). This causes the development of dystrophic processes and atrophy of liver cells. Echinococcosis blisters had a rounded shape of yellowish-whitish colour, with fluctuating exudate inside the bladder. Vesicles were located singly in a connective tissue capsule, from which necrotic masses were separated.

Microscopic examination of the liver of saigas free from helminth infestations showed that the organ was covered by a capsule formed of connective tissue, the main elements of which were collagen fibres. When staining by the Van Gieson method, the collagen fibres of the capsule are arranged longitudinally and acquire an intense red tint.

Connective-tissue partitions, which divide the liver into separate lobes, are poorly developed and are represented by single fibres, the number of which increases around portal tracts. Van Gieson’s staining reveals the lobular structure of the organ. In the centre of each hepatic lobe, and sometimes in an eccentric position, there is a central vein, which belongs to the veins of the muscle-free type. The wall of the central vein is lined with discontinuous endothelium, and its shape varies from round to oval. The lumen of the vein is pronounced and sometimes contains blood remnants.

In saigas with echinococcal invasion of the liver, the main pathological changes are associated with compression of the hepatic laminae, leading to atrophy of hepatocytes.

At the same time, the number and size of sinusoidal cells significantly increased, and lymphocytes, histiocytes, plasma cells, and neutrophils accumulated around sinusoidal capillaries. A considerable accumulation of blood clots was recorded in the central vein of the hepatic lobe, indicating poor exsanguination of the organ.

The intermolecular connective tissue of the liver of helminth-free sheep contains portal tracts consisting of triad vessels: arteries, veins, and bile ducts. The veins in the triad have the most significant lumen, often of elongated irregular shape. The endothelial lining of these vessels is smooth and flat, and a narrow layer of smooth myocytes represents the muscular sheath. Arteries in the triad have a small diameter and narrow lumen. Their inner sheath (intima) is tortuous and lined with flat endothelial cells. Bile ducts in the same area are small and their lumen is lined with cubic epitheliocytes, distinguishing them from arteries. In the location of the portal zone (triad zone), sometimes accumulations of leukocytes are observed.

In the liver of helminth-free saigas, liver cells (hepatocytes) form radial tracts running from the central vein to the borders of the lobe (hepatic beams). Hepatocytes have a 4-5-angular, sometimes oval shape. Fine granularity is seen against the background of oxyphilic cytoplasm. The basophilic nucleus (sometimes consisting of two parts) is usually large, round or oval and located in the centre of the cell. One or two brightly coloured nuclei may be observed in the weakly basophilic karyoplasm. Sinusoid capillaries are slightly dilated, and the number of sinusoidal cells is negligible. Their nuclei have a flattened shape.

A pathomorphological examination of the liver of five saiga antelopes affected by echinococcosis revealed significant changes in the organ structure. The main morphometric parameters of cysts and affected tissues are shown in Table 2.

Table 2 - Morphometric parameters of cysts and affected tissues of saiga

Parameter	Significance
The size of the cysts	
Minimum diameter of cysts	0,5 cm
Maximum diameter of cysts	5,1 cm
Average diameter of cysts	1,8 ± 0,6 cm
Percentage of changes in liver tissue	
Necrotized areas	12.5% of the total liver area
Areas of fibrotic changes	23,8%
Dystrophic changes in hepatocytes	34,2%
Microscopic changes	
Increase in the number of sinusoidal cells	1.7 times compared to the control group
Decrease in the number of active hepatocytes	by 28% in the affected areas
Average thickness of the fibrous capsule around the cysts	0,8 ± 0,2 mm
Circulatory changes	
Blood stasis in the central vein	was seen in 80% of cases
Increased density of inflammatory infiltrates	by 45% compared to normal tissue.

The data obtained indicate a significant destruction of the liver structure in echinococcosis, which is confirmed by a high degree of fibrous changes and atrophy of hepatocytes. In the future, a more detailed analysis of the effect of parasitic cysts on the functional state of the organ is required.

With an intense liver lesion by echinococci, a violation of the bar structure of the organ is noted. Biliary capillaries expand and overflow with bile. In case of weak invasion around the parasitic cyst, chronic reactive hepatitis with lymphocytic infiltration and pronounced fibroblastic reaction is found. In the liver cells, granular, less often fatty dystrophy predominates, as well as atrophy, which is also observed in the organ's parenchyma.

