UNIVERSITY OF SINDH JOURNAL OF ANIMAL SCIENCES
DOI: https://doi.org/10.57038/usjas.v7i03.6502
Uni. Sindh. J. Anim. Sci., vol. 7(3); 11-19, 2023
Email: editors.usjas@usindh.edu.pk
ISSN (P): 2521-8328
ISSN (E): 2523-6067
Published by University of Sindh, Jamshoro.

COENURUS CEREBRALIS ASSOCIATED PATHOLOGICAL FINDINGS IN GOATS: RESEARCH COMMUNICATION

MOBUSHRA IRSHAD[1], QAMAR UN NISA[1*], GULBEENA SALEEM[1], MUHAMMAD AVAIS[2], SYED KHURRAM FAREED[3]

[1]Department of Pathology, University of Veterinary and Animal Sciences, Lahore-Pakistan.
[2]Department of Veterinary Medicine, University of Veterinary and Animal Sciences, Lahore-Pakistan.
[3]Baqai College of Veterinary Sciences, Baqai Medical University, Karachi, Pakistan

ARTICLE INFORMATION

Article History:
Received: 14th June 2023
Accepted: 20th July 2023
Published online: 30th September 2023

Author's contribution
MI conducted research, QUN supervised research, GS assisted in experiment, MA designed the project, SKF helped in writing manuscript.

Key words:
Coenurus cerebralis; goat; cyst; histopathology; hematology

ABSTRACT

Coenurosis, which is also known as gid is a stage, which causes infection especially in goats, sheeps and sometimes also in human. This is the intermediate stage of the tapeworm of carnivores, known as Taenia multiceps. Blood, CSF, brain and cyst samples of total 30 (N=30) were obtained from the affected goats.CBC, serum biochemistry, PCR, cytology and histopathology was performed. The data about owner, management and conditions were recorded. Chi-square test and Independent t-test was used for analysis.Statistical analysis was performed on Statistical Package for the Social Sciences (IBM SPSS version 25) software. This study done yield data about the status of acute and chronic form of *Coenurosis cerebralis* in goats population of district Lahore and its cytological effects and histopathological lesion,as well as, its hematological effects and molecular characterization.The study findings helped in designing some strict measures for minimizing economic losses in livestock industry of Pakistan.

1. INTRODUCTION

Livestock is considered as one of the fastest growing subsectors of agriculture in Pakistan and its share in agriculture is 56% and 11% in GDP. Livestock promote socio-economic development and approximately 35 million people are involved in raising animals for meat and milk purposes. Due to increase in population and food demand, it becomes a vigorous source of income for the rural and plays an important role in alleviation of poverty as they earn 10-25% of their income from livestock. According to economic survey of Pakistan goat population is 53.5 million numbers and meat, milk and skin obtained from goats (Rehman *et al.*, 2017).

Within rural society goats are an important animal in livestock productions systems. Because of fewer resources and maintenance cost, low input requirements goat comprises the total wealth of poor families of rural areas. Quick reconstitution of flocks according to demand and after disaster needs only short period.

Diseases due to poor management and poor breeding policies are the major constraints in small ruminants' production systems. Goat productivity is mostly affected by helminthes parasites in Pakistan (Shiferaw & Abdela, 2016). In small ruminant *Ceonurus cerbralis* is considered as the major cause of stockbreeding losses (Sun *et al.*, 2017).

Coenurus cerebralis causes neurological parasitic disease, which is known as staggers, gid and sturdy, is a stage, which causes infection especially in goats, sheeps and in humans. This is the larval stage of the tapeworm of canid known as *Taenia multiceps* and normally present in intermediate host (Oryan *et al.*, 2015a). Tapeworms of Cyclophyllidea are among the crown groups of the subclass eucestoda. Among this Taeniidae family which consist of tapeworms of livestock in the genus Taenia. The general characteristics of different species exibit as specific arrangement of rosteller hooks on scolex in cyst (Hoberg, 2002).

* Corresponding Author: qamar.nisa@uvas.edu.pk

During the 17th century reliable records of the disease appeared in literature although the details of nervous symptoms of the disease have been discovered in literature from the time of Hippocrates. The adult tape worm inhabits the small intestine of canids which are definitive hosts and eggs are excreted within the feces and ingested by herbivores that act as intermediate host for parasite.

