Lesion Procedures in Psychiatric Neurosurgery

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Key words
- Major depression
- Neurosurgery
- Obsessive-compulsive disorder
- Stereotactic
- Surgery

Abbreviations and Acronyms
BD: Bipolar disorder
CGI: Clinical Global Improvement
CGPSS: Current Global Psychiatric Social Status Scale
CSTC: Corticostriatal-thalamocortical
DBS: Deep brain stimulation
MDD: Major depressive disorder
MRI: Magnetic resonance imaging
OCD: Obsessive-compulsive disorder
YBOCS: Yale-Brown Obsessive Compulsive Scale

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OBJECTIVE: **Lesion procedures for psychiatric indications have a history that spans more than a century. This review provides a brief history of psychiatric surgery and addresses the most recent literature on lesion surgery for the treatment of anxiety and mood disorders.**

METHODS: **Relevant data described in publications from the early 1900s through the modern era regarding lesion procedures for psychiatric indications, both historical and current use, are reported.**

RESULTS: **The early procedures of Burkhardt, Moniz, and Freeman are reviewed, followed by descriptions of the more refined techniques of Leksell, Knight, Foltz, White, and Kelly. The application of lesion procedures to obsessive-compulsive disorder, mood disorders, and addiction are discussed.**

CONCLUSIONS: **Lesioning procedures have informed modern deep brain stimulation targets. Recent lesioning studies demonstrate the efficacy and durability of these procedures in severely disabled patients. Judicious application of these techniques should continue for appropriately selected patients with severe, refractory psychiatric disorders.**

BRIEF HISTORY

The late eighteenth and nineteenth centuries witnessed the development of functional neuroanatomy—the concept that specific areas of the brain subserve particular functions. Gall (19) ascribed functional significance to individual units of the brain that he called mental organs. His theory of phrenology ultimately lost favor, but he was nonetheless a pioneer of the concept of localization of brain function. One of his detractors, Flourens (18), performed careful experiments that began to demonstrate the functions of the cerebral hemispheres, cerebellum, and brainstem. Broca (8) and Wernicke (70) further refined localization, especially for language function.

This increasing understanding of functional neuroanatomy led the Swiss psychiatrist Burckhardt to postulate that removing regions of cortex could specifically alter behavior (**Figure 1**) (46). His operations on six patients with psychiatric diagnoses in 1888 likely represent the first modern example of psychiatric neurosurgery. His results from these initial attempts were modest: one patient died after developing status epilepticus, one improved but then subsequently committed suicide, two remained stable, and two became more subdued.

In 1910, the Estonian neurosurgeon Puusepp reported results on 17 patients who underwent a frontal leukotomy-like procedure for manic-depressive disorder or epilepsy (43). Results from the initial four patients were poor; however, in the remaining patients, improvement and reduced aggression were seen (57).

In 1935, Fulton presented a landmark study in primate neurophysiology that would guide the direction of psychosurgery for the next 2 decades. Fulton and Jacobsen trained two chimpanzees to perform some basic behaviors. They noted that under certain conditions when reward was omitted, the animals would have clear emotional tantrums. Each animal then underwent a unilateral frontal lobectomy. Fulton and Jacobsen noted that there was no apparent change in their overall cognitive or emotional capacities. However, when the contralateral frontal lobe was also removed, they noticed marked changes in their emotional faculty without any gross changes in overall cognition. Specifically, they stopped responding to the omission of rewards. Fulton and Jacobsen presented their findings at the Second World Congress of Neurology in 1935. At this meeting, the Portuguese neurologist Moniz proposed ablation of frontal cortex for treatment of psychiatric disease in humans (25, 47).

Moniz enlisted the help of the Portuguese neurosurgeon Lima. In 1935, they performed a prefrontal leukotomy on a 63-year-old woman with anxiety, delusions, and melancholia. They injected alcohol into white matter tracts within the frontal lobes to sever connections responsible for the mental illness. The patient was considered to be cured, despite requiring continuous hospitalization (2). By 1936, Moniz and Lima introduced a new instrument called the leukotome, which consisted of a rod that had a retractable wire loop that could be inserted and rotated to sever white matter connec-

