**Integrative Therapy of Hydrocephalus**

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**Disclosure:**

 Roger M Clemmons teaches at the Chi Institute in Reddick, FL, but has no other financial relationship with any company mentioned in this article.

**Objectives:**

 1. Attendees will be able to understand the differential diagnosis of Hydrocephalus.

 2. Attendees will be able to assess therapeutic methods to help control Hydrocephalus and to determine when surgery might be indicated for treatment.

**HYDROCEPHALUS**HYDROCEPHALUS**:** Hydrocephalus is defined as an abnormal accumulation of cerebrospinal fluid (CSF) within the ventricular system of the brain accompanied by a concomitant loss of cerebral white matter or gray matter. This condition is a common neurologic disorder of miniature breed dogs and offers a unique challenge to the clinician for diagnosis and treatment.

 ***Pathophysiology***Pathophysiology ***of Hydrocephalus*:** Hydrocephalus develops as a sequel to excessive formation of CSF, to decreased absorption of CSF, or to a loss of cerebral tissue volume. The pathophysiology of the former two conditions is important because these causes of hydrocephalus are likely to respond to CSF shunting procedures. The third condition is not likely to respond to either surgical or medical management.

 As a result of excessive fluid accumulation in the ventricular system from increased formation or decreased absorption of CSF, a disequilibrium of forces exists at the ventricular-cerebral interface. Because the ventricular surface is semipermeable, there is a net flux of CSF into the periventricular extracellular fluid compartment. A concomitant decrease must occur in other cranial structures because no "dead space" exists within the cranial cavity. Cerebral vascular structures are most easily compressed, and with increased production of extracellular fluid from the ventricles, the periventricular white matter's reabsorptive capacity is overloaded. The vasculature of the white matter thereby collapses and leads to the development of periventricular white matter ischemia. Because oligodendroglia are sensitive to ischemic insult, demyelination and ventricular enlargement result. Therefore, early treatment must be given for maximal benefit to the patient.

 Some authors have not seen elevated intracranial pressure in dogs with hydrocephalus. In human patients likely to benefit from CSF shunting, however, transient or constantly increased ventricular pressure is common. Although the CSF pressure may be within normal levels in most dogs, increased intracranial pressure does occur in hydrocephalus and may play a significant role in the progression of this disorder. Hydrocephalus in the dog is associated with a higher initial resistance to CSF absorption, but an increased absorptive capacity. The mean rate of CSF formation is also found to be reduced. These findings suggest that canine hydrocephalus would be expected to exhibit low or normal ventricular pressures, but that minor changes in CSF volume would result in pressure increases that could not be normally transmitted or dispersed. Fluctuations in intraventricular pressure, as seen in man, would lead to periods of abnormally high pressures.

 ***Diagnosis***Diagnosis**:** The variability of signs of canine hydrocephalus often makes the diagnosis by clinical criteria alone difficult. In young animals in which a dome-shaped calvarium, open fontanelles, and a downcast gaze are also associated with neurologic dysfunction, however, the diagnosis may be easier. Confirmatory laboratory examinations include electroencephalography and radiology.

 The electroencephalogram of hydrocephalic dogs is characterized by high-amplitude, slow wave activity. This pattern is accentuated during sleep, but remains abnormal even during the alerting response. Although a correlation does appear to exist between the electroencephalographic changes and the degree of ventricular enlargement, these findings do not correlate with the clinical signs.

 Noncontrast radiographs may show some flattening of the gyral impressions upon the calvarium, but such changes are not pathognomonic. Contrast ventriculography with air or radio-opaque contrast agent adequately outlines an enlarged ventricular system. Positive-contrast ventriculography may also provide useful information about CSF circulation patterns and may indicate sites of obstruction to CSF flow. In addition, this technique may be useful in demonstrating shunt patency. Today, computer-assisted tomography (CAT scan) and magnetic resonance imaging (MRI) have replaced most other methods of brain imaging.

 Laboratory evaluation of ventricular fluid pressure, volume, and chemical and cellular characteristics may furnish helpful information about the underlying cause of hydrocephalus.

