CT and MR Imaging Findings in Cerebral Toxocaral Disease

E. Xinou, A. Lefkopoulos, M. Gelagoti, A. Drevelegas, A. Diakou, I. Milonas, and A. S. Dimitriadis

Summary: We report serial MR findings in a 54-year-old woman with eosinophilic meningencephalitis due to *Toxocara canis* infection, a parasitic disease contracted through exposure with soil contaminated by the eggs of the roundworm. MR imaging revealed several enhancing subcortical and white matter lesions in both lobes. Anthelmintic chemotherapy yielded marked improvement of the neurologic deficits and cerebral lesions. The specific MR findings—low signal intensity on T1-weighted images, high signal intensity on T2-weighted images, and contrast enhancement—and the clinical and epidemiologic features of CNS involvement are herein reviewed.

Many parasites can cause CNS infections, with toxoplasmosis, cysticercosis, and schistosomiasis being the most common. CNS involvement by other parasites, such as *Toxocara canis*, is extremely rare (1).

*Toxocara canis*, a roundworm common in dogs and other canids, may lead to three main forms of the disease, depending on the number of larvae ingested: occult, ocular, and visceral larva migrans. The last is characterized by generalized illness, abdominal symptoms, a skin rash, and symptoms arising from larval invasion of different organs (2). Among these organs, the clinically most important are the liver, lungs, eyes, and CNS (3). As a manifestation of visceral larva migrans, CNS involvement has been described on only a few occasions; descriptions include eosinophilic meningitis, encephalitis, or a combination of these entities. Our review of the medical literature produced only four cases of *T. canis* encephalitis (4–7) and four cases of myelitis (8–11) that were investigated with MR imaging.

We describe a case of toxocaral encephalitis assessed by using CT and MR imaging. This case is notable for its neuroradiologic findings, which are presented herein to highlight the clinical entity of cerebral toxocaral disease.

Received June 17, 2002; accepted July 12.

From the Departments of Radiology (E.X., A.L., A. Drevelegas, A.S.D.) and Second Department of Neurology (M.G., I.M.) AHEPA Hospital, Medical School, and the Laboratory of Parasitology & Parasitic Diseases, Veterinary School, Aristotele University of Thessaloniki (A. Diakou), Greece.

Address reprint requests to Athanasios S. Dimitriadis, Professor of Radiology and Chairman. S. Kiriakidi 1, Thessaloniki 54636, Greece.

© American Society of Neuroradiology
Follow-up T1-weighted MR images obtained 8 months after the initiation of treatment revealed hypointensity in the lesions that was more pronounced than that of MR images obtained at admission. No enhancement was noted on the postcontrast images. Additional findings were hyperintense cortical lesions in both T1- and T2-weighted images. These were in close proximity to the subcortical lesions (Fig 3).

The patient continued to have residual left-arm clumsiness, and her blood tests revealed further reduction of eosinophils (0.8% in 7340 WBCs). This finding indicated that the migration of the larvae was completed and that the tissues were no longer exposed to the parasite. However, titers for *T canis* antibodies were still positive in serum (IgG 2+; IgM 2+). The patient refused to undergo a repeat lumbar puncture.

**Discussion**

Infection with *T canis* is a common worldwide human helminthiasis that rarely affects the brain or the spinal cord. Seroprevalence is high in developed countries, especially in rural areas, and also in some tropical islands (12). An area is considered to pose a high risk for *Toxocara* infection when the infestation rate among dogs is over 7%. In Thessaloniki, Greece, the reported data indicate that infestation rates among dogs and cats is 29% and 66%, respectively, and the rate of soil contamination is 35% (13). For this reason, infection is possible in Thessaloniki even among those without close contact with dogs.

Humans become infected after ingesting embryonated eggs from soil (geophagia, pica) or after exposure to dirty hands or raw vegetables or to larvae from undercooked giblets. People then serve as transport hosts of *T canis*. After the infective eggs are ingested, they hatch. The larvae penetrate the intestinal wall and are carried by the circulation to a wide variety of tissues (liver, heart, lungs, muscle, eyes, CNS), where each worm becomes encapsulated by a collagenous capsule in a granulomatous reaction. Although the larvae do not grow or undergo any further development in these sites, they are metabolically active, and therefore, they can cause severe local reactions that are the bases of toxocariasis. They give off an array of enzymes, waste products, and cuticular components that cause tissue damage, necrosis, and a marked inflammatory reaction, in which eosinophils are a major component. Some have suggested that toxic eosinophil proteins released into the brain and other tissues contribute to the pathologic changes and clinical signs seen with this infection (2).

