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Clinical Perspectives on Psychiatric Neurosurgery

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Abstract
Introduction: Surgical interventions such as stereotactic radiosurgery and magnetic resonance-guided focused ultrasound, and neuromodulatory interventions such as deep brain stimulation (DBS) and vagal nerve stimulation, are under investigation to remediate psychiatric conditions resistant to conventional therapies involving drugs and psychological supports. ***Objective:*** Given the complicated history of psychiatric neurosurgery and its renaissance today, we sought to examine current perceptions and predictions about the field among practicing functional neurosurgeons. ***Methods:*** We designed a 51-question online survey comprising Likert-type, multiple-choice, and rank-order questions and distributed it to members of the American Society for Stereotactic and Functional Neurosurgery (ASSFN). Descriptive and inferential statistical analyses were performed on the data. ***Results:*** We received 38 completed surveys. Half ($n = 19$) of responders reported devoting at least a portion of their clinical practice to psychiatric neurosurgery, utilizing DBS and treating obsessive compulsive disorder (OCD) most frequently overall. Respondents indicated that psychiatric neurosurgery is more medically effective (OR 0, $p = 0.03242$, two-sided Fisher's exact test) and has clearer clinical indications for the treatment of OCD than for the treatment of depression (OR 0.09775, $p = 0.005137$, two-sided Fisher's exact test). Seventy-one percent of all respondents ($n = 27$) supported the clinical utility of ablative surgery in modern neuropsychiatric practice, 87% ($n = 33$) agreed that ablative procedures constitute a valid treatment alternative to DBS for some patients, and 61% ($n = 23$) agreed that ablative surgery may be an acceptable treatment option for patients who are unlikely to comply with postoperative care. ***Conclusions:*** This up-to-date account of practices, perceptions, and predictions about psychiatric neurosurgery contributes to the knowledge about evolving attitudes over time and informs priorities for education and further surgical innovation on the psychiatric neurosurgery landscape.

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Introduction

First-line therapeutic approaches to psychiatric illnesses offer remission to many patients, but an unmet need exists for those who do not respond to trials of pharmacotherapy or psychotherapy. Neuromodulatory and ablative interventions have been introduced or are currently under clinical investigation to respond to drug-resistant conditions. While safer than psychosurgery predecessors of the 20th century, modern psychiatric neurosurgery procedures continue to pose significant ethical challenges. Some of these challenges center on informed consent, delineating acceptable uses of psychiatric neurosurgery from misuses, potential harm to patients caused by overly reductionist explanations of mental illness, and stigma stemming from the dark history of psychosurgery [1–4]. Clinicians working in this field shoulder a great responsibility to pursue safe translation in this arena.

Previous studies have used semi-structured interview and survey methodologies to assess opinions held by the neurosurgical community on the topic of psychiatric neurosurgery [5–7]. In 2010, Mendelsohn et al. [6] conducted interviews with 47 neurosurgical staff and trainees. All participants endorsed psychiatric neurosurgery for refractory conditions as an ethical imperative, and stressed the importance of safety, efficacy, patient consent and the severity of the illness as important decision-making criteria. Participants largely supported the notion that societal attitudes will dictate the permissibility of surgical innovation in psychiatry, and many rejected the readiness of these interventions for widespread public acceptance.

At the same time, nearly half of 84 North American members of the World Society for Stereotactic and Functional Neurosurgery (WSSFN) indicated that psychiatric neurosurgery was a component of their functional neurosurgery practice [5]. Surgeons who practiced psychiatric neurosurgery used deep brain stimulation (DBS) most frequently overall and were more likely to support the future growth of both personal and global psychiatric neurosurgery practice than non-psychiatric neurosurgeons. Survey respondents ranked the reluctance of psychiatrists to refer patients, stigma surrounding psychiatric disease, and the historic misuse of psychosurgery as the 3 most significant obstacles preventing widespread use of functional neurosurgery to treat psychiatric illness.

Mendelsohn et al. [7] extended these inquiries to international members of the WSSFN in 2013. Similar to results from North America, approximately half of the 106 survey responses from functional neurosurgeons across the globe indicated the use of psychiatric neurosurgery within their clinical practice. The proportion of practice devoted to psychiatric neurosurgery remained small among this sample, however. Proportions of psychiatric neurosurgeons (PNS) reporting the use of lesion techniques exclusively (16%) and in combination with stimulation (26%) in clinical practice were higher than those reported by North American PNS. Both psychiatric and non-psychiatric neurosurgeons in this international sample believed that global trends for psychiatric neurosurgery would increase in the future. Reluctance of psychiatrists to refer patients, stigma surrounding psychiatric disease, and a lack of convincing evidence for psychiatric neurosurgery ranked as the top 3 impediments to greater acceptance of these procedures.