Other species which affect canines or feline and rodents are *Taenia pisiformis* and *Taenia taeniaeformis* and those which are of zoonotic importance include *Taenia solium* which is found in pigs and *Taenia saginata* present in cattle (Hoberg 2002). The metacestodal form was first time recognized by (Schuster *et al.*, 2015). The neurological form of *Coenurus cerebralis* in goat was reported first from Lahore, Pakistan by Greig (1977) which is caused by intermediate stage of *Taenia multiceps* (Rahman *et al*., 2017). The prominent feature associated with gid developed sporadically and progressively became more visible prior to the death of the animal postmortem findings revealed simultaneous occurrence of cerebral and hepatic form of coenurosis. While considering pathological findings in the affected organs, a different strain of *Taenia multiceps* was involved in the caprine coenurosis. Normally Coenurusis affects the brain, but its stray locations may also be recorded sometimes (Sharma *et al.*, 1995). There is also another form of this infection, which is caused by *Coenurus gaigeri* in: intramuscular, sub-cutaneous and connective tissues, as well as, liver, and lung also affected in goats (Oryan *et al.*, 2015b).

2. MATERIALS AND METHODS

Study Area

The second largest city as well as the capital of Punjab is Lahore. The total area is 1,772 square kilometers. The total population of Lahore is 11,126,285. The study was carried out on the infected goats which were randomly selected after physical examination at different veterinary hospitals and local slaughterhouses from the surroundings of Lahore.

Experimental Design

A total of 30 goats (n=30) were included in this study. Inclusion criteria was the suspected goats. The samples including blood, cerebrospinal fluid, brain, and cyst were collected. All the samples were collected by following standard protocol to minimize pain and discomfort to the animals while conducting these experiments.

The study was conducted to determine cytological examination, molecular characterization, haematological analysis, and histopathological lesions of *Coenurus Cerebralis* in goats.

Collection of Cerebrospinal fluid

Collection of CSF samples was performed by cerebellomedullary cisternal puncture.

Collection of Blood and Serum Samples

The blood samples were collected from the jugular vein of goats located in the neck region.

Sample collection for histopathology

The heads from 30 goats (n=30) were collected at the Abattoir after slaughtering. The head separated from the rest of the carcasses and brought to the UVAS postmortem laboratory where brain and cyst samples were collected from it.

Cytology of CSF

Cerebrospinal fluid samples were evaluated after simple centrifugation and stained with Giemsa.

Molecular Study

DNA was extracted from 200µl cerebrospinal fluid samples with genomic purification kit catalogue# 51304, using the QIAamp DNA Mini Kit (50) (Qiagen, Hilden, Germany) according to the manufacturer's protocol for PCR and for the confirmation of *Coenurus Cerbralis* in the collected CSF samples. DNA was stored at –20 °C. PCR was performed in a thermo cycler by following Initial denaturation at 95 °C for 5 minutes, denaturation at 94 °C for 1 minute, annealing at 55 °C for 1 minute, elongation at 72 °C for 1 minute and final elongation at 72 °C for 5 minutes was performed. A total of 35 cycles of denaturation, annealing and elongation were performed. The PCR products obtained from the mitochondrial region were electrophoresed on a 1.5 % agarose gel and stained with ethidium bromide (10 mg/ml). The amplification products were visualized under a UV trans illuminator and photographed.

Hematological analysis

From blood sample complete blood count was performed to check the changes in the level of white blood cells, lymphocyte, monocyte, granulocyte, hemoglobin, red blood cell count, PCV, MCV, MCH, MCHC, RDW, PDW, HCT, PCT and platelets by using the MS4Se fully automated hematology cell counter (Melet Schloesing Laboratories, France) according to the manufacturer's protocol.

Serum chemistry

Total protein estimation from collected blood sample was performed by using Edif Sphera Chemistry Analyzer (Edif Instruments S.r.I Via Ardeatina, 132 – 00179 Roma, Italy) according to the manufacturer's protocol.

Histopathology

Collected tissues samples were examined histopathologically by using standard techniques. To prevent any autolytic changes tissue samples were fixed in 10% neutral buffered formalin with the ratio of 1:10 and allowed it to be adequately fixed for 24-48 hours. The sample was further proceeded by following steps; dehydration, clearing, sectioning, embedding, and staining with H&E stain.

3. RESULTS AND DISCUSSION

The research study was performed with the objective of observing the changes in blood parameters of goats affected with fatal infection and for diagnosis of *Coenurus cerebralis* based on PCR. Cytology of samples was performed for the observation of effects of infection on cerebrospinal fluid. The alteration in brain tissues of goats including presence of cyst was observed. Histopathology of brain and cyst for the observation of changes in tissues was performed. The alterations in blood were checked by performing complete blood count including various parameters like packed cell volume, MCV, MCH, MCHC, red cell distribution width, red blood cell, white blood cell, lymphocyte, monocyte, granulocyte, hemoglobin, and platelets. For observation of serum chemistry total protein estimation was performed. Cytology of samples was performed for the observation of effects of infection on CSF.

