Veterinaria Italiana, 2011, **47** (3), 333-340

Survey on coenurosis in sheep and goats in Egypt

Enas A. Desouky, Ahmed I. Badawy & Refaat A. Refaat

Summary

A total of 75 sheep and goats from apparently healthy and from clinically affected flocks were examined for *Coenurus cerebralis* cysts from different localities in Egypt. Of 25 animals examined from clinically diseased sheep and goats, 25 (100%) revealed the presence of infestation with one to four coenuri in the brain. The sites of predilection were the left hemisphere (48%), followed by the right hemisphere (40%) and the cerebellum (12%). There was no apparent effect of the age of sheep and goats on susceptibility to infestation with *C. cerebralis*. Another 50 animals from apparently healthy sheep and goat herds presented no *C. cerebralis* cysts. The cysts from infested sheep could infest newborn puppies experimentally, with a prepatent period of 60 days post infestation. A total of 15 immature worms that were recovered from one puppy did not reach patency until 105 days post infestation with *C. cerebralis* cyst scolices. Pathological changes in *C. cerebralis*-infested sheep brain revealed parasitic elements, demyelinated nerve tracts, hyperaemic blood vessels with round cell infiltration, encephalomalacia with round cell infiltration and palisading macrophages and giant cells, as well as focal replacement of the brain parenchyma with caseated and calcified materials. The morphological characteristics of both the larval stage from sheep and goats and adult worms of *Taenia multiceps* from experimentally infested dogs are described. The results conclude that *C. cerebralis* is one of the principal causes of nervous manifestations of coenurosis in clinically diseased sheep and goats in Egypt.

Keywords

Coenurosis, *Coenurus cerebralis*, Dog, Egypt, Goat, Sheep, *Taenia multiceps*, Morphology, Pathology.

Indagine sulla cenurosi nella popolazione ovina e caprina in Egitto

Riassunto

Sono stati esaminaiti 75 esemplari di pecore e capre, apparentemente sani o con segni clinici, provenienti da diverse località dell'Egitto, per verificare la presenza di cisti da Coenurus cerebralis. *In 25 esemplari (100%), provenienti da greggi con animali clinicamente affetti, è stata riscontrata un'infestazione con un numero di cenuri variabile da 1 a 4, localizzati nell'emisfero sinistro del cervello (48%), nell'emisfero destro (40%) e nel cervelletto (12%). Non è stata riscontrata correlazione tra età degli animali e suscettibilità all'infestazione. Le cisti prelevate da pecore infette sono state in grado di infestare gli agnelli appena nati con un periodo asintomatico di 60 giorni post-infezione. Quindici parassiti immaturi recuperati da un agnello non sono stati, invece, in grado di causare sintomi fino a 105 giorni dopo l'infezione con gli scolici di* Coenurus cerebralis. *Le alterazioni patologiche nel cervello delle pecore infestate hanno evidenziato: elementi parassitari, demielinizzazione localizzata, vasi ematici iperemici con infiltrazione di cellule tonde, abbondanti macrofagi e cellule giganti nonché una localizzata sostituzione del parenchima cerebrale con materiali caseosi e calcificati. Nei 50 esemplari apparentemente sani non sono state riscontrate cisti. Nel lavoro vengono descritte le caratteristiche morfologiche sia dello stadio larvale di* Taenia multiceps *in pecore e capre sia di vermi adulti in cani infettati*

Department of Parasitology, Faculty of Veterinary Medicine, Zagazig University, 44519 Zagazig City, Sharkia Province, Egypt
ahmed_badawy2000@hotmail.com

sperimentalmente. Dai risultati è stato possibile concludere che il Coenurus cerebralis, *in Egitto, è una delle principali cause dei sintomi nervosi attribuibili alla cenurosi in pecore e capre clinicamente malate.*

Parole chiave
Cane, Capra, Cenurosi, *Cenurus cerebralis*, Egitto, Morfologia, Patologia, Pecora, *Taenia multiceps*.