In the time since the publication of these surveys, much has evolved within the psychiatric neurosurgery landscape. Clinical guidelines governing the investigational and therapeutic applications of psychiatric neurosurgery were published in 2014, inviting functional neurosurgeons, psychiatrists, neurologists, neuropsychologists, and neuroethicists to formally engage in the advancement of these procedures [4]. Clinical trials for DBS alone now span numerous psychiatric indications – from depression to schizophrenia to addiction – across 14 countries [8, 9]. Most recently, magnetic resonance-guided focused ultrasound (MRgFUS), a minimally invasive, fast-acting lesioning technique that targets brain tissue using ultrasound energy, has entered phase I clinical trials for patients with treatment-resistant depression, obsessive compulsive disorder (OCD), and Alzheimer disease [10].

Against this backdrop and rapid progress in the field, we sought to deliver an up-to-date understanding of functional neurosurgeon practices, views, and predictions regarding psychiatric neurosurgery in North America. We hypothesized that the role of ablative procedures among functional neurosurgeons would be less pronounced than before given reports of public aversion towards them [11], a recent influx of scientific inquiry dedicated to neuromodulation [12, 13], and perceived patient preference for non-ablative procedures [14]. Likewise, we hypothesized that the volume of research in this area, device industry involvement, and the historical background of these interventions would also influence views of contemporary ablative and neuromodulatory interventions with respect to clinical applicability, evidence quality, and future directions.

Table 1. Basic demographics

Gender	
Male	34 (89%)
Female	3 (8%)
Prefer not to respond	1 (3%)
Age, years	
25–34	1 (3%)
35–44	13 (34%)
45–54	12 (32%)
55–64	9 (24%)
65 and older	3 (8%)
Country of practice	
Canada	6 (16%)
USA	32 (84%)
Medical school	
Canada	9 (24%)
USA	27 (71%)
Abroad	2 (5%)
Years in practice	
<5	6 (16%)
5–9	11 (29%)
10–14	5 (13%)
15–19	
20 or more	10 (26%)
Fellowship training in functional neurosurgery	
Yes	25 (66%)
No	
Practice setting (n = 41)	
Academic	33 (81%)
Community	3 (7%)
Private	4 (10%)
Other	1 (2%)

Methods

A 51-question, computerized, Internet-based survey was developed drawing upon the work of previous groups [5, 7]. Questions were divided into 3 main categories: basic demographics, clinical practice, and attitudes towards psychiatric neurosurgery. Unlike previous surveys [5, 7], the present survey included an adaptive element, allowing respondents who indicated that psychiatric neurosurgery was a component of their clinical practice to receive questions belonging to a fourth category about frequency of techniques utilized and conditions treated. Questions posed later in the survey about perceptions towards psychiatric neurosurgical procedures and conditions were correspondingly adapted based on responses received from functional neurosurgeons within this fourth category. Further, if a respondent indicated that psychiatric neurosurgery was a component of their clinical practice and that DBS was their most-frequently used intervention, subsequent questions about psychiatric neurosurgery attitudes and perceptions were tailored to the most frequently utilized intervention specifically. Functional neurosurgeons reporting no current use of psychiatric neurosurgery in their clinical practice received default questions that assessed perceptions towards ablative surgery as an intervention and depression as a condition. The survey was piloted among members of the study team. Institutional Research Board approval was obtained from Michigan State University (STUDY00001237).

Survey Distribution

The survey was distributed by e-mail to members of the American Society for Stereotactic and Functional Neurosurgery (ASSFN) by an administrator of the society. A reminder e-mail was sent 2 weeks after the initial distribution. Responses to the survey were voluntary and anonymous.

Data Preparation

Fifty-four survey responses were obtained. Sixteen were incomplete and were excluded from analysis.

Data Analysis

Descriptive statistics are reported as frequencies and rounded percentages. Response comparisons between the following groups were assessed post hoc for group differences using two-sided Fisher's exact tests: (1) functional neurosurgeons who treat psychiatric conditions and those who do not; (2) functional neurosurgeons with 15 years or more experience and those with 14 years or less; (3) attitudes regarding neuromodulatory interventions and attitudes regarding ablative interventions; and (4) attitudes regarding psychiatric neurosurgery for the treatment of OCD and attitudes regarding psychiatric neurosurgery for the treatment of depression. Group differences were probed in group 1 based on previous surveys distributed within this population [5, 7]. The responses of physicians who indicated the use of psychiatric neurosurgery in their own clinical practice delineated comparison groups 3 and 4 based on responses representing surgeons' most frequently utilized interventions and most frequently treated disorders, respectively. We also tested for group differences by level of clinical experience. Data were analyzed using R version 3.5.2 [15].

