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Preliminary report on the ventriculoperitoneal shunt placement in a giant breed dog

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Abstract

Congenital hydrocephalus is usually diagnosed within the first weeks to months of life of affected puppies. These patients are typically smaller than their siblings and have obtunded mentation, strabismus, and a range of visual deficits. Surgery is recommended mostly in cases where conservative medical treatment is not effective, but surgery is sometimes not accepted by owners and they opt for humane euthanasia. A 6-month-old female Great Dane was referred to our clinic with ataxia, disorientation, blindness, and seizures. Ventrolateral strabismus, hypermetria, and delayed postural reactions were observed at admission. Congenital hydrocephalus was diagnosed and confirmed with magnetic resonance imaging. Ventriculoperitoneal shunt was placed. The dog responded well to surgical intervention, neurological deficits improved after surgery. To our knowledge, this is the first described case of ventriculoperitoneal shunt application in a giant breed dog. The dog is nearly two months post surgery, with no recorded seizures, and it is gradually improving neurologically. The presented clinical case is unique due to the breed and also due to the fact that owners of large breeds of dogs usually have much greater expenses for their therapy compared to small breeds, which makes them rare cases in clinical practice that are rarely reported in veterinary literature.

Canine, hydrocephalus, seizures, surgery

Hydrocephalus is formed when abnormal dilatation of the ventricular system occurs due to inadequate circulation of cerebrospinal fluid (CSF) and secondary brain parenchyma compression results in clinical signs. Correlation between severity of neurological signs and abnormal anatomy has not been established (Rusbridge et al. 2000). The pathway of CSF begins in the lateral ventricles, it passes through the interventricular foramina into the third ventricle, mesencephalic aqueduct, and fourth ventricle, and it continues into the subarachnoid space by passing through the lateral apertures of the fourth ventricle (deLahunta and Glass 2009).

Fluid can accumulate in the ventricular system in case of internal hydrocephalus, or in the subarachnoidal space and is referred to as external hydrocephalus. Communicating hydrocephalus results from extraventricular impairment of CSF flow and absorption, and in rare cases, its production (Coates et al. 2006; Estey 2016). Obstructive (i.e., non-communicating) hydrocephalus is characterized by the accumulation of CSF due to disruption of CSF flow within the ventricular system before entering the subarachnoid space. Compensatory hydrocephalus (i.e., hydrocephalus ex-vacuo) occurs when CSF occupies the space in the cranial cavity that normally would be occupied by brain parenchyma, for example secondary to senile brain atrophy or after destruction of parenchyma during ischaemic events (deLahunta and Glass 2009).

Congenital hydrocephalus is usually considered obstructive (deLahunta and Glass 2009) and it is suspected to be associated with fusion of the rostral colliculi, causing secondary mesencephalic aqueductal stenosis (Summers 2000). The treatment of hydrocephalus should be dictated by the underlying cause in addition to the physical

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status of the patients and their age. In most instances, medical therapy offers only temporary palliation of clinical signs (Thomas 2010). This is certainly true in cases of obstructive hydrocephalus in which decreased CSF production offers a short-term remediation of clinical signs but has no primary effect on relieving the obstruction. In rare cases, long-term medical therapy can be considered in animals with congenital hydrocephalus for which CSF is not surgically drained (Harrington et al. 1996; Thomas 2010).

Medical treatment may include general supportive care and drugs to limit CSF production and to reduce intracranial pressure (ICP). Glucocorticoids such as prednisone at antiinflammatory doses of 0.25–0.50 mg/kg b.i.d. are used orally for a period of 1 month and then tapered every 7 days until the minimum dose of 0.1 mg/kg is reached to control the clinical signs. Dexamethasone has also been often used, although long-term use should be avoided because of the higher incidence of side effects. Diuretics are used to decrease a production of CSF. Acetazolamid, a carbonic anhydrase inhibitor used at doses of 10 mg/kg every 6–8 hours, has been shown to decrease CSF production, however, this does not always correspond with reducing ICP (Estey 2016). Omeprazole, a gastroprotectant functioning as a protein pump inhibitor, is routinely used to ameliorate gastrointestinal side effects caused by glucocorticoids, and its administration has reportedly shown a 26% decrease in CSF production (Lindvall-Axelsson et al. 1992). Mannitol, hypertonic saline, and furosemide may provide a temporary decrease in ICP, and they are therefore reserved for emergency cases. Attention should be paid to possible electrolyte disturbance when using any diuretic, especially when combined with glucocorticoids. Measuring sodium and potassium concentrations, and assessing hydration status is required during such medical management. Surgical therapy is usually chosen after unsatisfactory results of combinations of these drugs for a period of few weeks (Coates et al. 2006).