Introduction

Coenurosis, Gid or sturdy, is a fatal condition caused by *Coenurus cerebralis*, the larval stage of the canine tapeworm, *Taenia multiceps*, which inhabits the small intestine of wild and domestic canids (the definitive host). Sheep and goats represent the most common intermediate host for this tapeworm. *C. cerebralis* develops in the brain and spinal cord, causing acute or chronic clinical manifestations, such as depression, circling, blindness, head deviation and ataxia culminating in the death of affected animals and consequently incurring economic losses (2, 3, 9). Moreover, various reports of human infestation with this larval stage have been described elsewhere. For example, cysts have been detected in the central nervous system and intramuscular areas (8, 11), as well as intraocular cavities with endophthalmitis and retinal detachment with subsequent loss of vision (10). In Egypt, cases confirming the presence of *C. cerebralis* have been described in both humans and animals (1, 5). The aim of this study was to investigate sheep and goats for *C. cerebralis* in different localities in Egypt, as well as study experimental infestation in dogs.

Material and methods

Collection and examination of sheep and goats for *Coenurus cerebralis*

A total of 50 heads (30 sheep and 20 goats) were collected from apparently healthy animals slaughtered at the El-Basatein abattoir in Cairo, as well as 25 heads collected from clinically diseased sheep and goats suffering from nervous manifestations, staggering gait, with or without blindness. These samples, collected by farmers in different localities in the Sharkia Province (Minya El-Kamh and Neshwa villages) and in the Suez region, were investigated. The heads of sheep and goats for *C. cerebralis* were examined (15). Briefly, the skin was removed, skulls were incised and the brain and spinal cord were removed and examined both visually for visible cysts and by transverse sectioning of the cerebrum and cerebellum to detect small lesions. The coenuri were identified (18) and the ages of the animals were estimated based on dentition (20).

Experimental infestation of puppies

Three newborn puppies were maintained at the laboratory and were fed clean milk and bread. Each puppy received a single subcutaneous dose of ivermectin (0.2 mg/kg body weight) and oral administration of niclosamide (0.5 g/puppy). Faecal samples were examined regularly using both sodium chloride floatation and sedimentation techniques to ensure that they were free from enteric parasites, especially cestodes. Two puppies were orally infested once, with 190 and 240 scolices, respectively, from *C. cerebralis* cysts collected from infested sheep brain, and the third puppy was kept as a non-infested control (1). After one month, faecal samples from all puppies were collected daily and examined for the presence of *T. multiceps* eggs or proglottids. At the end of the experiment, the puppies were sacrificed using an intravenous barbiturate overdose. The intestine was opened longitudinally and adult cestodes were collected for further identification.

Preparation of permanent specimens from cysts and adult worms of *Taenia multiceps*

After relaxation in the refrigerator, specimens were compressed between two glass slides and were fixed in 10% formalin for at least 24 h. Further processing and staining with alum carmine stain followed (12). Measurements were obtained using a calibrated eye piece micrometer and photographs were taken with a Canon digital camera (Canon, Japan).

Histopathological studies

Positive brain tissues were fixed in 25% formalin, followed by passages in 70%, 80%, 90%, 95% and 100% dilutions of alcohol for dehydration and then clarified in two changes of zylol and embedded in paraffin. Sections 4 µ thick then were prepared and stained routinely with haematoxylin and eosin (7).

Results

Prevalence, organ distribution and age susceptibility

As shown in Table I, of 25 sheep and goat heads examined, 25 heads (100%) proved to be infested with one or more coenuri. The sites of predilection were the left hemisphere (48%), right hemisphere (40%) and cerebellum (12%). The greatest number of coenuri recovered from a single infested head was four cysts. There was no apparent effect of the age of the sheep and goats on susceptibility to infestation with *C. cerebralis*, as the infestation rate was 100% in all clinically diseased animals of different ages.

Experimental infestation of puppies with *Coenurus cerebralis*

The experimental infestation of laboratory-bred puppies with *C. cerebralis* cysts obtained from sheep (Table II) revealed that the first puppy started to shed eggs and gravid segments of *T. multiceps* after 60 days post infestation. After scarification of this puppy, 25 adult worms were collected from the small intestine; the worms were found attached to the end of the duodenum and in the ileum parallel to the intestine. The second puppy did not give any gravid segments or eggs in its faeces until scarification and, when scarified after 105 days post infestation, 15 immature worms attached to the ileum were observed. The control puppy did not produce any gravid segments or eggs in its faeces and no worms were recovered post mortem.