Dystrophic changes are observed around the inflammatory focus, forming a fibrous capsule, including elements of loose fibrous tissue. The outer layer of the capsule consists of cellular components, and the inner layer consists of fibrous structures. The cyst cavity is filled with turbid infiltrate, in which developing echinococcal scolexes are found. Echinococcal protoscolexes can be located not only in the cyst cavity but also in the fibrous capsule, as well as outside it, in the liver tissue. Cysts often contain turbid, jelly-like detritus. In the capsule, connective tissues with a predominance of fibrous structures develop, which can lead to the development of parasitic cirrhosis. A thick layer of fibrous capsule consisting of cells and fibres is formed around the cyst.

Histologic examination of the liver affected by echinococcosis reveals atrophy of the parenchyma in the adjacent tissues. The cuticular shell of the cyst is a layered formation. The connective tissue is characterised by perivascular fibrosis and the presence of granulation tissue. Adjacent to the cyst, sections of hepatic beams are destroyed, and the shape of hepatocytes is changed - they become elongated. Granular dystrophy of hepatocytes is observed in the liver parenchyma adjacent to the cyst capsule. Perivascular infiltrates were found in the fibrous capsule of the cyst, and stasis and slugging of erythrocytes were detected in the capillaries.

Discussion. Echinococcus is a genus of parasitic tapeworms that poses significant public health and veterinary issues globally, primarily due to its implication in echinococcosis, a disease manifesting as cystic echinococcosis and alveolar echinococcosis. The life cycle of Echinococcus involves complex interactions between definitive hosts, typically canids, and intermediate hosts that include a wide range of mammals, including livestock and humans. A comprehensive understanding of the genotypic diversity and molecular epidemiology of Echinococcus species is essential to elucidate transmission dynamics and develop effective control measures.

Recent genomic studies have facilitated deeper insights into the biology of Echinococcus species. For instance, the sequencing of Echinococcus oligarthrus has revealed significant genetic similarity to Echinococcus multilocularis, expanding the genomic resources available for studying host-parasite interactions. Moreover, genetic diversity among Echinococcus strains significantly affects various characteristics of the parasite, such as its pathogenicity and drug sensitivity, underscoring the necessity for molecular characterization in epidemiological studies. This diversity is a global concern that can hinder effective treatment strategies across different geographical regions.

Echinococcosis has gained recognition as a neglected tropical disease, prompting a need for improved diagnostic and therapeutic approaches. Advances in immunology have contributed to novel diagnostic techniques that employ immunodiagnostic and DNA methods, thereby enhancing detection rates of cystic echinococcosis and alveolar echinococcosis in endemic populations. Several reviews summarize the current understanding of the life cycle, clinical presentation, and management of echinococcosis, confirming the parasite's status as a major public health concern. The development of new drug targets, identified through genomic insights, illustrates the potential for improved treatment strategies that target the unique biological features of Echinococcus species [22].

Recent findings regarding alternative splicing and gene expression profiles in Echinococcus support the notion that these parasites exhibit complex biological processes that influence their interactions with the host immune system and their overall pathogenicity. These studies provide an essential framework for future research aimed at understanding the immunological mechanisms of Echinococcus infections, potentially leading to effective vaccines and therapeutic interventions.

Wild animals play a pivotal role in the epidemiology of echinococcosis, serving as both definitive and intermediate hosts that perpetuate the parasite's life cycle. Much of the recent research has focused on understanding the transmission dynamics in wildlife, particularly emphasizing wild carnivores such as foxes, wolves, and jackals, which are known to harbor and disseminate different Echinococcus species. Echinococcus multilocularis, an agent of alveolar echinococcosis, circulates substantially in wild definitive hosts. Concurrently, wild carnivores in Slovenia act as reservoirs, reinforcing the importance of wildlife surveillance in the control strategies against both cystic and alveolar echinococcosis.

The implications of wildlife involvement extend beyond mere transmission. Wild animals serve as indicators of the broader environmental circulation of Echinococcus spp., underpinning the zoonotic risk to humans and domestic animals. Multiple studies have demonstrated that wild carnivores are integral in the persistence of these parasitic infections in ecosystems. For example, research from central Europe has consistently observed the significance of red fox populations in sustaining the life cycle of E. multilocularis. Moreover, the genetic diversity observed in Echinococcus spp. from wild carnivores in Kazakhstan suggests that wildlife reservoirs contribute to parasite variability, emphasizing the necessity of monitoring these populations to predict shifts in infection patterns and potential emergences of new strains.