The site of *T canis* invasion depends on multiple factors, including the number of ingested larvae, genetic factors of the host, and whether previous exposure has occurred (2). *T canis* larvae are known to invade the CNS of animals; however, in contrast to *Baylisascaris procyonis*, *Toxocara* organisms are not often associated with clinical CNS disease. Similarly, clinically overt brain disease in humans is less common with *Toxocara* than with other organisms, although a few cases of overwhelming infection are known (14). Clinical CNS disease is related to the number of larvae entering the brain and to the severity of CNS damage and inflammation (15).

In 1951, Beautymann and Woolf (16) were the first to publish evidence of toxocaral cerebral infection. They found second-stage larva in the left thalamus of an English child whose death was attributed to poliomyelitis. Since then, many reports have described eosinophilic granulomas and vasculitic lesions in the brains of children and adults (17, 18). These lesions are predominantly in the cerebral and cerebellar white matter, with or without the presence of larvae (2). The latter observation is due to the fact that larvae enmeshed in a granulomatous reaction are not permanently imprisoned by this host reaction, as they can apparently burrow out of the reaction, migrate elsewhere, and elicit the same reaction anew. For this reason, the cellular composition of the granulomas cannot be used to indicate the length of infection (19).

Toxocariasis is not the only helminthic parasitic infection that causes eosinophilic meningoencephalitis. Many other parasites and fungi are associated with eosinophilic meningoencephalitis. These include *B procyonis, Coccidioides immitis,* and *Angiostrongylus cantonensis,* and they vary in terms of geographic locale and patterns of CNS involvement (15).

The diagnosis of neurotoxocariasis is based on several findings: high serum titers of *T canis* antibodies (measured with sensitive immunologic methods, ELISA or Western blotting that use *Toxocara* excretory-secretory antigens) (12), eosinophilia in the blood and/or CSF, the demonstration of an intrathecal synthesis of anti-*T canis* antibodies, and close contact with dogs. The clinical and radiologic improvement, as well as the normalization of the CSF parameters during antihelminthic therapy, supports the diagnosis (8).

Despite the normal CSF findings (eg, five to six
A, On this nonenhanced sagittal T1-weighted MR image, the occipital lesion appears hyperintense (arrowhead), whereas the frontal lesion is hypointense (arrow).
B, Axial FLAIR MR image shows multiple hyperintense lesions. The center of the right occipital lesion appears hypointense (arrowhead).
C and D, Axial (C) and coronal (D) contrast-enhanced T1-weighted MR images show marked contrast enhancement of the lesions. Note the area of parasagittal meningeal enhancement (arrow) on the right side, close to the frontal-lobe lesion.

