Cat optic nerve imaging with metrizamide

Jeffrey P. Davis, Victor M. Haughton, Gerald J. Harris, O. Petter Eldevik, and Walter E. Gager

Metrizamide is a water-soluble, nonionic radiocontrast medium that penetrates better into narrow subarachnoid spaces than do oily contrast media or gas. We performed metrizamide optic nerve thecography on five cats with iatrogenic orbital lesions. Optic thecograms successfully demonstrated displacement of the optic nerve, obstruction of the optic nerve sheath subarachnoid space, and extravasation of the contrast medium from a punctured optic nerve sheath. Metrizamide-induced seizures could be prevented by intramuscular preadministration of diazepam.

Key words: optic nerve sheath, optic nerve, metrizamide, optic nerve imaging, encephalography, cranial nerve imaging, high resolution plain radiography, microfocal x-ray imaging

Metrizamide is a water-soluble, nonionic, radiographic contrast medium that has been used in Europe for myelography and cisternography. Iodine accounts for a large portion of its total molecular weight; its high water solubility results from the amide linkage of an iodinated phenyl moiety, metrizoic acid, to a simple aminated sugar, glucosamine. Metrizamide penetrates better into spinal nerve root sheaths and pathologically narrowed subarachnoid spaces than do oily contrast media or gas. It has been used intracranially to define cranial nerve anatomy in the basal cisterns and to visualize acoustic neuromas. The U.S. Food and Drug Administration recently approved metrizamide for intrathecal use.

A radiographic technique for visualizing the optic nerve opacified with intrathecal metrizamide, optic thecography (OT), recently has been described. We report here use of the procedure to image optic nerve lesions in cats.

Materials and methods

Experimental subjects were five healthy adult mongrel cats weighing 3.0 to 4.5 kg. After premedication with ketamine (10.0 mg/kg intramuscular) and atropine (0.05 mg/kg intramuscular), the animals were placed prone on an x-ray table with the head down and flexed for 4 min. The suboccipital puncture was made with a 3.8 cm 22-gauge spinal needle. Then 2 ml of cerebrospinal fluid were removed, and metrizamide (2 ml, 300 mg/ml iodine) was injected slowly through the spinal needle. After the contrast medium had been injected, the cat was held vertically with the head down and flexed for 4 min. The animal was positioned so that the chiasmatic cistern was superior to the optic nerves to retain metrizamide in the optic nerve sheaths. Direct magnification (2.4 X) radiographs of the head in submento-vertex, lateral, and oblique projections were obtained with a 0.3 mm focal spot x-ray tube. Each animal underwent at least one baseline OT prior to surgery.

In cat 1, 4 ml of catalyzed Dow-Corning Silastic were injected percutaneously into the lateral orbit approximately 4 mm behind the globe. Cats 2, 3,

Fig. 1. Normal cat optic thecogram. A, Submento-vertex view. B, Lateral view. Metrizamide is evident in the chiasmatic cistern (arrowheads) and in the optic nerve sheath (arrows). The angulation of the optic nerve and sheath midway in the orbit is typical.

Table 1. Procedure and Results

<table>
<thead>
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<th>Cat</th>
<th>Procedure</th>
<th>Results</th>
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<tr>
<td>1</td>
<td>OT seven times in 6 months</td>
<td>Adequate opacification</td>
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<tr>
<td>2</td>
<td>OT 14 times in 6 months</td>
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<tr>
<td>3</td>
<td>OT six times in 6 months</td>
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<tr>
<td>4</td>
<td>OT three times in 3 months</td>
<td>Adequate opacification</td>
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<tr>
<td>5</td>
<td>OT once, 1 day after receiving intradural silicone</td>
<td>Adequate opacification</td>
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Results

Of 36 attempts at OT, adequate optic nerve sheath opacification was achieved in 32. In cats 1, 2, and 5, opacification was excellent; in cats 3 and 4, it was adequate. In the four unsuccessful attempts, contrast agent either was confined to the cervical subdural space or appeared over the convexities without opacifying the optic nerve sheath. In successful procedures, the optic nerve subarachnoid space was opacified for about 30 min. Optic nerves were best defined on films taken 5 to 20 min after metrizamide injection. Contrast medium appeared on radiographs as a thin, uniformly dense layer surrounding the optic nerve from the optic canal to the scleral junction (Fig. 1). On baseline OT, the course and appearance of the optic nerves showed little variation. Except for small variations in contrast densities, x-ray findings of optic nerve morphology in each animal were reproducible. Measurements taken from optic thecograms and corrected for magnification showed the inside diameter of normal cat optic nerve sheaths to be from 1.0 to 1.5 mm, depending on the animal’s size.