For the fulfillment of these objectives, suspected goats showing nervous signs including froth from nostrils, frequent bleating, circling, staggering gait, blindness, bumps into objects and paralysis were used. A total of 30 goats (n=30) were used in this study. The samples were collected from the local Abattoir and clinics by following standard protocol. The sampling was performed by following three steps; firstly, the blood samples of 4-5 ml were collected for CBC and serum chemistry, secondly CSF samples of 4-5ml were collected for PCR and cytology, and thirdly different brain sections and cyst were collected for histopathology. All the samples were collected by using sterile and standard techniques and transported to the laboratories of UVAS Lahore. The history of animal including sex, age, breed, area, duration, purchase or marketed and signs was recorded. The data regarding the owner including name, contact number and residential address was collected.

In this study first the identification of showing certain nervous signs was performed. The visually suspected goats were mostly showing signs of high temperature, restlessness, high respiratory rate, unilateral blindness, paralysis, froth from nostril and mouth and downer condition. After slaughter the presence of cysts were confirmed as it is specific sign of this infection as shown in figure 1, 2 and 3.

CSF samples cytology show presence of different cells in cerebrospinal fluid. The presence of the following cells: eosinophils, red blood cells, white blood cells, lymphocytes, neutrophils, and monocytes were detected during microscopic examination of slides from the infected goat.

By the PCR, 21 goats were found positive, and 9 goats were found negative. The suspected goats, which were confirmed with PCR later, show that there were significant differences in values of blood parameters between affected and healthy goats as shown in table 1.

The result of serum biochemistry shows there was significant difference in the value of total protein concentration of effected goats as shown in table 2.
Total protein concentration was increased in the blood of the gid infected goats. The most prominent changes observed grossly were hemorrhages, thinning and atrophy of overlying cerebral tissues. During microscopic examination macrophages infiltration, Leukocytic infiltration along with red blood cells was also observed. Perivascular cuffing microgliosis, cestode cutis debris and fewer lymphocytes were also observed microscopically. Chronic inflammatory cells, degenerative mononuclear cells, histiocytes, langerhans giant cells, necrosis and congested blood vessels were also noticed as shown in figure 4 to 16.

Meat production is one of the major activities of Pakistani Livestock Sector. Currently owing to changing lifestyle and awareness regarding balanced diet, meat demand has drastically increased. Regardless of the nature of the economy, the agriculture sector plays pivotal roles in the economic development of the developing countries. Livestock is the single largest contributor to overall agriculture i.e., 53.2 percent. Livestock is considered as one of the fastest growing subsectors of agriculture in Pakistan and its share in agriculture is 56% and 11% in GDP. Approximately 35 million of people are involved in raising animals for meat and milk purposes. On the other hand, the population growth, increase in per capita income and export revenue is fueling the demand of livestock and livestock products and population growth, urbanization and income growth in developing countries are fuelling a massive global increase in demand for food of animal origin. That is why it becomes a vigorous source of income for the rural and playing an important role in alleviation of poverty as they earn 10-25% of their income from livestock. From goat meat ,milk and skin obtained (Rehman *et al*., 2017)

Coenurosis *is* a fatal zoonotic disease of small ruminants and known as gid, sturdy, staggers. It is neurological parasitic infection caused by intermediate stage of metacestode of *Taenia multiceps* which is a tape worm of canids (Oryan *et al*., 2015a). *Coenurus Cerebralis* causes economic losses in exports by condemnation of the effected organs of the animal like brain or by killing the animal or by reduction in productivity of the animals (Abera *et al*., 2016).

In this study the suspected goats were diagnosed by physical and neurological examination of the animal as described by (Zobba *et al*., 2014a) as well as (Li *et al*., 2017). The same method of diagnosis from history and clinical manifestations was described. In current study the identification of infection showing certain nervous signs was performed. The visually suspected goats were mostly showing the signs of drowsiness, irregular gait, circling and failure to hold head straight as observed by (Hassanein & Elghaffar 2016). High temperature, restlessness, high respiration, appetite loss and unable to stand were also observed as described by (Shiferaw & Abdela, 2016). Other neurological symptoms which were observed include blindness of either left/ right or both eyes as observed by (Oryan *et al*., 2014) . In chronic condition paralysis also observed as by (Al-Riyami *et al*., 2016)