The presented clinical case is a rare instance of hydrocephalus development in a giant dog breed, which is not often documented. Besides genetic predisposition of smaller breeds that are commonly affected, their clinical over-representation might be due to their high popularity. The other reason for the small number of publications about large dog breeds with hydrocephalus can be the fact that many large dog breeds are intensively used for work and these dogs are rarely treated in the event of serious diseases that will negatively affect their future use as working dogs, and therefore their owners prefer euthanasia.

Case presentation

A 6-month-old intact female Great Dane weighing 29 kg was presented to our veterinary hospital with ataxia, disorientation, blindness and seizures. The clinical signs were observed by the owners for two months, during this time the dog was treated at another workplace with prednisone and levetiracetam with no reported improvement. At admission, a ventrolateral strabismus, ataxia with hypermetria, blindness and delayed postural reactions on all four limbs were observed. Upon clinical examination the dog was bright, alert and responsive, and had normothermia and normopnoea. All vital signs were unchanged and results of haematology, biochemistry and urinalysis were unremarkable. Thoracic radiographs and abdominal ultrasound were obtained and no pathological findings were found. Congenital hydrocephalus was diagnosed based on the magnetic resonance imaging (Plate II, Fig. 1) and a medium pressure ventriculoperitoneal shunt (Medtronic, Minneapolis, USA) was placed on the same day.

Medetomidin (0.01 mg/kg) and butorphanol (0.3 mg/kg) were used intravenously for premedication, induction was continued with propofol to effect. During magnetic resonance imaging examination and during surgery the dog was under general inhalation anaesthesia (isoflurane 1.5% in oxygen). The Dräger Fabius Tiro Anaesthesia Workstation (Drägerwerk AG & Co., Lübeck, Germany) was used with thorough monitoring of vital signs including blood pressure.

Before surgery, the surgical field was widely clipped and scrubbed with alcohol, betadine, and chlorhexidine. The dog was given 22 mg/kg cefazoline i.v. and during the whole procedure it was supplemented with NaCl infusion (2 ml/kg/h).

A curved incision was done along the caudal aspect of the parietal bone and it was continued along the medial base of the pinna. The skin flap was released and positioned cranially over the eye. A small hole was drilled in the parietal bone large enough to allow the shunt placement and it was covered with a sterile gauze. The stab incision was done on the left abdominal wall, approximately 2.5 cm caudal to the last rib, halfway between the spine and ventral plane of the abdominal wall. A 2.5 mm diameter barium-impregnated shunt catheter (Medtronic Inc., Minneapolis, USA) was placed subcutaneously and tunnelled to the neck where it was secured with a haemostat. The Delta shunt attachment site was chosen along the back of the skull with the shunt valve directional arrow oriented caudally. A winged right angle catheter anchor was chosen. The paired unit was attached to the rostral attachment site of the Delta shunt. The shunt catheter with fenestrated tip was placed after the dura was cut with a needle to the premeasured depth of 2.7 cm into the left ventricle. The winged anchor was sutured to the periosteum of the skull. The Medtronics medium pressure Delta fixed valve was attached to the distal catheter. When the CSF was confirmed to flow, the attachments were secured with simple sutures. The distal portion of the catheter (12.5 cm in length) was inserted into the abdominal cavity using a blunt muscle separation, the peritoneum was cut with a scalpel blade. After the procedure, the subcutaneous tissue was closed with a continuous suture pattern and the skin was closed with a continuous interlocking suture pattern.

After the surgery, plane radiographs were taken to confirm the right placement of the shunt. The dog responded well to surgical therapy, recovery was smooth and uneventful. The neurological deficits improved after surgery, eyes were in normal position and the cotton ball test results were normal. The dog was monitored during the night and then discharged from the hospital. It was prescribed antibiotics amoxicillin/clavulanic acid (Synulox, Zoetis, Prague, Czech Republic) 15 mg/kg p.o. q 12 h and the corticosteroid prednisone (Prednison, Zentiva, Prague, Czech Republic) 0.5 mg/kg p.o. q 12 h for 14 days, opioid tramadol (Tramadol Mylan, McDermott Laboratories Ltd, Dublin, Ireland) 5 mg/kg p.o. q 8 h for 3 days, and the antiepileptic drug phenobarbital (Phaenemal, Desitin Arzneimitttel GmbH Hamburg, Germany) 3 mg/kg q 12 h for two months. The dog was given a soft Elizabethan collar and the owners were instructed to adhere to a strict rest until the incisions fully healed.

The patient came two weeks later for the surgical stitches removal and the owners reported a satisfactory convalescence. The dog was eating and eliminating well and its movements and coordination were improved. Four weeks after that, the dog was neurologically almost normal, with only mild ataxia and normal vision, attitude, and behaviour. Currently, the patient is doing well.