 ***Surgical Correction***Surgical Correction**:** The decision to place a ventriculoperitoneal shunt should be based upon the progression of clinical signs. The triad of dementia, gait abnormalities, and incontinence is an accurate predictor of responsiveness to shunting procedures in people and can be used in the dog.

The choice of anesthesia should be considered carefully because agents that increase the intracranial pressure may have disastrous consequences. Although isoflurane increases intracranial pressure slightly, this effect can be minimized by hyperventilating the animal for several minutes with oxygen-rich gases prior to the addition of isoflurane to the breathing mixture. Owing to the rapidity with which anesthetic depth can be altered with isoflurane, it is currently the agent of choice.

 The animal is positioned in ventral recumbency, and the calvarium, the neck, and the right, dorsolateral body surface to the paralumbar fossa are surgically prepared. The area is draped, preferably with a barrier drape material.

 A slightly paramedian incision is made over the surface of the calvarium. The subcutaneous tissue and musculature overlying the bony calvarium is dissected free at approximately half the distance from the lateral canthus of the eye to the occipital protuberance and 1 to 1.5 cm from the midline. At this point, a bur hole sufficient to pass the shunt tubing is made through the skull. In small dogs and cats with a thin calvarium, the skull may be carefully cut away with a sharp scalpel blade. The dura is incised, and a shortened, sharpened mare's catheter is inserted into the ventricular cavity. The ventricular end of the shunt tubing is then introduced through the mare's catheter or through the hole made by the catheter in the cerebral tissue. The length of shunt tubing to be inserted into the ventricle should be determined by the depth required to enter the ventricle with the catheter. The shunt tubing is fixed in place with nonabsorbable suture material passed through a hole in the outer cortical lamina of the calvarium. The muscular layers are apposed around the tubing. Once CSF is noted flowing distally in the shunt tubing, the tubing is clamped to prevent excessive CSF loss.

 Alligator forceps are passed subcutaneously through a small skin incision every 9 to 12 cm and are used to pull the distal end of the shunt tubing to the paralumbar fossa. At this point, the peritoneal end of the shunt tubing is bluntly thrust through the body wall and into the peritoneal cavity by grasping it with hemostatic forceps. An additional 15 to 25 cm of shunt tubing should be allowed to lie freely in the peritoneal cavity. The flow of CSF from the tube should be monitored for a few minutes to ensure shunt patency. The skin incisions are closed in a routine manner.

 The advent of silicones materials for shunt tubing has greatly improved the success rate for these procedures. Several shunt systems have been described for ventriculoperitoneal shunting employing special valves, pumping devices, and catheter tips. These materials come sterile, but are readily sterilized by ethylene oxide or autoclave. The peritoneal end may be cut to length at the time of operation. Any increase in intraventricular pressure is dissipated through the shunt by the passage of CSF into the peritoneal cavity.

 ***Postoperative Management and Complications***Postoperative Management and Complications**:** Aseptic surgical technique is essential to ensure postoperative success. The routine use of antibiotics is not indicated. If their use is indicated, however, the veterinarian must consider the lack of a normal blood-brain barrier in the choice of an agent. For example, penicillins are known to be epileptogenic and should be used with caution.

 The complications associated with the procedure are minimal. In general, these complications can be broken into certain categories: shunt failure due to device failure and infections secondary to the shunt. In patients with hydrocephalus, the practicality of this system may allow considerable salvage of neurologic tissue.

 ***TCM Diagnosis and Treatment***TCM Diagnosis and Treatment**:**  Hydrocephalus can be the result of kidney jing deficiency where the kidney fails to support the development of marrow. The kidney does not nourish the child (liver) leading to stagnation of blood and qi. The grandparent (kidney) does not control the grandchild (heart) leading to mania. The grandchild (kidney) becomes rebellious and insults the grandparent (spleen) leading to accumulation of damp. As such, hydrocephalus can be thought of as the result of a spleen deficient damp pattern, where the accumulation of damp affects the mind and heart. The treatment principle is to dry the damp, dissolve the turbidity, eliminate the excess fluid and clear the mind.

**Local AP points:** BL-10, GV-20, GV-21

**Special AP points:** GV-26, PC-6, LI-4, SP-6, SP-9, KID-10

**TCM herbal:** *Peanut’s Hydrocephalus formula* (Jing Tang Herbal, Reddick, FL)