Morphological description of larval and adult stages of *Taenia multiceps*

Coenurus cerebralis cysts

Grossly, the cysts were round or oval, large and bladder like. They measured approximately 3 cm-4 cm in diameter and were filled with large amounts of fluid. In addition, they contained numerous macroscopic invaginated scolices (up to 500 per cyst) (Fig. 1A). Microscopically, the scolex showed four cup-shaped suckers and a rostellum armed with 18-34 typical taeniid hooks arranged in double rows (large and small) (Figs 1B and 1C).

Table I
Prevalence of *Coenurus cerebralis* in sheep and goats

Animals	Healthy animals		Clinically diseased animals			
				Cerebrum		Cerebellum
	Examined	Infested (%)	Examined	Infested (%	Right hemisphere (%)	Left hemisphere (%)	Infested (%)
Sheep	30	– (0%)	15	15 (100%)	5 (33.33%)	8 (53.33%)	2 (13.33%)
Goats	20	– (0%)	10	10 (100%)	5 (50%)	4 (40%)	1 (10%)
Total	50	– (0%)	25	25 (100%)	10 (40%)	12 (48%)	3 (12%)

Table II
Experimental infestation of puppies with *Coenurus cerebralis*

Puppies	Infective dose	Prepatent period	Worms recovered	Infectivity rate (%)
1st (positive)	240 scolices	60 days	25 adult worms	13.2
2nd (positive)	190 scolices	–	15 immature worms	15.0
3rd (control	–	–	–	–
Total	430 scolices	–	40	9.3

A. *Coenurus* cyst in brain (arrow) (digital photo)

B. *Coenurus* cyst showing multiple scolices (×100)

C. Higher magnification of rostellar hooks of *Coenurus* scolex (×400)

Figure 1
Morphological characteristics of a *Coenurus cerebralis* cyst

Taenia multiceps adults from experimentally infested dogs

The worms were whitish in colour, measured 42 cm-50 cm in length and had 70-120 segments per worm (Fig. 2A). The scolex was globular in shape, with four cup-shaped suckers that ranged from 360 µm to 414 µm (mean: 387 µm) in diameter and presented with a prominent rostellum measuring 288 µm to 450 µm (mean: 369 µm) in length and between 486 µm and 540 µm (mean: 513 µm) in diameter (Fig. 2B). The rostellum was armed with double rows of typical taeniid hooks. The total number of hooks in each scolex ranged from 21 to 30 (mean: 25.5). The length of large hooks ranged from 180 µm to 198 µm (mean: 189 µm), while the length of small hooks was 108 µm to 126 µm (mean: 117 µm). The mature segments were almost square in shape and measured 4 mm to 5 mm (mean: 4.5 mm) in length and 4 mm to 5 mm (mean: 4.5 mm) in breadth and contained a single set of genital organs (Fig. 2C). Gravid segments were usually longer than they were broad and measured 6 mm-9 mm (mean: 7.5 mm) in length and between 2 mm and 3 mm (mean: 2.5 mm) in breadth. The number of lateral uterine branches ranged from 9 to 20 at each side (Fig. 2D). The eggs were spherical, brown in colour and measured between 42 µm and 45 µm (mean: 43.5 µm). They were surrounded by a radially striated egg shell and contained a hexacanth embryo (Fig. 2E).

Histopathological changes in *Coenurus cerebralis*-infested sheep brain

As shown in Figure 3, developing parasitic cysts were seen in the subarachnoid space where the cerebrospinal fluid is abundant for their development. Scolices were invaginated from the cyst wall and were in continuation with the cerebrospinal fluid in the subarachnoid space through invaginating points. Early developing cysts were also observed in some sections.

Cysts in the brain substance where cerebrospinal fluid was lacking were associated with distended Virchow-Robin spaces with cerebrospinal fluid, encephalomalacia and demyelinated nerve tracts (Fig. 4). Hyperaemic blood vessels with round cell infiltration, encephalomalacia with round cell infiltration and palisading macrophages and giant cells, as well as focal replacement of the brain parenchyma with caseated and calcified materials were observed (Fig. 5).

