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Neurosurgery and Acquired Brain Injury
An Educational Primer

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Introduction

Injuries of the nervous system are particularly frightening to clients and families because of the many unknowns that still revolve around nervous system function, and because of the potential for resulting life-long disabilities or functional deficits. Recovery from brain injury is best achieved with the full participation of the patient and/or his or her family. To this end, each patient and involved family member needs to have an understanding of basic brain anatomy, physiology and pathology, as well as recuperative abilities, expressed as clearly as possible in understandable language. Because the organization of the brain is extremely complex and since an understanding of the brain and types of possible injuries is not part of our elementary, high-school, or even college education, teaching the patient and family is an ongoing process throughout treatment and rehabilitation. It behooves the neurosurgeon to provide as much of that education as possible during the acute care period of time, and to prepare the patient and family for the rehabilitation process during which the therapists will continue to provide education. The latter phase should also include preparation for re-integration into the community or for long-term care.

The nervous system consists of the brain, the spinal cord, and the peripheral nerves. While the neurosurgeon is usually involved in the care of any part of the nervous system, this chapter will address only injuries of the brain. The basic information required by an injured individual and/or his family to understand the injury, its implications and its treatment will be introduced in the following pages.

Anatomy

The brain is a soft mass weighing about two and a half pounds, fairly tightly packed in a three-layered skin known as the meninges (Truex & Carpenter, 1971). The inner or pial layer is translucent and is firmly adherent to the brain. Over the pia, the middle or arachnoid layer is extremely thin and is separated from the pia by a narrow space containing a clear colorless fluid called cerebrospinal fluid.
The outermost layer is the **dura mater**, thick and tough, easily separable from the arachnoid, with several folds to be identified later (Truex & Carpenter, 1971). The brain and its coverings are contained in a hard, closed box, the **skull**. The only opening out of the skull is at the skull base where the brain connects with the spinal cord through the **foramen magnum** (large opening) (Truex & Carpenter, 1971). If a brain is removed from the skull and the outer layer of meninges—the dura—is peeled off, the brain surface is noted to have multiple folds or **convolutions** and grooves or **sulci** coming together in a large mushroom like structure sitting on a narrow stalk—the **brain stem**. The large mushroom-like portion has two halves, the left brain and the right brain, separated by a deep groove at the bottom of which is a bridge of brain connecting the two halves. A fold of the dura extends down the groove and is called the **falx**. The main body of the brain is separated from a lower smaller portion of the brain—the **cerebellum**—located just behind the brain stem. Another fold of the dura called the **tentorium** separates the two parts of the brain (Brodal, 1969; Standing, 2005; Truex & Carpenter, 1971). The brain shares its space inside the skull with blood vessels—arteries and veins—and with the cerebrospinal fluid (CSF). A normal brain contains 140 to 170 cc (4.7 to 5.7 oz) of CSF manufactured in four almost slit-like cavities in the brain called **ventricles**. The brain produces approximately one cupful of fluid every 24 hours. The entire structure—brain, meninges, blood vessels, cerebrospinal fluid, and skull—is perched at the very top of the spinal column (Rouviere et al., 1962; Standing, 2005; Watson, 1995).

The basic anatomical functional unit of the brain is the **neuron**. Billions of neurons are located in several layers near the surface of the brain. This is the **gray matter**. Other neurons are packed in clusters deep in the brain, called **basal ganglia**. Each active neuron has about 80,000 connections with neurons around it. The connections occur at microscopic contact points known as **synapses**. Longer connections between the neurons and deeper parts of the brain travel in bundles through the **white matter** (Dimancescu, 2000; Standing, 2005; Truex & Carpenter, 1971). At the subcellular level, each neuron contains multiple structures that manufacture chemicals and provide energy. Around the neurons are trillions of smaller support cells—the **glial cells** (Brodal, 1969). With special staining techniques in the laboratory, these structures can be seen under a microscope and constitute the cellular anatomy of the brain.

**Physiology**

The brain has autonomic, sensory, motor, and cognitive functions. In very simple terms, autonomic functions are located deep in the brain, in the **midbrain** and in the **brain stem**; sensory functions in the back parts of the brain, **occipital**, **parietal**, and **posterior temporal** lobes; motor function in the **frontal** lobes; and cognitive functions, including memory, concentration, and emotions are more diffusely represented, requiring integration of both sensory and motor functions of the brain (Dimancescu, 1986, 2000; Rouvire et al., 1962). The cerebellum,