



Reviews

Psychosurgery: past, present, and future

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Abstract

Psychosurgery, the neurosurgical treatment of psychiatric disease, has a history dating back to antiquity, and involves all of the clinical neurosciences. This review discusses the history of psychosurgery, its development in the 19th century, and the conditions of its use and abuse in the 20th century, with a particular focus on the frontal lobotomy. The transition to the modern era of psychosurgery is discussed, as well as the neurobiology underlying current psychosurgical procedures. The techniques of stereotactic cingulotomy, capsulotomy, subcaudate tractotomy, and limbic leukotomy are described, as well their indications and side effects. Due to the past abuse of psychosurgery, procedures are currently under strict control, and the example of the Cingulotomy Committee at the Massachusetts General Hospital is discussed. Finally, future directions of psychosurgery and somatic therapies are explored, including transcranial magnetic stimulation, vagal nerve stimulation, deep brain stimulation, gene therapy, and stem cell therapy. In summary, this review provides a concise yet comprehensive introduction to the history, current practice, and future trends of neurosurgery for psychiatric disorders.

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1. Introduction

The neurosurgical treatment of psychiatric disease has a rich, complex, and controversial history, involving all of the clinical neurosciences. The origins of psychosurgery will be traced from antiquity, with a more recent historical perspective developed from the mid-19th century and the genesis of brain–behavior correlation. From this groundwork, the innovations of psychosurgical pioneers such as Gottlieb Burckhardt, Egas Moniz, and Walter Freeman will be discussed. The rise and fall of the frontal lobotomy will be emphasized, as well as the transition to the modern era of psychosurgical procedures. The discussion of the current state of psychosurgery will involve the description of four major procedures: anterior cingulotomy, subcaudate tractomy, limbic leukotomy, and capsulotomy. The indications, safety, and efficacy of these procedures will be discussed, as well as the cognitive neuroscience underlying their approach. The future trends of psychosurgical procedures will be described: vagal nerve stimulation, deep brain stimulation, gene therapy, and cellular therapy, as well as the alternative therapy of transcranial magnetic stimulation.

2. The origins of psychosurgery

The origins of psychosurgery can be traced to antiquity through the practice of trephination, the procedure of craniotomy with the cylindrical saw termed the “trephine.” At the Ensisheim burial site in France, a trephined skull has been identified that carbon dates to the neolithic period of the stone age, or approximately 5100 BC [1]. The evidence of proper healing and the estimation of a relatively long lifespan of the individual suggest a surgical rather than a traumatic origin of the wound. Irrespective of the validity of this interpretation, literature on trephination for the relief of neuropsychiatric symptoms including affective and psychotic disorders can be dated to 1500 BC [4]. Thus, the history of psychosurgery is as ancient as the recorded history of psychiatric disease itself.

The groundwork for the modern era of psychosurgery, however, was established in the 19th century during an era of neuroscientific inquiry characterized by brain–behavior correlation. Clinicopathologic correlation of neurologic insults provided critical insight into the neuroanatomical substrates of higher cognitive functions such as language, most notably the aphasias described by Broca and Wernicke [13,94]. There is little doubt, however, that the most famous “experiment of nature” in the cognitive

neurosciences occurred on September 13, 1848 to a Vermont railroad worker named Phineas Gage. The strange explosion on that day resulted in a 109 cm-long, 3 cm-thick, fine-pointed rod being shot into his orbit, through his brain, through his skull and onward into the air. The consequences were remarkable: much to the surprise of all he quickly recovered consciousness and survived the blast. More importantly, however, he was transformed from an intelligent, upstanding citizen to an uninhibited vagabond. His physician Dr. John Harlow [34] noted the disruption of “the equilibrium...between his intellectual faculty and animal propensities,” but his friends were perhaps more eloquent when they said that “Gage was no longer Gage.” Almost 150 years later, Damasio et al. [21] published a study of Gage’s skull, proposing a trajectory of injury through the ventromedial portion of the prefrontal cortex, and correlated symptomatology with a cohort of patients with similar neuropathology.

The birth of modern psychosurgery is attributed to the Swiss psychiatrist Gottlieb Burckhardt. Influenced by the climate of brain–behavior correlation in the latter half of the 19th century, and in particular the demonstration by Mairet of hypertrophic temporal gyri in schizophrenic patients [54], he performed the first psychosurgical procedures of the modern era in 1888. The process involved the excision of cerebrum (the so-called “topectomy”) at multiple foci in frontal, parietal, and temporal cortices. The outcomes of the six cases ranged from success (in three patients) to failure (in one fatal case). Needless to say, the criteria of post-operative success were ambiguous, a difficulty of evaluation that has historically plagued psychosurgery. Burckhardt’s psychosurgical innovation was not received favorably in Switzerland, and he abandoned this project after the publication of his results in 1891 [14,39]. Despite the fame of Egas Moniz and the infamy of Walter Freeman, Gottlieb Burckhardt enjoys the distinction of being the founder of psychosurgery.

The early decades of the 20th century saw a continued interest in brain–behavior and clinicopathologic correlation, and a variety of somatic and neurosurgical therapies for psychiatric disorders were being explored. It is of significance to note, however, that these early decades deepened a schism between the fields of neurology and psychiatry that was to reach its apex with the era of Freudian psychoanalysis [74]. Neurology and psychiatry—which were historically unified—became conceptually, academically, clinically, and physically isolated from one another. By the time of World War II, psychiatry had minimized the importance of biological theories and approaches to mental illness. Thus, it comes as no surprise that many of the so-

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