Discussion

In our study, 75 heads of apparently healthy and clinically diseased sheep and goats from different localities in Egypt were investigated for infestation with *C. cerebralis*, the larval stage of *T. multiceps*. As shown in the results, all clinically diseased sheep and goats proved to be infested with this larval stage, with an infestation rate of 100%, while all apparently healthy animals were gave negative results.

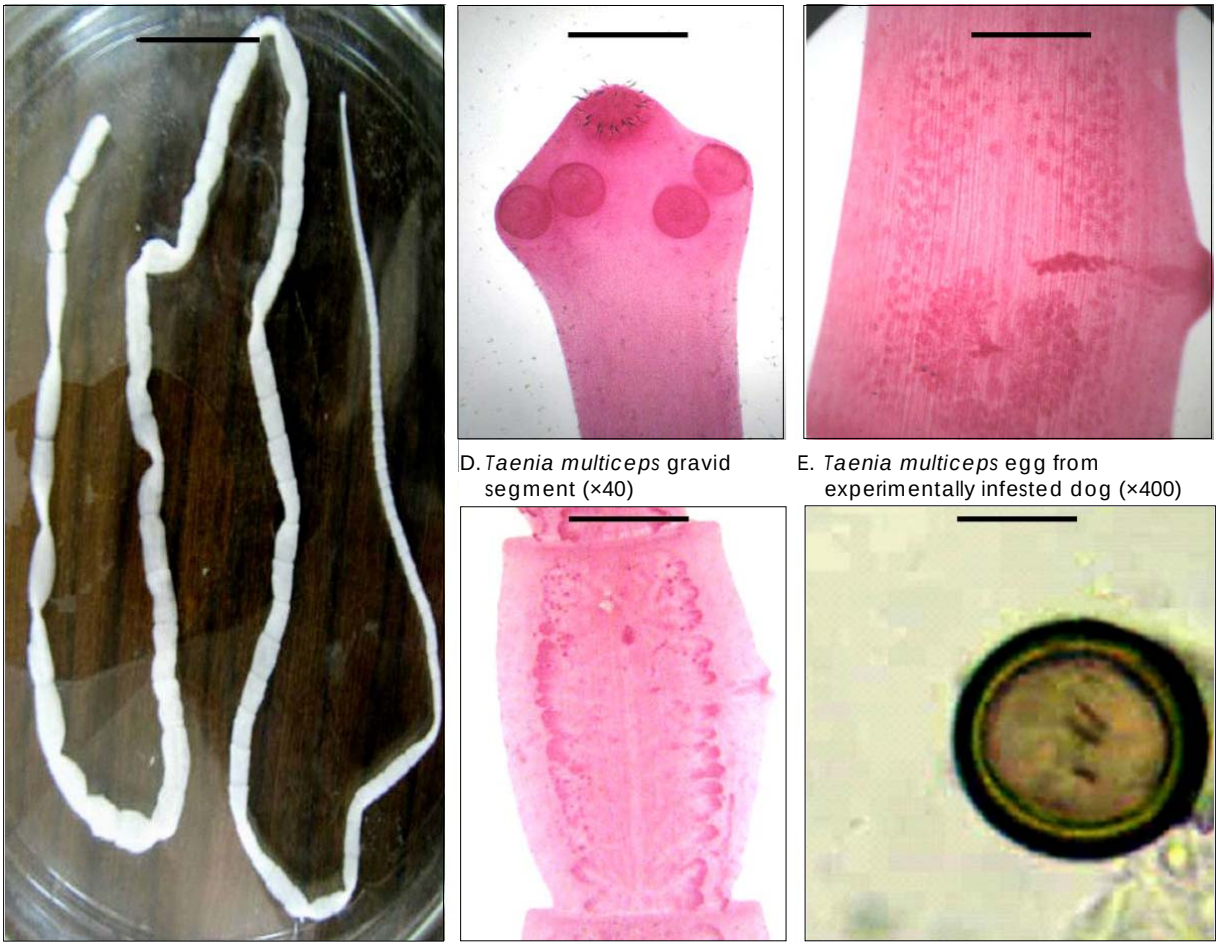
Similar results were obtained by Scala *et al.* (15), in which 299 cerebral coenurosis lesions were observed of a total of 120 sheep with suspected symptoms of coenurosis. Furthermore, a 100% infestation rate with *C. cerebralis* was recorded in 37 clinically sick sheep by Achenef *et al.* (3). These results indicate that coenurosis must be taken into consideration in cases of sheep and goats suffering from nervous manifestations. On the other hand, our study revealed no infestation among the apparently healthy animals (0%). Similar lower infestation rates among sheep and goats (3%, 1.5% and 0.35%) have been recorded elsewhere (1, 2, 15), respectively. A variation in infestation rates could be attributed to the distribution of carnivores, the final hosts, to the grazing behaviour, to the breed of sheep and goats or to environmental factors that affect the survival of the worm's eggs on pastures.