In the present study, CSF was collected from suspected goats for cytological examination. Collected CSF was transported to the laboratory using standard procedure, and immediately slides were prepared by centrifugation and staining with Giemsa. Cytological evaluation of CSF showed increased eosinophils as well as presence of lymphocytes. Other cells including red blood cells, lymphocytes and neutrophils were also present in s the smear of CSF. The presence of eosinophilia in CSF smear has been considered as effective pre-method for the diagnosis of parasitic infection like gid as observed by (Oruç & Uslu, 2006)

In this study polymerase chain reaction was performed on CSF samples for the diagnosis of *Coenurosis cerebralis* infection in goats. For this purpose, 4-5 ml of CSF samples were collected from the suspected goats and transported to the laboratory following standard protocol. For PCR the first mitochondrial DNA was extracted from CSF by using QIAamp DNA Mini Kit. PCR was performed by following certain conditions as described by (Oryan *et al*., 2015a) . The presence of parasite was confirmed by gel electrophoresis after seeing through trans illuminator. The PCR of 30 goats were performed out of which 21 were positive and 9 were found negative.

So PCR also used for identification of parasite in ruminants as described by (Oryan *et al*., 2015a) . There were some variations in results were recorded. Some goats results showed positive but they do not had cyst in brain. Similarly, some results were negative even for the goats having cyst in brain. Variation in results may be due to some external factors. But still examination of the brain containing cyst having thin wall and filled with transparent fluid remain as definitive diagnosis despite the availability of these tests(Afonso *et al*., 2011). Similar method was described for diagnosis as separation of head after slaughtering and by visible examination of brain (Miran, 2013) and by checking localization of cyst in brain (Scott, 2012).

In the present study blood samples were collected from the suspected goats and there were significant differences recorded in values of hematological parameters between affected and healthy goats. There was an increase in white blood cells, lymphocytes, monocytes, granulocytes and red blood cells. The decrease in MCV, MCH and MCHC were also recorded. There was increase in RDW and platelets. In some cases decrease in hemoglobin recorded as observed by (Ghosh *et al*., 1998) but others parameters were contrast from the results . In some cases no effect on hematological parameters recorded as recorded by (Kumar *et al*., 2002)

In the present study the blood samples were collected from the suspected goats and the result shows there was significant difference in the value of total protein concentration. Total protein concentration was increased which were different from previous data as (Kumar *et al*., 2002) . In the similar serological studies the decrease in the level of total protein was recorded which is different from our current study (Saleh, 2004). There was no significant increase recorded in serum protein according to (Altintaş *et al*., 1997). Variations in the result of these studies can be due to geographical, species variations and due to some other factors influencing the change in natural infections.

In the present study head of the slaughtered goat was collected from slaughterhouse and clinics and transported to University of Veterinary and Animal Sciences laboratory where further steps of processing of the tissues were performed according to the standard protocol. On opening of the skull thinning and atrophy of the overlaying cerebral tissues was recorded. In addition, there was presence of visible cyst, which was ruptured on opening and fluid discharge abruptly as observed by (Haridy *et al*., 2013). The surrounding brain tissues revealed perivascular cuffing as observed by (Oryan *et al*., 2015a).The cellular debris were also recorded as by (Ioannidou *et al*., 2015)

4. CONCLUSION

From the results of the present study, it can be concluded that there are significant tissue changes in brain and formation of cyst as well as many blood alterations occurs. PCR can be used for the diagnosis of *Coenurus cerebralis.*

5. CONFLICT OF INTEREST

All authors have declared that there is no conflict of interests regarding the publication of this article.

6. ETHICAL STATEMENT

Hereby, Mobushra Irshad consciously assures that this material is the author's 'own research and analysis in a truthful and complete manner. All sources used are properly disclosed. All authors have been personally and actively involved in substantial work leading to the paper and will take public responsibility for its content.

REFRENCES

Greig, A., & Holmes, E. (1977). Coenurosis in cattle. *Veterinary Record, 100*(13), 266-266.

Haridy, M., Sakai, H., El-Nahass, E.-S., El-Morsey, A., Anwar, S., & Yanai, T. (2013). Coenurus cerebralis cysts in the left lateral cerebral ventricle of a ewe. *Journal of Veterinary Medical Science, 75*(12), 1643-1646.

Hassanein, K. M., & Elghaffar, S. K. A. (2016). Internal hydrocephalus caused by Coenurus cerebralis in a ewe. *Journal of Advanced Veterinary and Animal Research, 3*(2), 184-187.

Hoberg, E. P. (2002). Taenia tapeworms: Their biology, evolution and socioeconomic significance. *Microbes and Infection, 4*(8), 859-866.