In cat 1, medial displacement and straightening of the optic nerve by the injected silicone was clearly evident. The optic nerve intrathecal space did not appear narrowed at any point. Similar findings were noted in optic thecograms of cat 2, in which the retrobulbar silicone sphere had been implanted. In cat 3, the optic nerve sheath filled only proximal to the ligature. In cat 4, contrast was seen within the optic nerve theca proximal but not distal to the crushed segment (Fig. 2). In cat 5, metrizamide was noted to leak from the nerve sheath at the puncture site (Fig. 3).

Two cats had diffuse myoclonus beginning about 30 min after metrizamide injection. Seizure activity ceased 5 to 10 min after intramuscular administration of 0.5 mg. of diazepam. Cat 1 had seizures after the elev-
enth, twelfth, and thirteenth OT procedures; cat 2 had seizures after the third and seventh procedures. In some instances of myoclonus, radiographs showed metrizamide over the cerebral convexities.

After receiving the intraorbital silicone injection, cat 1 became listless and remained so for six months but behaved otherwise normally in that period. Cat 4 died of a subarachnoid hemorrhage caused by a traumatic suboccipital puncture during its fourth postoperative OT. Cat 5 died of a subarachnoid hemorrhage immediately after a traumatic suboccipital puncture at the time of its second postoperative OT. None of the cats had evidence of weight loss or persistent behavioral change due to metrizamide.

Discussion

Continuity of the cerebral cisterns with the optic nerve subarachnoid space has been demonstrated in man and animals by means of cadaver dissections and intrathecal injections of either soluble dye, India ink (a colloidal suspension), or soluble macromolecules. Suboccipitally injected Thorotrast has been demonstrated radiographically in the optic nerve sheaths of albino rats and of a dog. Passage of iophendylate into the optic nerve sheath has been observed in two patients undergoing cervical myelography. One patient developed decreased visual acuity and orbital pain on the side exposed to iophendylate, the other was asymptomatic during 2 years of follow-up.

In the present study the mortality rate (6% of procedures) may be related to difficulty in puncturing the small cisterna magna of the cat. Death from OT is unlikely in animals in which a lumbar puncture is used. However, better opacification of the optic nerves of small animals might be obtained with cisternal contrast injections than with lumbar. The cisternal approach results in less dye dilution by cerebrospinal fluid as the agent is manipulated into the optic nerve sheaths.

The high incidence of seizures observed in these preliminary studies (14% of procedures) may be related to excessive amounts of contrast agent reaching the cerebral cortex.

Fig. 2. Optic thecogram of cat 4 with crushed right optic nerve A. Both optic nerves fill well in submento-vertex view. There is a suggestion of poor filling in the distal right nerve. B, Oblique view showing some irregularity of the right contrast column (arrows). Lack of filling in the distal sheath (arrowheads) is definite.

The positioning required to opacity the optic nerve sheath in cats sometimes caused flow of the agent over the cerebral convexities. Metrizamide is epileptogenic when the cerebral cortex is exposed to it in high concentrations. The incidence of seizures after intrathecal metrizamide is 0.02% to 0.05%. We have observed no seizures from OT since we have given diazepam (0.15 mg/kg intramuscularly) to cats ½ hr prior to metrizamide injection.

Basic radiation physics suggest that optic nerve thecography with a microfocal spot x-ray tube may allow detection of deformities of the optic nerve or of the optic neural subarachnoid space as small as 0.2 mm. Further investigation of the ability of this technique to demonstrate optic nerve abnormalities and optic nerve cerebrospinal fluid dynamics, as well as assessment of the...
histopathologic effect of metrizamide on the cat optic nerve and globe, are in progress.

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