Results of this investigation conclude that there was no apparent effect of the age of the clinically diseased sheep and goats on susceptibility to infestation with *C. cerebralis*. By comparing results of this study with those of previous studies (15, 16, 17, 19), it can be concluded that clinical coenurosis can affect all ages of sheep and goats above 3 to 4 months of age, whereas the infestation of lambs below this age is not clinically apparent, due to the more chronic nature of the disease and the delayed maturation of the coenuri after 6 to 9 months (18), which is related to the

A. *Taenia multiceps* adult worm from experimentally infested dog (digital photo)

B. *Taenia multiceps* scolex (×100)

C. *Taenia multiceps* mature segment (×40)



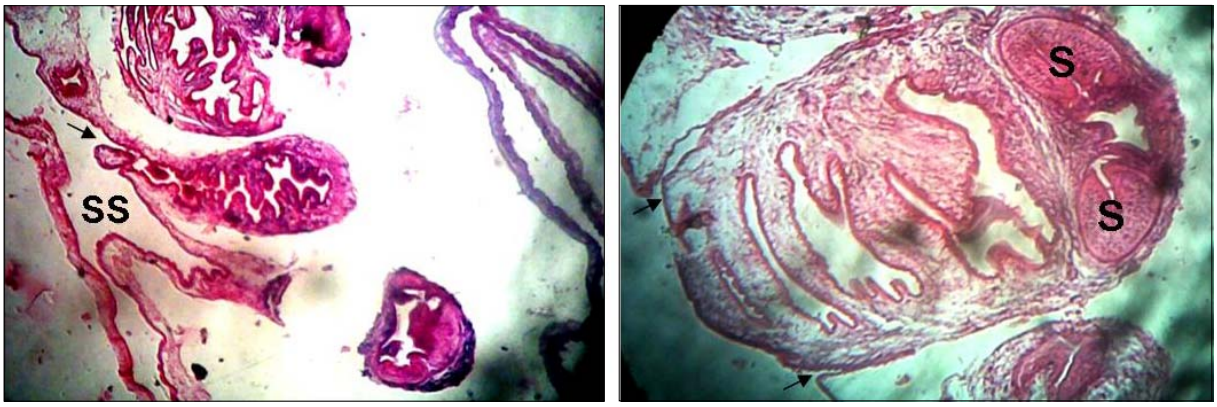
D. *Taenia multiceps* gravid segment (×40)

E. *Taenia multiceps* egg from experimentally infested dog (×400)

Figure 2
Morphological characteristics of *Taenia multiceps* adult and egg

A. An invaginated scolex in continuation with the cerebrospinal fluid in the subarachnoid space (SS) through the invaginating point (arrow) (×100)