Huang, X., Xu, J., Wang, Y., Guo, C., Chen, L., Gu, X., ... Yang, G. (2016). GP50 as a promising early diagnostic antigen for Taenia multiceps infection in goats by indirect ELISA. *Parasites & Vectors, 9*(1), 618.

Ioannidou, E., Psalla, D., Papadopoulos, E., Diakou, A., Papanikolopoulou, V., Karatzias, H., ... GIADINIS, N. D. (2015). Regurgitations in a Lamb with Acute Coenurosis-A case Report. *Iranian Journal of Parasitology, 10*(2), 301.

Kheirandish, R., Azizi, S., Mirzaei, M., & Sami, M. (2012). Prevalence, predilection sites and pathological findings of Taenia multiceps coenuri in slaughtered goats from south-east Iran. *Onderstepoort Journal of Veterinary Research, 79*(1), 1-5.

Kumar, A., Rana, R., Vihan, V., & Arora, N. (Eds.). (2002). *Proceedings of the V National Seminar on Strength challenges and opportunities in small ruminants diseases in new millennium*, Organized by ISSGPU at Jaipur on December.

Li, W., Zhang, N., Yue, L., Yang, Y., Li, L., Yan, H., ... Fu, B. (2017). Transcriptomic analysis of the larva Taenia multiceps. *Research in Veterinary Science, 115*, 407-411.

Miran, M. B. (2013). Coenurosis in slab-slaughtered sheep and goats in Ngorongoro district: Prevalence and predisposing factors of the disease. *Sokoine University of Agriculture*.

Miran, M. B., Nzalawahe, J., Kassuku, A. A., & Swai, E. S. (2015). Prevalence of coenurosis in sheep and goats at three slaughter slabs in Ngorongoro District, Tanzania. *Tropical Animal Health and Production, 47*(8), 1591-1597.

Nourani, H., & Kheirabadi, K. P. (2009). Cerebral coenurosis in a goat: Pathological findings and literature review. *Comparative Clinical Pathology, 18*(1), 85-87.

Oruç, E., & Uslu, U. (2006). Comparative cytopathological and histopathological studies of sheep with suspected Coenurus cerebralis infection. *Turkiye Parazitolojii Dergisi, 30*(4), 285-288.

Oryan, A., Akbari, M., Moazeni, M., & Amrabadi, O. (2014). Review Paper Cerebral and non-cerebral coenurosis in small ruminants. *Tropical Biomedicine, 31*(1), 1-16.

Oryan, A., Amrabadi, O., Sharifiyazdi, H., Moazeni, M., Akbari, M., & Ghane, M. (2015a). Application of polymerase chain reaction on cerebrospinal fluid for diagnosis of cerebral coenurosis in small ruminants. *Parasitology Research, 114*(10), 3741-3746.

Oryan, A., Moazeni, M., Amrabadi, O., Akbari, M., & Sharifiyazdi, H. (2015b). Comparison of distribution pattern, pathogenesis and molecular characteristics of larval stages of Taenia multiceps in sheep and goats. *Small Ruminant Research, 132*, 44-49.

Rahman, M. M., Sultana, S., Hassan, M. Z., & Rahman, M. M. (2017). Surgical management of gid disease in goat at Rangpur district of Bangladesh. *Asian Journal of Medical and Biological Research, 3*(1), 109-113.

Rehman, A., Jingdong, L., Chandio, A. A., & Hussain, I. (2017). Livestock production and population census in Pakistan: Determining their relationship with agricultural GDP using econometric analysis. *Information Processing in Agriculture, 4*(2), 168-177.

Saleh, I. (2004). Some biochemical studies on serum of sheep affected with coenurus cerebralis. *Vet. Med. J., 52*(1), 61-68.

Scala, A., & Varcasia, A. (2006). Updates on morphobiology, epidemiology and molecular characterization of coenurosis in sheep. *Parassitologia, 48*(1-2), 61-63.

Schuster, R., Sivakumar, S., Wieckowsky, T., & Reiczigel, J. (2015). Abattoir survey on extra-cerebral coenurosis in goats. *Helminthologia, 52*(4), 303-309.

Schuster, R. K., Sivakumar, S., & Wieckowsky, T. (2010). Non-cerebral coenurosis in goats. *Parasitology Research, 107*(3), 721-726.

Scott, P. (2012). Diagnosis and treatment of coenurosis in sheep. *Veterinary Parasitology, 189*(1), 75-78.

Sharma, D., Sanil, N., Agnihotri, M., & Singh, N. (1995). Subcutaneous coenurosis in barbari goat. *Indian Veterinary Journal, 72*, 1203-1205.