The epidemiological interplay between wild and domestic hosts further complicates control measures. A systematic review that underscored the importance of understanding the ecology of Echinococcus spp. not only in domestic animals but also in wildlife. Their synthesis indicates that wild animal reservoirs, by maintaining independent cycles of infection and occasionally bridging the gap to domestic cycles, pose a persistent threat to public health. This zoonotic interface is particularly critical in regions where human encroachment into wildlife habitats is increasing, thus elevating the risk of cross-species transmission.

Control strategies must therefore be multifaceted, incorporating wildlife management as a core component. Interventions such as the deworming of wild foxes, as investigated, have shown promise in reducing the environmental contamination of Echinococcus eggs, thereby mitigating the risk of human and domestic animal exposure. Such measures, while logistically challenging, represent important steps towards integrated One Health approaches that address the complexity of zoonoses at the wildlife–domestic human interface. This comprehensive strategy not only requires continuous monitoring of wildlife populations but also calls for collaborative efforts across veterinary, public health, and ecological sectors [23].

The ecosystem dynamics of wild animals play an essential role in the transmission and persistence of echinococcosis. The research compiled from various geographic regions presents a compelling case for integrated surveillance and control programs that include wild carnivores as central figures in the epidemiological network. As emerging trends indicate, a deeper understanding of wildlife reservoirs, coupled with modern molecular and ecological tools, will be indispensable for predicting epidemic outbreaks and ensuring the effective management of echinococcosis worldwide.

The diagnosis of Echinococcus infections in animals is a challenging task that involves a combination of parasitological, serological, molecular, and imaging approaches to address the complexities arising from the parasite's diverse life cycle and host range. In definitive hosts such as canids, noninvasive methods have been increasingly adopted. Among these, coprodiagnostic techniques—including coproantigen enzyme-linked immunosorbent assay (ELISA) and copro-PCR—have proven to be instrumental in both epidemiological studies and the implementation of control programs. These methods are particularly attractive due to the ease of sample collection and the avoidance of more invasive necropsy procedures. The sensitivity of copro-PCR is further enhanced by recent modifications that improve the reliability of fecal DNA examinations, while real-time PCR assays offer the added benefit of simultaneous species identification, which is critical in endemic regions experiencing mixed infections.

Serological approaches have also advanced in recent years as a means to detect Echinococcus infection in definitive and intermediate hosts. For example, the development of in-house ELISA and Western blot protocols adapted for canine samples has demonstrated high sensitivity and specificity, thereby representing promising diagnostic strategies in veterinary settings. These serological assays often target antigens that are uniquely expressed by the parasite and absent in the host, minimizing cross-reactivity and increasing diagnostic accuracy. However, while serodiagnosis is an important tool, its practical application can sometimes be limited by variable antibody responses in different animal species and at various stages of infection. This necessitates the integration of serological testing with other diagnostic methods to improve overall sensitivity and specificity in the detection process.

Molecular diagnostics have emerged as a critical component in the differentiation of Echinococcus species, which is essential given that morphologically similar eggs can lead to misdiagnosis if examined only microscopically. Mutation scanning techniques and PCR assays have been developed not only to distinguish between Echinococcus species but also to detect genetic variation within populations. For instance, species-specific PCR assays have been effectively used to differentiate Echinococcus granulosus from species such as E. multilocularis and E. shiquicus in regions where these parasites co-exist. High-throughput sequencing and microRNA profiling have also been evaluated for their potential diagnostic applications in animal hosts, offering a novel approach by detecting parasite-specific non-coding RNAs that are absent in vertebrate hosts. This molecular layer adds significant robustness to diagnostic protocols, especially when used in combination with traditional serological and coprodiagnostic techniques.

Imaging methodologies, including radiography, ultrasonography, and computed tomography (CT), have been explored primarily in the context of diagnosing alveolar echinococcosis in dogs. Although these imaging techniques provide valuable insight into the localization and extent of pathological lesions in the liver and other organs, their use in veterinary diagnosis is still evolving and has yet to achieve the validation noted in human clinical diagnosis protocols. Imaging findings in animals are often used as supportive evidence in conjunction with serological and molecular results, thus enabling a more comprehensive diagnostic approach.