B. Invaginated scolex showing the invaginating site (arrow) and suckers (S) (×400)



C. Scolex showing the suckers (S) and rostellar hooks (arrow) (×400)

D. An early developmental stage of the scolex (arrow) originating from the cyst wall (CW) (×400)

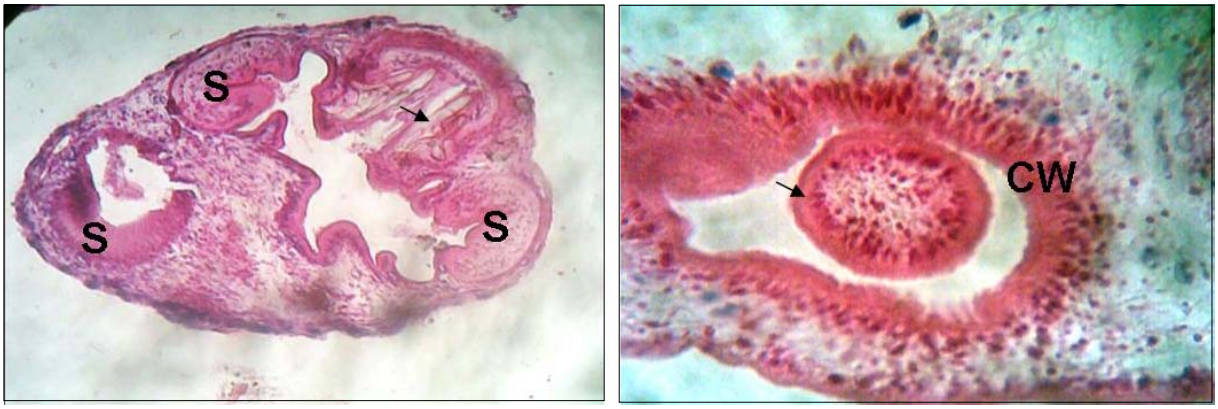


Figure 3
Coenurus cerebralis cyst in the subarachnoid space where the cerebrospinal fluid is abundantly available for the development of the cysts

A. Distended Virchow-Robin space with cerebrospinal fluid with encephalomalacia (×100)

B. Distended Virchow-Robin space with cerebrospinal fluid with encephalomalacia ×400)

C. Demyelinated cerebral nerve tracts (×400)

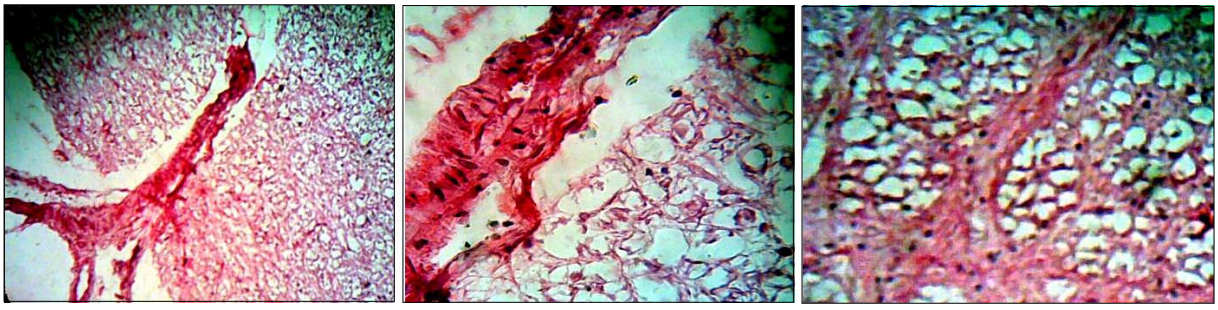
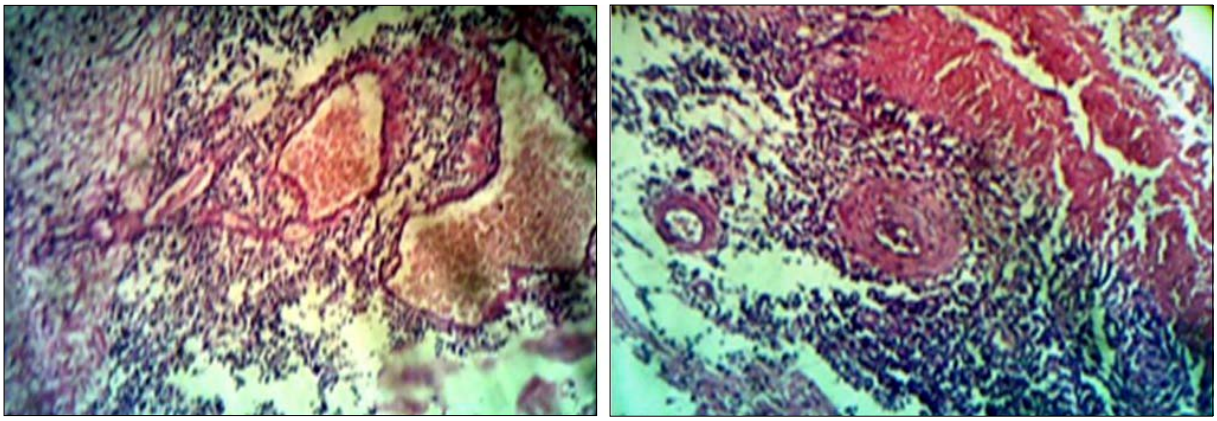