Shiferaw, A., & Abdela, N. (2016). Public health and economic significance cerebral coenurosis in sheep and goat: a review. *Acta Parasitol Glob, 7*(2), 54-65.

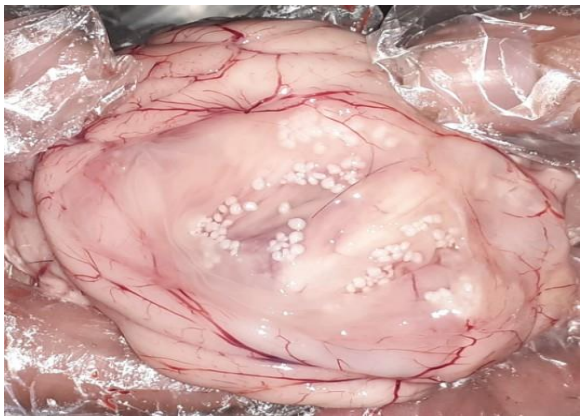


Figure 1. Cyst from the brain of goat

Figure 2. Sample of brain showing presence of cyst

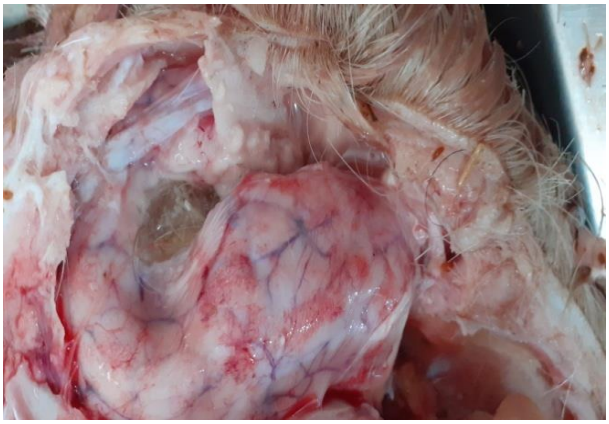


Figure 3. Presence of hemorrhages and cyst in brain

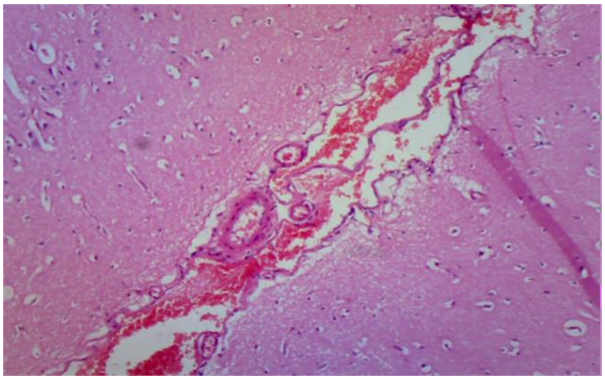


Figure 4. Micrograph of brain cross section showing congested blood vessels (H&E, 10X)

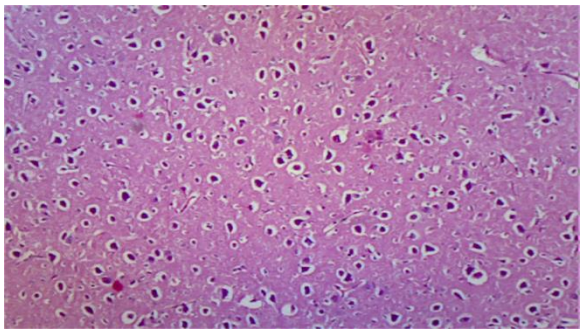


Figure 5. Microphotograph of brain cross section showing gliosis (Hematoxylin-Eosin, 10X)

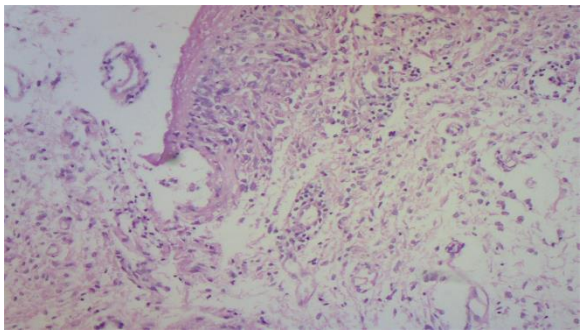


Figure 6. Photomicrograph of brain cross section showing leukocytic infiltration (Hematoxylin-Eosin, 10X)