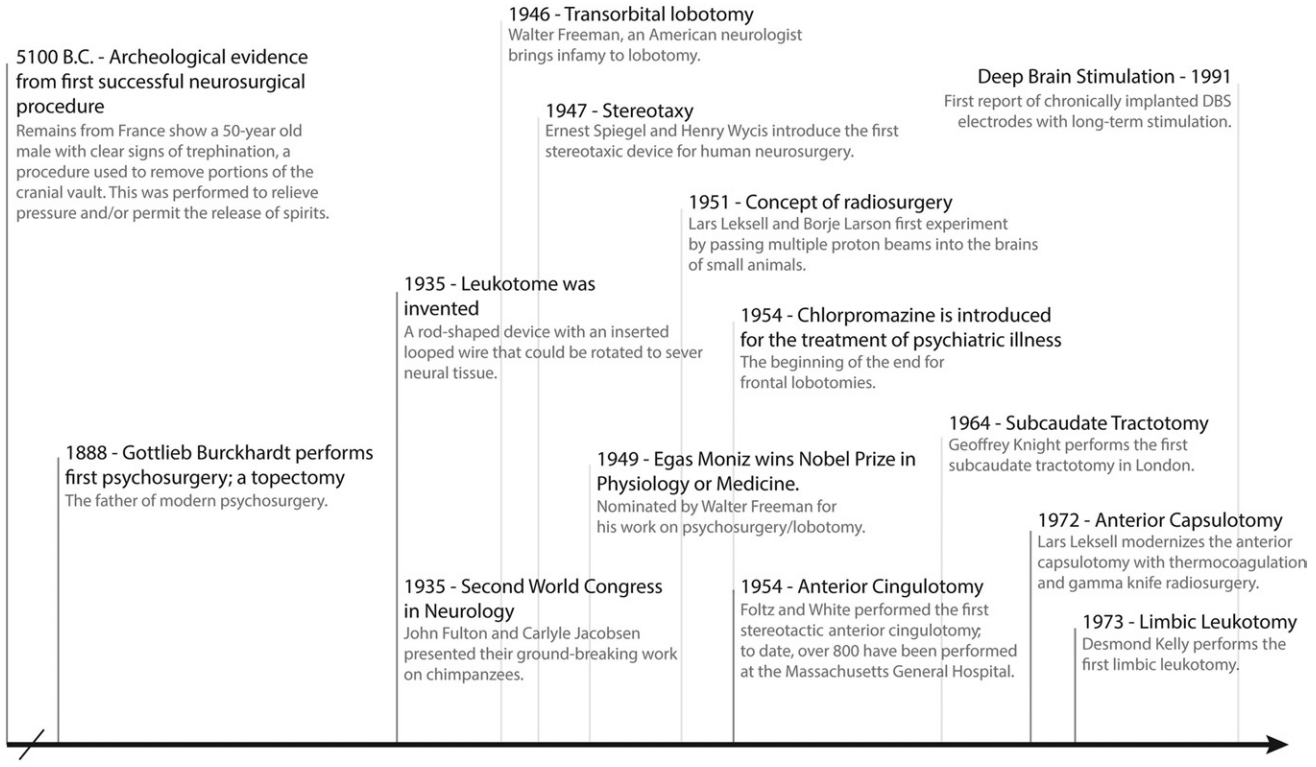

Figure 1. Timeline of major events in the history of psychosurgery.

tions. The procedure was done bilaterally with approximately six 10-mm circular lesions per side. Over the next 2 years, Moniz published numerous articles and books on the procedure, and he won the Nobel Prize in Medicine or Physiology in 1949.

Concurrent to Moniz's work, in 1936, the American neurologist Freeman and neurosurgeon Watts began exploring prefrontal lobotomy as a treatment for psychiatric illness. At the time, psychiatric illness was a staggering problem in the United States, with an estimated 400,000 psychiatric inpatients and an annual cost of $1.5 billion (47). In an effort to make the procedure more widely available, Freeman and Watts introduced the transorbital leukotomy in 1946. The procedure did not require an operating room and was originally performed in Freeman's office. An icepick-like tool, called an orbitoclast, was inserted above the eyelid and driven through the orbital roof with a mallet. Sweeping motions were made with the orbitoclast in the desired plane to severe white matter tracts. The procedure was done bilaterally. An estimated 60,000 procedures were performed from 1936–1956 (2). However, increasingly indiscriminate use of the procedure, an accumulating tally of complications, and the development of the first neuroleptics such as chlorpromazine eventually brought an end to the frontal lobotomy era (17).

The development of stereotactic procedures by Tailarach and Leksell in the late 1940s (42) allowed the creation of smaller, more precisely targeted lesions, resulting in improved outcomes and reduced complications. Stereotactic ablation procedures that were developed over the next 2 decades are still in use today to treat patients with severe disease that is refractory to conventional pharmacologic and behavioral therapy. Modern practice of psychiatric neurosurgery must take careful account of ethical objections raised against the notorious transorbital frontal lobotomies of the middle decades of the 20th century. The ensuing public backlash led to the convening of a U.S. Congressional Commission in the late 1970s to investigate the appropriate selection and treatment of patients for these procedures. Their report formed the basis for guidelines governing the practice of psychiatric neurosurgery (12, 69).

At the present time, psychiatric neurosurgery procedures are most often performed to treat severe, refractory anxiety disorders such as obsessive-compulsive disorder (OCD) and mood disorders such as bipolar disorder (BD) and major depressive disorder (MDD) (**Table 1**). We briefly describe these conditions and outline the ablative procedures available to treat them. In addition, we discuss treatment of addiction, both historically and more recent international efforts.

OBSESSIVE-COMPULSIVE DISORDER

Description

OCD is an anxiety disorder characterized by persistent unwanted thoughts (obsessions) and ritualistic behaviors or mental acts (compulsions). The intrusive nature of obsessions is a source of overwhelming anxiety and often requires repetitive performance of time-consuming or socially inappropriate behaviors to subdue. OCD is generally considered to be a chronic illness with a lifetime prevalence of 2%–3% in the United States (32, 58). The current standard