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Psychology

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*Edited by*

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fiber tracts connecting the frontal lobes to the rest of the brain. A rod with a retractable wire loop was inserted and rotated through a burr hole drilled in the skull to create a cavity in the neural tissue (Mashour, Walker, & Martuza, 2005). Modifications allowed closed procedures by placing and rotating a leukotome (cutting instrument) into 1-cm burr holes drilled through the bony arch at the outer border of the eye socket. The transorbital lobotomy was introduced in 1946; this procedure was performed with an instrument resembling an ice pick inserted through the bony orbits above the eyes and then swept across the prefrontal cortex (Heller, Amar, Liu, & Apuzzo, 2006).

Precise placement of lesions became possible in the late 1950s with the invention of a stereotaxic instrument that held the head in a fixed position; a knife or electrode could then be lowered into the brain at a point predetermined by a set of three-dimensional coordinates as defined by an atlas (anatomical map) and x-rayed reference points in the brain. The use of knife cuts was gradually replaced by the use of electric currents or radio-frequency waves delivered through electrodes. Some neurosurgeons have also used cryoprobes, radioisotopes, proton beams, ultrasound, and thermocoagulation (Weingarten & Cummings, 2001).

Emotional changes occur in a variety of neurological disorders, including epilepsy, stroke, movement disorders, and trauma. Clinically, it has been noted that lesions in distinctly different areas of the brain will disrupt emotional processing at different levels or stages. Therefore, a common feature shared by theories of emotional dysfunction is that multiple brain systems are involved (Barbas, Saha, Rempel-Clower, & Ghashghaei, 2003; Oscar-Berman & Bowirrat, 2005). The theories may be classified into those stressing asymmetrical contributions of the two cerebral hemispheres and those emphasizing frontal-cortical-subcortical system connections. Damage to different frontal lobe circuits and their projections to cortical and subcortical regions can result in behavioral abnormalities, impaired emotional processing, and dysregulation (Weingarten & Cummings, 2001).

Disruption of the dorsolateral prefrontal circuit results in impaired executive functioning, perseveration, and inability to shift strategies. Lateral orbitofrontal circuit dysfunction results in disinhibition, irritability, and inappropriate behavior. Disruption of the anterior cingulate circuit can result in profound apathy, minimal emotional response to pain, and akinetic mutism. The basal ganglia are a major target for these frontal circuits; thus patients with Parkinson's disease present with disruption of emotional processing (Clark, Oscar-Berman, Shagrin, & Pencina, 2007).

The most effective early targets for relief of psychiatric symptoms involve the medial and ventral areas of the frontal lobes bilaterally. Other regions with well-defined connections to specific frontal areas have been targeted for psychosurgery. These regions are part of the frontal-subcortical circuitry and include the cingulum,

## PSYCHOSURGERY

Psychosurgery is the surgical removal or destruction of healthy brain tissue for relief of severe, persistent, and debilitating psychiatric symptomatology. Cranial surgery can be traced back, with early archaeological evidence of trepanation, to around 7300–6220 B.C. (Lillie, 1998). However, the first widespread application of psychosurgery procedures to psychiatric patients began in the late 1930s, reached its peak in the 1960s, and began to decline in the 1970s (Weingarten & Cummings, 2001).

In the first half of the twentieth century, the most frequently used technique was the frontal lobotomy, wherein fibers in the frontal lobes were cut bilaterally to destroy the

amygdala, several areas in the thalamus and hypothalamus, and anterior portions of the internal capsule (to interrupt frontothalamic projections). Tractotomy is the interruption of fiber tracts connecting frontal areas with lower brain centers, and it has been used to treat major depression, anxiety, and obsessive-compulsive disorder. Cingulotomy is the lesioning of the anterior cingulate area for treatment of severe anxiety and/or depression. Limbic leukotomy involves both tractotomy and cingulotomy, and the lesions are part of both the medial and lateral circuits of the limbic system. Amygdalotomy has been effective in a majority of patients with aggressive behaviors associated with temporal lobe epilepsy. Pallidotomy or thalamotomy for patients with severe Parkinson's disease has restored motor function to normal levels, but these beneficial effects may not be permanent (Kiss et al., 2003).

Because psychosurgery is most often performed on apparently normal brain tissue, its practice has generated considerable controversy. In his 1986 book *Great and Desperate Cures*, Valenstein exposed many factors leading to the abuse of psychosurgery in the mid-twentieth century, including the absence of psychotropic medications, overcrowded psychiatric asylums, poorly defined clinical indications, and sparse patient follow-up records. The National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research supported several intensive investigations on the use and efficacy of psychosurgery ([http://www.bioethics.gov/reports/past\\_commissions/index.html](http://www.bioethics.gov/reports/past_commissions/index.html)). Opponents of psychosurgery have compared it with the abuses of human subjects in biomedical experiments carried out in Germany during World War II. Those in favor of psychosurgery have argued that its prohibition would rob patients of their right to effective medical treatment by limiting the scope of procedures available.

Currently, the number of procedures in the classic sense of ablation of healthy tissue has dropped significantly, on account of the use of pharmacologic agents and a number of minimally invasive techniques purported to produce less damage and fewer adverse effects. Such procedures include transcranial magnetic stimulation (TMS) to brain areas associated with emotional regulation, deep brain stimulation (DBS) for modulation of subcortical regions associated with Parkinson's disease, and vagal nerve stimulation to treat epilepsy and major depression (Heller et al., 2006). Vagal nerve stimulation was approved in 2005 for treatment of refractory major depression; however, its use for treatment of epilepsy warrants further investigation.

The term *psychosurgery* has become less popular as neurosurgeons, psychiatrists, and cognitive neuroscientists develop and redefine psychosurgical procedures to include a combination of treatment modalities. To date, *neuromodulation* is a common term that includes a variety of surgical, electrical, and pharmacological approaches, as

well as gene therapy and stem cell transplantation, to treat severe chronic illness due to pain, movement disorders, epilepsy, and specific psychiatric disorders. The present state of psychosurgery necessitates a potential redefinition of functional neurosurgery to encompass neuromodulation techniques for a variety of ethical, legal, and scientific concerns.

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