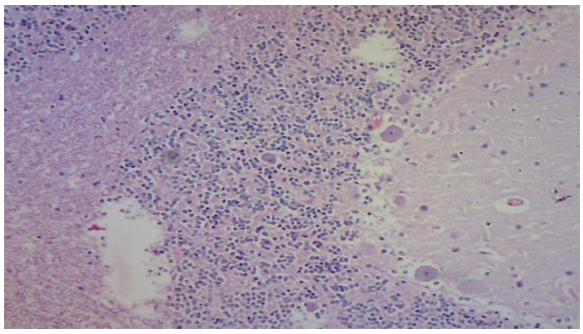


Figure 7. Photomicrograph of brain cross section showing leukocytic infiltration (Hematoxylin-Eosin, 10X)

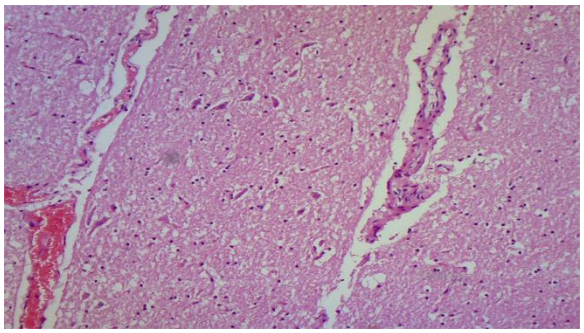


Figure 8. Micrograph of brain cross section showing congested blood vessels (H&E, 10X)

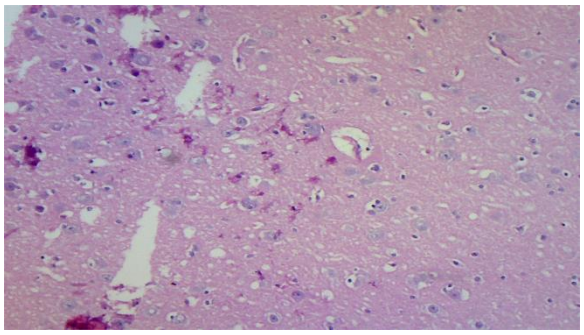


Figure 9. Micrograph of brain cross section showing gliosis (Hematoxylin-Eosin, 10X)

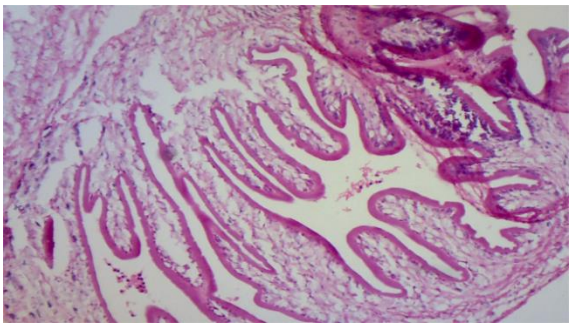


Figure 10. Photomicrograph of cyst cross section (Hematoxylin-Eosin, 10X)

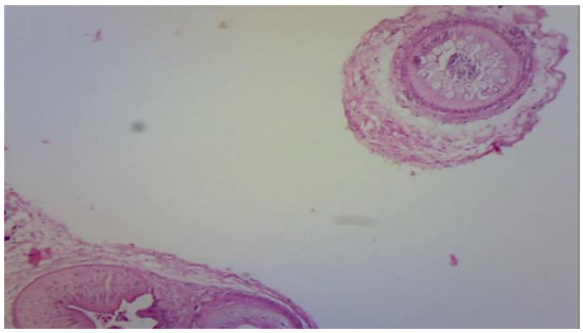
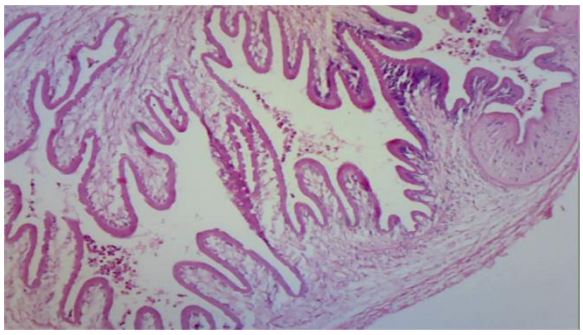


Figure 11. Photomicrograph of cyst cross section (Hematoxylin-Eosin, 10X)



Figuure 12. Photomicrograph of cyst cross section (Hematoxylin-Eosin, 10X)