Discussion

Ventricular shunts transfer the CSF from the brain ventricles to another body cavity, e.g. the right atrium or the abdominal cavity. In veterinary medicine, ventriculoperitoneal (VP) shunts are most commonly used. Placement of a VP catheter allows the flow of CSF from the brain ventricles to the peritoneal cavity, preventing a build-up of pressure in the brain. Shunts are usually made of a silicone material and they are impregnated with barium for radiopacity. These shunts are equipped with a one-way valve that responds to a pressure differential between the ventricles and the space into which the distal catheter drains. There are low, medium and high pressure valves, but newer models are adjustable and some contain reservoirs for easy CSF withdrawal and sampling (Thomas 2010; Gradner et al. 2019).

Excessive shunting may have serious consequences as it can lead to a collapse of the dilated ventricles and subsequent rupture of vessels, resulting in subdural haematomas. In animals, the risk of siphoning and subsequent overdrainage is lower than in people as the shunt is more horizontal and the head is approximately level with the abdomen. A medium pressure valve (0.69 kPa) was selected for our patient as this is closest to the normal canine ventricular pressure (between 0.67 and 1.60 kPa) (Harrington et al. 1996; Dewey et al. 2006). Careful monitoring is important as overdrainage is possible, especially in animals with severely dilated lateral ventricles and only a thin rim of cerebral cortex on imaging (Harrington et al. 1996).

Ventriculoperitoneal shunt complication rates range from 25% to 29%, with most of them occurring within the first three months. Shunt obstruction is the most common complication of VP shunt placement. Obstructions can be caused by blood clots, debris, proliferative glial tissue, choroid plexus, or abdominal adhesions, all of which can lead to failure of CSF flow (Coates et al. 2006; Biel et al. 2013). Other mechanical defects include kinking, breaking, or separation of catheter components (Harrington et al. 1996; Gradner et al. 2019). Shunt infections are another main complication and they are typically identified within two months after surgery (Thompson 2009). Treatment of an infection often requires removal of the shunt, culturing the organism, and instituting treatment based on sensitivity results (Estey 2016). Magnetic resonance imaging features of a shunt-associated infection have been outlined in a dog as hyperintensity of the ventricular lining on T2-weighted and FLAIR sequences and as a marked contrast enhancement of the ependymal layer on T1-weighted post-contrast images (Platt et al. 2012). Pre-existing skin infections serve as a major contraindication of surgical treatment.

As of now, both medical and surgical treatments rely on the decreasing production of CSF without a possibility to address the primary cause of this condition. Success rates of surgical treatment vary according to the surgeon's experience due to risks of complications mentioned earlier in the text. Thanks to the increase of canine population and willingness of the owners to pursue treatment combined with advancements in veterinary care, the number of reported cases of this condition is growing.

Conclusion

The presented case report demonstrates the successful surgical treatment of congenital hydrocephalus in a unique clinical patient, a six-month-old puppy of a Great Dane.

This clinical case deserves the attention of clinicians and veterinary practitioners in terms of the possibility of successful neurosurgery interventions in non-typical breeds of dogs. In this case, the therapeutic method of choice was a VP shunt placement. It is important to have thorough diagnostic and therapeutic tools and to pay close attention to the postoperative care and possible complications.

Conflict of interest

The authors declare no conflict of interest.

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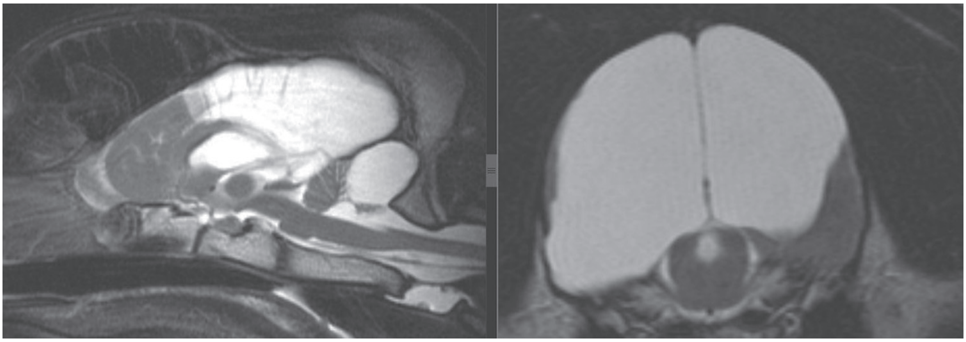

Fig. 1. A T2-weighted sagittal and axial (at the level of thalamus) magnetic resonance images (1.5 T Siemens, 3 mm slices) of the dog with hydrocephalus. In the sagittal image the occipital lobe parenchyma is visualised due to the dilated lateral ventricles. A cystic hyperintense formation is visualised at the caudal part of the cerebellum. In the axial image severe dilation of lateral ventricles and absence of brain parenchyma is visualised.