FIG 3. Follow-up axial MR images obtained 8 months after the initiation of treatment.
A, Nonenhanced T1-weighted image the right frontal lesion (arrowhead) shows signal intensity almost identical to that of the CSF. This finding indicates chronic gliotic changes.
B and C, Consequent contrast-enhanced T1-weighted images reveal the absence of enhancement.
D, Nonenhanced T1-weighted image at the convexity shows multiple, small, hyperintense cortical lesions due to cortical necrosis (arrowheads).
cells per milliliter, negative antibody titer) in our
to our diagnosis was completely documented.
Several reports indicate that serum or even CSF Tox-
cara titers are of limited value for diagnosis because
the results are often negative or borderline, especially
in patients with a pure cerebral infestation (5, 6).
Therefore, the diagnosis was based on the positive
Toxocara titer in the serum, the marked reduction of
the activity (contrast enhancement) of the lesions on
MR imaging, and the improvement of the patient’s
neurologic status during antihelminthic therapy. The
striking recovery was attributed to the treatment
rather than the spontaneous course of the disease.
Recent reports (5, 20, 21) suggest the simultaneous
administration of immunosuppressants (eg, cortico-
steroids) with albendazole, although we are aware of
no results confirming the superiority of this combined
treatment to single therapy (8).
Neurotoxocariasis is mainly manifested by a gran-
ulomatous process, as in other parasitic CNS infesta-
tions (2). MR images show multifocal, circumscribed
lesions in the brain with strong contrast enhancement or
a combination of circumscribed and diffuse changes in
chronic infections; these are nonspecific findings (5, 6).
In the English-language literature, four reports
cerebral toxocaral disease investigated with MR
imaging are available. They all describe multiple sub-
cortical, cortical, or white matter lesions that were
hypoattenuating on CT scans, hyperintense on T2-
weighted MR images, and homogeneously enhancing
(4–7). Only Ruttinger and Hadidi (6) have described a
case in which a marked decrease in the size and
number of the lesions was present after antihelmin-
thetic treatment.
Four other reports describe spinal cord involve-
ment with solitary or multiple lesions that were hy-
perintense on T2-weighted images and that enhanced
strongly after the administration of contrast material
(8–11). In all of the cases mentioned as well as in our
case, involvement of only the CNS occurred with
normal findings in the skin, lungs, and liver.
In our case, the lesions were located in both hemi-
spheres, mostly subcortically. At admission, they were
all hypoattenuating on CT scans, hypointense on T1-
weighted images, and hyperintense on T2-weighted
images. An exception was the center of the right
occipital-lobe lesion, which was hyperattenuating on
CT scans and hyperintense on both T1- and T2-
weighted MR images. This finding was suggestive of
microhemorrhages or cortical necrosis due to infarc-
tion. The granulomas had strong homogeneous en-
hancement on the first MR image, and this was
thought to result from a focal disruption of the blood-
brain barrier due to a reactive inflammatory process;
this was suggestive of an active infection (8).
The focal meningeal enhancement observed near
the right occipital subcortical lesion is probably due to
the extension of the inflammation in the subarach-

noid space. This observation has been described once
before in the radiologic literature (22). The CT and
MR imaging findings on admission, in combination
with the clinical presentation, were more suggestive
of an inflammatory process than of brain infarcts.
At follow-up, the more pronounced hypointensity
of the lesions on T1-weighted images and their hy-
perintensity on T2-weighted images were obviously
the result of chronic gliotic changes, and the absence
of enhancement on postcontrast images was sug-

gestive of inactive infection. MR imaging also revealed
hyperintense cortical areas (on both T1- and T2-
weighted images) near the granulomas. These were a
result of cortical necrosis presumably due to multiple
brain infarcts caused by immune vasculitis.

Immune vasculitis is also a well-known complica-
tion of other parasitic diseases (eg, neurocysticero-
sis) in which the parasite compromises primarily
the small cerebral vessels (5, 23). In an angiographic
study of 28 patients with cerebral subarachnoid cys-
ticercosis, Barinagarrementeria and Del Brutto (24)
demonstrated that 53% of all patients with subarach-

noid cysticercosis had angiographically documented
cerebral arteritis and that most of them were symp-
tomatic (80%).

To our knowledge, only one angiographically doc-
umented report describes cerebral vasculitis in neu-
rotoxocariasis (5). This case involved the occlusion
of multiple small branches of the middle cerebral artery
that resulted in multiple brain infarcts. On the other
hand, in a few reported cases, cerebral infarction
developed during anti-helminthic treatment (Hermi-
heime reaction) (24).

In our case, cerebral infarctions were close to the
granulomas and developed during antihelminthic
treatment; therefore, their cause was difficult to de-
fine. Therefore, whether cerebral infarctions are due
to an acute inflammatory reaction to the Toxocara
antigen, to a delayed-type hypersensitivity to antihel-
minthic drugs, or both, is unclear.

This case report confirms that CT and MR findings
cerebral toxocariasis are nonspecific and that se-
rologic studies of blood and CSF are necessary to
establish the diagnosis. On the other hand, serial MR
imaging during antihelminthic chemotherapy for neu-
rotoxocariasis is a valuable tool for monitoring the
course of the disease, whereas serum tests for T canis
antibodies may be less useful because results can
remain positive for months or years after clinical
improvement occurs, and T canis antibodies in the
CSF of patients with pure cerebral toxocariasis may
be negative (8, 10).

Conclusion

In a patient with hyper eosinophilia of unknown
origin and cerebral granulomatous disease, the differ-
ential diagnosis of T canis infection must not be over-
looked (5).

References