In addition to laboratory and imaging tests, the role of wildlife surveillance in understanding the eco-epidemiology of Echinococcus has gained prominence. Studies on wild canids, such as wolves, foxes, and coyotes, reveal that these animals can harbor multiple species or genotypes simultaneously. This zoonotic reservoir complicates transmission dynamics and further stresses the need for integrated diagnostic strategies that can be effectively applied across diverse host species. By combining molecular, serological, and imaging diagnostics, veterinary health professionals can achieve higher diagnostic accuracy, which is crucial for designing control programs that target both domestic and wild animal populations.

The diagnostic landscape for Echinococcus in animals is characterized by an evolving integration of conventional and novel approaches. The use of coproantigen detection and advanced PCR techniques offers high specificity, while serological assays complement these by providing evidence of host immune responses. Moreover, emerging molecular markers such as miRNAs and genomic markers pave the way for future diagnostic advancements that will likely enhance early detection and control of zoonotic transmission.

The pathology and morphological changes associated with Echinococcus infections in animals, particularly in the liver, are critical for understanding the disease's impact on animal health and its potential zoonotic implications. Echinococcus species, primarily Echinococcus granulosus and Echinococcus multilocularis, can cause significant liver pathology by forming cysts, leading to various complications. Echinococcus granulosus typically leads to the development of hydatid cysts in the liver, which can vary in size and number depending on the host and the strain of the parasite. These cysts are characterised by a fibrous capsule surrounding a fluid-filled cavity containing protoscolices and daughter cysts. These cysts can induce significant morphological changes in liver tissue, including fibrosis and inflammation. Infection with Echinococcus spp. results in hepatic fibrosis, which can lead to complications such as jaundice, portal hypertension, and cholecystitis due to the destruction of typical liver architecture [22]. This pathological alteration is primarily due to the host's immune response to the cysts, which can lead to chronic inflammation and scarring of the liver tissue. In cases of alveolar echinococcosis caused by Echinococcus multilocularis, the pathology is more severe and complex. In this case, the cysts are not well-defined and can invade surrounding tissues, leading to a neoplastic-like growth pattern. Pielok et al. described how advanced cases of alveolar echinococcosis can result in portal hypertension due to the extensive infiltration of liver tissue by the parasite, complicating diagnosis and treatment [23]. The irregular growth of these cysts can mimic malignant tumours, making radiological differentiation challenging. This invasive nature of E. multilocularis can lead to significant morbidity and mortality in affected animals.

Co-infections with other pathogens can also influence the morphological changes in the liver due to Echinococcus infection. For instance, studies have shown that co-infection with Fasciola hepatica can alter the morphology of Echinococcus granulosus cysts, resulting in smaller cyst sizes and changes in the immune response within the cysts [24, 25]. Such interactions highlight the complexity of liver pathology in the context of multiple infections and the need for comprehensive diagnostic approaches. Immunohistochemical studies have provided insights into the cellular responses within the liver during Echinococcus infections. Carollo et al. emphasised the role of non-parenchymal cells, such as Kupffer cells, in the liver's immune response to Echinococcus cysts [26]. The distribution and activation of these cells can influence the extent of inflammation and fibrosis observed in infected livers. Understanding these cellular dynamics is crucial for developing targeted therapies and management strategies for animal Echinococcus infections.

Echinococcus infections lead to significant pathological and morphological changes in the liver of affected animals. The formation of hydatid cysts and the associated immune responses can result in fibrosis, inflammation, and complications such as portal hypertension. The interplay between Echinococcus and other pathogens further complicates the pathology, necessitating a multifaceted approach to diagnosis and treatment.

Conclusion. Pathomorphological studies in the liver of saigas from the Ural population that have reached three years of age indicate characteristic features of the organ, including a brownish-reddish colouration with a specific structure, the presence of shallow notches on the blunt edge, and the division of the liver into two lobes with pronounced outgrowths. These data serve as an essential guide for further anatomical and histological studies of the liver of this population.

Significant changes in liver structure were found in saigas infected with echinococcus, caused by the cyst's mechanical compression of the organ tissues. This leads to the development of dystrophic processes and atrophy of hepatocytes, which affects the general functioning of the liver. Microscopic analysis of the liver in uninfected animals revealed typical features of the organ structure: a capsule formed by collagen fibres, poorly developed connective-tissue partitions, and a distinct lobular structure.

In echinococcal invasion, characteristic changes such as compression of hepatic plates, atrophy of liver cells, enlargement of sinusoidal cells, and infiltration with inflammatory cells are detected. Blood stasis is observed in the central vein, indicating impaired exsanguination of the organ. Inflammatory reactions are detected, followed by a fibrous capsule development around the parasitic cysts.