Figure 4
Ovine coenurosis lesions caused by *Coenurus cerebralis* cysts in the brain substance where the cerebrospinal fluid is lacking

A. Hyperaemic blood vessels with round cell infiltration (×100)

B. Encephalomalacia with palisading of macrophages along caseated materials facing the previously existing cyst (×100)



C. Palisading macrophages and giant cells along caseated materials (×400)

D. Focal replacement of the brain parenchyma with caseated and calcified debris (×100)

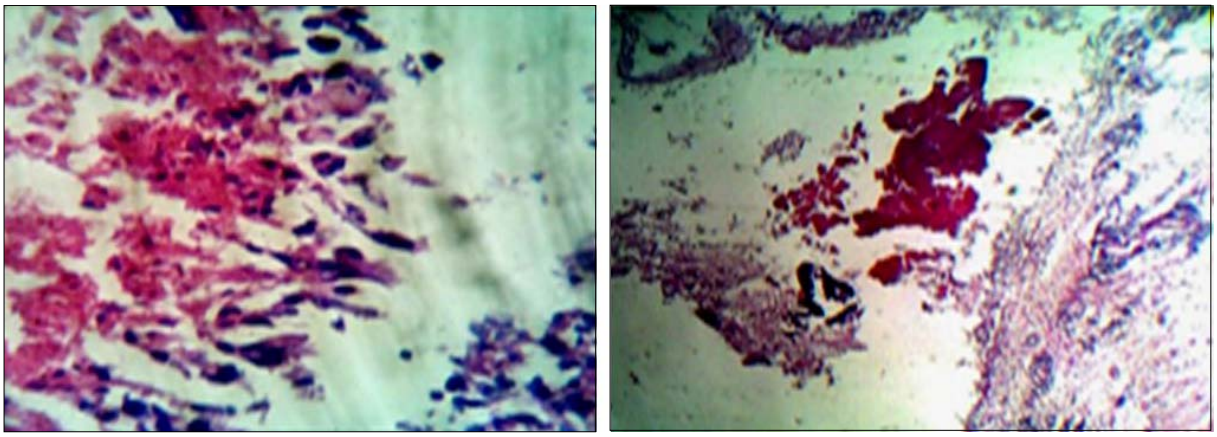


Figure 5
Ovine coenurosis lesions caused by *Coenurus cerebralis* cysts in the brain substance where the cerebrospinal fluid is lacking

appearance of the clinical manifestations of coenurosis.

In regard to the experimental infestation of puppies with *C. cerebralis* cysts obtained from sheep, our results revealed that the prepatent period in experimentally infested dogs was 60 days. These results concurred with those of other workers (1, 18), who stated that the prepatent period of *T. multiceps* ranged from 55 to 70 days. However, an earlier prepatent period for this cestode (40-42 days, was documented by Scala and Varcasia (14). On the other hand, in one experimentally infested dog, eggs or gravid segments were not produced until the date of autopsy, 105 days post infestation. Similar findings were described by Aslani and Ramzi (6), in which 96 immature *T. multiceps* worms were collected from experimentally infested dogs with *C. cerebralis* cysts 3 months post infestation. Although the cause was not clear, the immunological status of the dogs or strain variations of the infective cysts might have been the cause.

There were no observable differences in the morphology of both *C. cerebralis* cysts and the adult *T. multiceps* worms, compared to earlier descriptions (1, 6, 18).

Histopathological findings of sheep brain infested with *C. cerebralis* revealed encephalomalacia, round cell infiltration, caseation and calcification. Similar findings were also described by Anglov and Belchev and by Oruc and Uslu (4, 13).

Conclusion

It can be concluded that *Coenurus cerebralis* is the main cause of nervous manifestations of sheep and goats that are clinically affected by coenurosis in Egypt.

