MAGNETIC RESONANCE IMAGING AS A USEFUL TOOL FOR THE SELECTION OF PHARMACOLOGICAL AND SURGICAL TREATMENT OPTIONS FOR CANINE HYDROCEPHALUS

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Abstract

A group of 12 dogs, eight of small breeds and four of medium-sized breeds, were used in the study. Prior to the magnetic resonance imaging (MRI) scans, all dogs were subjected to neurological, laboratory, and electroencephalographic examinations, and trans-fontanel ultrasonography was additionally performed in two patients. The acquired obstructive hydrocephalus was diagnosed in two dogs, idiopathic obstructive hydrocephalus – in four patients, obstructive congenital hydrocephalus – in five dogs, and hydrocephalus ex vacuo – in one patient. Ten dogs were put under the pharmacological therapy, and in two patients the condition was treated surgically. MRI proved to be a valuable tool that supports selection of the appropriate pharmacological and surgical treatment. MRI scans also appear to be useful in monitoring an effectiveness of the applied form of treatment.

Key words: dog, hydrocephalus, magnetic resonance imaging, therapy.

Symptoms of hydrocephalus are observed in 1%-1.5% of the human population. Statistical data indicates that congenital hydrocephalus occurs in 0.9 - 1.8 births per 1,000. No such estimates are available for animals, particularly in dogs. Hydrocephalus is a condition caused by abnormal accumulation of cerebrospinal fluid in the ventricular system, which expands cranial cavities and increases intracranial pressure. The main causes of hydrocephalus include an increased secretion of cerebrospinal fluid, obstructions in the ventricular system and intracranial fluid cavities, and an abnormal outflow of venous blood from the sinus area. Hydrocephalus can be classified into non-communicating - obstructive (congenital, idiopathic, acquired) and communicating. Special forms of hydrocephalus include hydrocephalus ex vacuo, both internal and external, and these based on intracranial pressure. Additionally, normotensive and hypertensive hydrocephalus can be differentiated (3, 4).

In dogs, the management of hydrocephalus involves pharmacological treatment with the use of diuretic and steroid drugs, as well as, surgical treatment (4). During the surgery, the ventricular system is drained and excess fluid is evacuated to the peritoneal cavity via a shunting system. In obstructive hydrocephalus, the factors that cause blockage of the ventricular system and obstruct fluid flow in intracranial cavities have to be eliminated. The objective of this study was to assess the usefulness of magnetic resonance imaging as a tool supporting the choice of pharmacological or surgical treatment of hydrocephalus in dogs.

Material and Methods

The experiment was performed on 12 dogs (Table 1) whose owners had consented to the pharmacological or surgical treatment. Before magnetic resonance imaging (MRI) scans, all patients were subjected to clinical, neurological, laboratory, and electroencephalographic examinations. Dogs with an unclosed fontanels additionally underwent a trans-fontanel ultrasound examination (Fig. 1).

The patients were examined by a low-field MRI scanner with a magnetic field intensity of 0.25 Tesla (Vet Grande, Esaote) under a general anaesthesia. Images of the brain were produced in the sagittal, transverse, and dorsal planes using T1-weighed and T2-weighed sequences as well as FSE T2 (T2-weighed fast spin echo), SE T1 (T1-weighed spin echo), and FLAIR (fluid attenuated inversion recovery) GE (gradient echo) sequences. The ultrasound examination was performed by Hitachi EUB 525 apparatus with 7.5 MHz probe. In 10 cases, the owners gave their consent to the pharmacological treatment only. The patients from that
group were administered 0.25–0.5 mg/kg of prednisone (Encorton®, Polfa) every 12 h per 1 week, then the therapy was tapered to the lowest alternate–day dose able to control neurologic signs. Furosemide (Furosemidum, Polpharma) was used in 1.0 mg/kg every day and, alternatively, 5-10 mg/kg of acetazolamide (Diuramid®, Polpharma) per os.

Patient No. 2 was diagnosed with an acquired obstructive hydrocephalus secondary to atlantoaxial instability with spinal cord compression above 50% (Fig. 2).

Fig. 1. Chihuahua dog with ultrasonographic view of hydrocephalus.

Dogs No. 1 and 2 (see Table 1) were subjected to surgical treatment. Laparoscopically controlled ventriculoperitoneal shunting was performed in patient No. 1 with technique proposed by Adamiak et al. (1). Patient No. 2 was diagnosed with an acquired obstructive hydrocephalus secondary to atlantoaxial instability with spinal cord compression above 50% (Fig. 2).

Fig. 2. Dog No. 2 treated surgically.

The performed treatment involved the removal of the squamous part of the occipital bone, and three weeks later – ventral stabilisation of atlantoaxial instability.