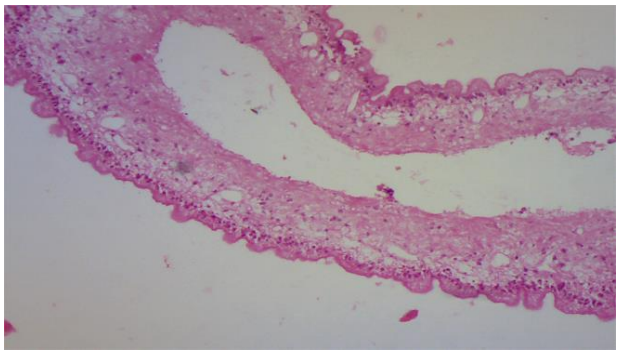


Figure 13. Microphotograph of cyst cross section showing cutis debris (Hematoxylin-Eosin, 10X)

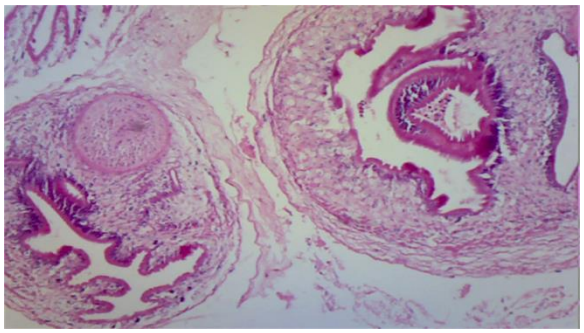


Figure 14. Photomicrograph of cyst cross section (Hematoxylin-Eosin, 10X)

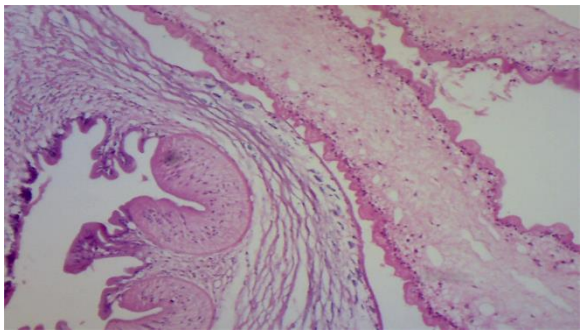


Figure 15. Photomicrograph of cyst cross section (Hematoxylin-Eosin, 10X)

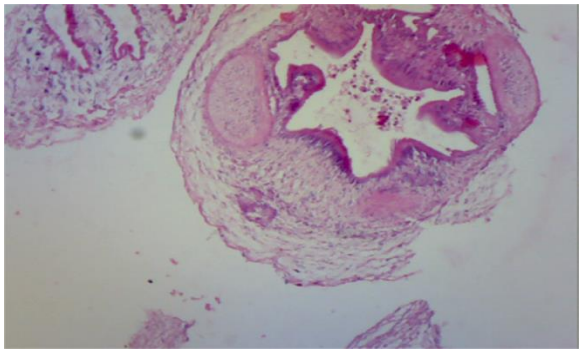


Figure 16. Photomicrograph of cyst cross section (Hematoxylin-Eosin, 10X)

Table 1: Comparative values of hematology infected and non-infected animals

Hematological parameters	Groups		P-Value (P<0.05)
	Infected animals	Non-infected animals	
WBC count (10^9/L)	37.76± 283.35	11.66±2.33	0.013
Lymphocytes (10^9/L)	22.72±346.58	5.82±0.24	0.132
Lymphocytes (%)	52.54±576.76	59.60±24.96	0.620
Monocytes (10^9/L)	1.32±0.67	2.33±0.72	0.63
Monocytes (%)	4.39±3.63	3.10±0.37	0.260
Granulocytes (10^9/L)	11.75±34.33	3.36±0.02	0.021
Granulocytes (%)	38.43±455.06	42.66±116.33	0.740
Hemoglobin (g/dL)	8.26±0.93	9.46±0.30	0.045
Red blood cells (10^{12}/L)	19.56±22.32	12.70±14.32	0.022
PCV (%)	30.11±17.43	30.47±44.40	0.894
MCV (fl)	17.68±30.73	19.27±9.02	0.633
MCH (pg)	4.87±2.20	6.60±1.44	0.053
MCHC (g/dl)	25.56±31.62	31.70±9.25	0.076
RDW	17.72±12.08	10.36±1.90	0.001
Platelets	471.48± 354.10	393.66± 50.90	0.710
MPV (fl)	5.74±0.41	5.46±0.90	0.508
PCT (%)	0.38±0.13	0.03±0.01	0.117

Table 2: Comparative values of serum biochemistry of infected and non-infected animals

Serum biochemistry	Groups		P-Value (P<0.05)
	Infected animals	Non-infected animals	
Total protein g/dl	7.3± 0.13	6.5±0.04	0.001