Acknowledgment

Dr Osman Atallah, Professor of Pathology at the Faculty of Veterinary Medicine at Zagazig University, is sincerely thanked for his valuable help and support in revising the pathology sections of the manuscript.

References

1. Abedl-Maogood S.Z. 2005. Studies on metacestode of sheep with reference to serodiagnosis of *Coenurus cerebralis*. PhD thesis, Faculty of Veterinary Medicine, Cairo University, 130 pp.
2. Abo-Shehada M.N., Jebreen E., Arab B., Mukbel R. & Toergerson P.R. 2002. Prevalence of *Taenia multiceps* in sheep in northern Jordan. *Prev Vet Med*, **55**, 201-207.
3. Achenef M., Markos T., Feseha G., Hibret A. & Tembely S. 1999. *Coenurus cerebralis* infection in Ethiopian highland sheep: incidence and observations on pathogenesis and clinical signs. *Trop Anim Health Prod*, **31** (1), 15-24.
4. Anglov A.K. & Belchev L. 1986. Clinical picture and pathomorphology of acute coenurosis in sheep. *Vet Med Nauki*, **23** (6), 19-25.
5. Antonios S.N. & Mina S.N. 2000. A case report of human *Coenurus cerebralis* in Tanta, Egypt. *J Egypt Soc Parasitol*, **30** (3), 959-960.
6. Aslani M.R. & Ramzi G.R. 2001. Muscular coenurosis in sheep. *J Vet Parasitol*, **15**, 157-158.
7. Bancroft G.D., Stevens A. & Turner D.R. 1996. Theory and practice of histological techniques, 4th Ed. Churchill Livingston, London, 766 pp.
8. Benifla M., Barrelly R., Shelef I., El-On J., Cohen A. & Cagnano E. 2007. Huge hemispheric intraparenchymal cyst caused by *Taenia multiceps* in a child. Case report. *J Neurosurg*, **107** (6), 511-514.
9. Bussell K.M., Kinder A.E. & Scott P.R. 1997. Posterior paralysis in a lamb caused by a *Coenurus cerebralis* cyst in the lumber spinal cord. *Vet Rec*, **140**, 560.
10. Ibechukwu B.I. & Onwukeme K.E. 1991. Intraocular coenurosis: a case report. *Br J Ophthalmol*, **75** (7), 430-431.
11. Ing M.B., Schantz P.M. & Turner J.A. 1998. Human coenurosis in North America: case reports and review. *Clin Infect Dis*, **27** (3), 519-523.
12. Kruse O.W. & Pritchard M.H. 1982. The collection and preservation of animal parasites. Technical Bulletin, University of Nebraska, Lincoln and London, 141.
13. Oruc E. & Uslu U. 2006. Comparative cytopathological and histopathological studies of sheep with suspected *Coenurus cerebralis* infection. *Turkiye Parazitol Derg*, **30** (4), 285-288.
14. Scala A. & Varcasia A. 2006. Updates on morphobiology, epidemiology and molecular characterization of coenurosis in sheep. *Parassitologia*, **48** (1-2), 61-63.
15. Scala A., Cancedda G.M., Varcasia A., Ligios C., Garippa G. & Genchi C. 2007. A survey of *Taenia multiceps* coenurosis in Sardinian sheep. *Vet Parasitol*, **143**, 294-298.
16. Sharma D.K. & Chauhan P.P.S. 2006. Coenurosis status in Afro-Asian region: a review. *Small Ruminant Res*, **64**, 197-202.
17. Skerritt G.C. & Stallbaumer M.F. 1984. Diagnosis and treatment of coenuriasis (Gid) in sheep. *Vet Rec*, **115** (16), 399-403.
18. Soulsby E.J.L. 1982. Helminths, arthropods and protozoa of domesticated animals. 7th Ed. Ballière Tindall, London, 117-119.
19. Tirgari M., Howard B.R. & Boargob A. 1987. Clinical and radiographical diagnosis of *Coenurus cerebralis* in sheep and its surgical treatment. *Vet Rec*, **120** (8), 173-178.
20. Toergerson P.R., Williams D.H. & Abo-Shehada M.N. 1998. Modeling the prevalence of *Echinococcus* and *Taenia species* in small ruminants of different ages in northern Jordan. *Vet Parasitol*, **79** (1), 35-51.