Histologic examination confirms the presence of significant pathologic changes in the liver, including chronic reactive hepatitis and fibrosis. These changes indicate serious dystrophic and inflammatory processes in the organ. These processes destroy liver cells, change their morphology, and develop fibrotic tissue, which may contribute to cirrhosis in the future.

Thus, this study's results confirm that echinococcal invasion of the liver in saigas causes severe morphological and functional changes in the organ. Further study is required to develop effective diagnostic and treatment methods for this disease in the saiga population.

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ТҮЙІН

Бұл мақалада Жәнібек ауданының аумағында 3 жастағы 5 киіктің өлекселерінің бауырын патоморфологиялық зерттеу ұсынылған.

Бауыр құрылымындағы патоморфологиялық өзгерістер органның түсінің қызыл-қоңыр түске өзгеруімен сипатталды, бауыр оң жақ бөлігінде айқын процестермен екі бөлікке бөлінді. Бауырдың эхинококкпен зақымдануындағы патоморфологиялық өзгерістер зерттелді, олар орган тіндерінің механикалық қысылуымен, гепатоциттердің дистрофиясымен және атрофиясымен, сондай-ақ қабыну процестерінің дамуымен ерекшеленді. Микроскопиялық зерттеулер көрсеткендей, сау жануарларда бауыр коллаген талшықтарынан тұратын капсуламен жабылған, мүшенің лобулярлы құрылымы айқын көрінеді. Бауырда эхинококкоздан зардап шеккен аймақтардың пластинкаларының қысылуы, синусоидалы жасушалардың ұлғаюы, қабыну жасушаларының жиналуы және орталық венада қанның тоқырауы түрінде айтарлықтай иммуноморфологиялық өзгерістер байқалды. Паразиттік кисталардың айналасында талшықты капсула дамыды, бұл цирроздың дамуына әкелуі мүмкін.

Гистологиялық зерттеу, паренхималық атрофияның болуын және бауыр жасушаларында құрылымдық өзгерістерді растады, сонымен қатар периваскулярлық инфильтраттар мен капиллярлардағы қызыл қан жасушаларының тоқырауын анықтады. Зерттеу нәтижелері эхинококкозбен инвазияланған киіктер бауырындағы морфологиялық өзгерістерді түсіну үшін белгілі бір мағынаға ие.

Осылайша, бауырдың эхинококкозбен ауыр зақымдануымен, негізінен бауыр құрылымының бұзылуы, өт қабының ұлғаюы және өт капиллярларының кеңеюі байқалады. Фокальды кистаның айналасындағы әлсіз инвазиялық процесте лимфоидты-гистиоцитарлы жасушалардың шоғырлануы бар созылмалы реактивті гепатит айқын фибробластикалық реакциямен анықталады.

РЕЗЮМЕ

В данной статье представлено патоморфологическое исследование печени 5 сайгаков 3 лет, павших на территории Жанибекского района.

Патоморфологические изменения в структуре печени характеризовались изменением цвета органа до красновато-бурой окраски, печень разделена на две доли с выраженными отростками в правой доле. Изучены патоморфологические изменения при эхинококкозном поражении печени, которые отличались механическим сдавливанием тканей органа, дистрофией и атрофией гепатоцитов, также развитием воспалительных процессов. Микроскопические исследования показали, что у здоровых животных печень покрыта капсулой состоящих из коллагеновых волокон, отчетливо выражена дольчатая структура органа. В печени пораженная эхинококкозом наблюдались значительные иммуноморфологические изменения в виде компрессии печеночных пластинок, увеличение синусоидальных клеток, скопление воспалительных клеток и застоем крови в центральной вене. Вокруг паразитарных кист развивалась фиброзная капсула, что может привести к развитию паразитарного цирроза.

Гистологическое исследование, подтвердило наличие атрофии паренхимы и структурных изменении в клетках печени, а также выявило периваскулярные инфильтраты и застои эритроцитов в капиллярах. Результаты исследования имеют определенные значения для понимания морфологических изменений в печени при эхинококкозной инвазии.

Таким образом, при сильном поражении печени эхинококкозом, отмечается в основном нарушение строения балок печени, увеличение желчного пузыря и расширение желчных капилляров. При слабом инвазионном процессе вокруг очаговой кисты обнаруживается хронический реактивный гепатит со скоплением лимфойдно-гистиоцитарных клеткои выраженной фибробластической реакцией.