Overview of Traumatic Brain Injury

Pamela Fettig, DVM, DACVECC
Oradell Animal Hospital
Paramus, New Jersey

Traumatic brain injury (TBI) can occur in up to 25% of dogs following severe blunt trauma. Head trauma cases are caused by vehicular accidents, purposeful harm, penetrating wounds, crush injury, falls from heights, and other traumas.

Overview of Traumatic Brain Injury

Common head trauma injuries include:

- Concussion: A brief loss of consciousness with no underlying histopathologic lesion.
- Contusion: Bruising of the brain associated with hemorrhage and edema.
- Coup and contrecoup lesions: At the site of impact and in the opposite brain hemisphere, respectively.
- Lacerations: Disruption of the brain parenchyma—the most severe injury.

Hematomas: Several types can occur within the brain parenchyma (axial) or outside the brain (extraaxial) in the subarachnoid, epidural, or subdural sites. Any type of bleeding or hematoma formation can lead to increased intracranial pressure (ICP).

Head trauma consists of primary and secondary brain injuries. Primary injury (eg, fracture, hemorrhage) is the physical disruption of intracranial structures at the time of the event. Secondary injury, which can occur minutes to days following the TBI, is associated with a massive release of excitatory neurotransmitters and decreased availability of adenosine triphosphate (ATP), the energy required by all cells, which leads to cellular and cerebral edema.

Cerebral cells with low energy availability induce concurrent overproduction of oxygen free radicals, leading to further cell death.

Severely increased ICP can ultimately impair blood flow to the brain (see Figure 1), leading to increased cerebral CO2; the subsequent sympathetic nervous system response to increase blood pressure in an effort to restore cerebral blood flow (CBF) can lead to reflex bradycardia (Cushing reflex).

Hypercapnia can induce vasodilation and increase ICP; hypocapnia can induce vasoconstriction with subsequent cerebral ischemia. Pain and agitation can increase ICP.

Figure 1. Blood flow to the brain. Blue line = PaO2; red line = mean arterial blood pressure (MAP); and gray line = PaCO2. The normal brain has the ability to maintain cerebral blood flow (CBF) despite any changes in cerebral perfusion pressure (CPP). This is caused by pressure and by chemical autoregulation, which prevents under- and overperfusion of the brain. A MAP or CPP between 50 mmHg and 150 mmHg helps maintain adequate CBF. Outside this range, blood flow becomes linear with MAP. PaO2 and PaCO2 can change the diameter of vessels and affect blood flow to the brain. This autoregulation is lost after head trauma.

Courtesy of Dr. Pamela Fettig