Table 1

<table>
<thead>
<tr>
<th>No.</th>
<th>Breed</th>
<th>Age</th>
<th>Sex</th>
<th>Hydrocephalus type</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>English bulldog (Fig. 1)</td>
<td>7 years</td>
<td>♂</td>
<td>Obstructive idiopathic</td>
<td>Laparoscopy-assisted ventriculoperitoneal shunting</td>
</tr>
<tr>
<td>2</td>
<td>Yorkshire terrier (Fig. 2)</td>
<td>3 months</td>
<td>♂</td>
<td>Obstructive acquired</td>
<td>Removal of squamous part of occipital bone and ventral stabilisation of atlantoaxial instability</td>
</tr>
<tr>
<td>3</td>
<td>Chihuahua (Fig. 3)</td>
<td>2 months</td>
<td>♀</td>
<td>Obstructive idiopathic</td>
<td>Pharmacological</td>
</tr>
<tr>
<td>4</td>
<td>Maltanese</td>
<td>3 months</td>
<td>♂</td>
<td>Obstructive congenital</td>
<td>Pharmacological</td>
</tr>
<tr>
<td>5</td>
<td>Yorkshire terrier</td>
<td>5 months</td>
<td>♀</td>
<td>Obstructive congenital</td>
<td>Pharmacological</td>
</tr>
<tr>
<td>6</td>
<td>Pomeranian</td>
<td>5 months</td>
<td>♀</td>
<td>Obstructive congenital</td>
<td>Pharmacological</td>
</tr>
<tr>
<td>7</td>
<td>Pekingese</td>
<td>6 years</td>
<td>♂</td>
<td>Obstructive acquired</td>
<td>Pharmacological</td>
</tr>
<tr>
<td>8</td>
<td>Yorkshire terrier</td>
<td>1 year</td>
<td>♀</td>
<td>Obstructive congenital</td>
<td>Pharmacological</td>
</tr>
<tr>
<td>9</td>
<td>Bullterrier</td>
<td>2 months</td>
<td>♂</td>
<td>Obstructive congenital</td>
<td>Pharmacological</td>
</tr>
<tr>
<td>10</td>
<td>French bulldog</td>
<td>2 years</td>
<td>♂</td>
<td>Obstructive idiopathic</td>
<td>Pharmacological</td>
</tr>
<tr>
<td>11</td>
<td>French bulldog</td>
<td>3 years</td>
<td>♂</td>
<td>Obstructive idiopathic</td>
<td>Pharmacological</td>
</tr>
<tr>
<td>12</td>
<td>Yorkshire terrier</td>
<td>1 year</td>
<td>♀</td>
<td>Ex vacuo</td>
<td>Pharmacological</td>
</tr>
</tbody>
</table>
Results

MRI scans have revealed changes characteristic of hydrocephalus in all patients. The type of hydrocephalus was identified based on the results of MRI scans and additional tests. MRI scanning times ranged from 15 to 20 min, and the difference resulted from the choice of sequences, slice thickness, and gap size.

In dog No. 1, the clinical symptoms of hydrocephalus gradually receded after the surgery. No signs of aggression or mental deficit status were noted 30 d after the treatment. The owner reported that the dog was eager to play and showed no recurring signs of the disease. On day 30 after the surgery, the dog was subjected to an MRI scan, that revealed a reduction of ventricular cavities. In patient No. 2, the clinical symptoms of hydrocephalus disappeared on the day after surgery, but a relapse was noted on 14 d later. The dog underwent a second operation, involving a ventral stabilisation with the use of two Kirschner wires and polymethylmetharylate (PMMA). All neurological symptoms subsided 24 h after the surgery. A post-operative MRI scan was not performed due to a risk that metal implants would migrate in the magnetic field and produce artifacts.

Three dogs subjected to pharmacological treatment underwent MRI scans after two months of therapy. A significant reduction in the size of ventricular chambers was not observed despite an alleviation of clinical symptoms. Long-term clinical improvement was not reported in the remaining dogs that had undergone pharmacological treatment.

Discussion

In the group of 12 dogs under the study, acquired obstructive hydrocephalus was diagnosed in two dogs, idiopathic obstructive hydrocephalus – in four patients, obstructive congenital hydrocephalus – in five dogs, and hydrocephalus ex vacuo – in one patient. An adequate choice of patients with an identified type of hydrocephalus is the main prerequisite for the selection of appropriate treatment (5). Surgery is the definitive therapy for hydrocephalus. In the analysed group of dogs, 10 patients were treated pharmacologically due to the owners’ decisions. According to the authors’ previous experience, pharmacological therapy delivers short-lived results, and it is less effective than surgical treatment, as noted on the example of two dogs that underwent surgery in this study. However, due to a high cost of surgical procedures, the choice of the method of treatment always depends on the owners.

Magnetic resonance imaging proved to be a valuable tool that supports the selection of the appropriate pharmacological and surgical treatment. In patients, who did not have metal implants inserted during the surgery, MRI scans may be performed to evaluate an effectiveness of the therapy. MRI is a highly useful technique especially when pharmacological treatment is not successful in alleviating or eliminating clinical symptoms. The reviewed sources clearly indicate that surgical treatment of hydrocephalus with the involvement of ventriculoperitoneal shunting delivers much better results than pharmacological therapy (6). However, even after surgery, the long-term outcome is guarded regardless of the cause of hydrocephalus (2). MRI turns out to be a conclusive method for diagnosing hydrocephalus; also it supports the selection of an appropriate form of the treatment and evaluation of its efficiency.

References