Results

Demographics and General Practice

Respondents were predominantly male (n = 34, 89%), and two-thirds were between the ages of 33 and 54. The majority of respondents practice in the United States (n = 32, 84%), while the remainder practice in Canada (n = 6, 16%). Slightly more than half (n = 21, 55%) of respondents had at least 10 years of experience in the field, with roughly one-quarter (n = 10, 26%) indicating 20 years or more. Two-thirds of respondents obtained formal fellowship training in stereotactic and functional neurosurgery; the other third indicated no fellowship training (Table 1).

Movement disorders accounted for a self-reported average of 46% of all functional neurosurgery referrals to the respondents (SD 34%; Fig. 1). Psychiatric conditions excluding chronic pain accounted for an average of just 7% of all respondents' clinical practices (SD 20%); how-

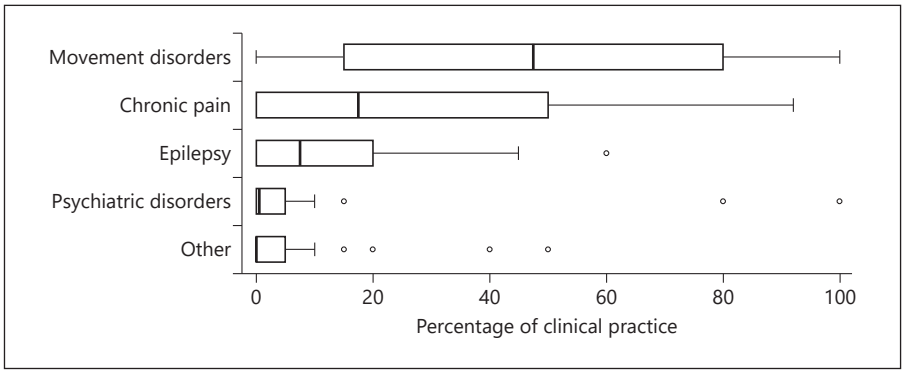

Fig. 1. Functional neurosurgeon practice by condition.

ever, 2 respondents reported that psychiatric referrals comprise 80 and 100% of their individual practices, respectively.

Psychiatric Neurosurgery Practice

Clinicians who reported that psychiatric referrals account for a portion of their clinical practice were considered PNS (n = 19, 50%). Nearly two-thirds of PNS reported having <15 years of experience in the field of functional neurosurgery (n = 14, 64%). DBS was ranked as the most frequently utilized intervention for psychiatric referrals by 47% of PNS who answered questions about their psychiatric neurosurgery practice, while OCD was ranked as the most frequently treated condition (n = 13/18, 72%; one surgeon reported treating both OCD and depression equally; both responses were included). Most PNS reported using a combination of neuromodulatory (DBS, vagal nerve stimulation) and ablative interventions (MRgFUS, chemical ablation, electrocoagulation, stereotactic radiosurgery) when treating psychiatric conditions (n = 12/17, 71%). Thirty-five percent reported using neuromodulatory methods exclusively, while 12% (n = 2/17) reported using only ablative methods.

Ablative Procedures

No statistical differences were observed between PNS and non-PNS, or between clinicians with 15 years or more years of experience in the field and those with fewer than 15 years of experience when asked about attitudes towards ablative neurosurgery. Most neurosurgeons supported a continued role for ablative surgery for psychiatric conditions, with only 16% agreeing that ablative surgery should no longer be performed in a psychiatric context. Eighty-seven percent of clinicians agreed that ablative surgical procedures represent a valid alternative to DBS for some psychiatric patients, such as patients who will likely not comply with postoperative care (61%). More than two-thirds (79%) of clinicians agreed that ablative surgery is more cost-effective than DBS.

Table 2. Attitudes towards the use of psychiatric neurosurgery for OCD and depression

For the treatment of depression/ OCD, psychiatric neurosurgery	Depression (n = 24)	OCD (n = 13)
Is safe	22 (92)	12 (92)
Is medically effective	16 (67)*	13 (100)*
Is cost effective	14 (58)	12 (92)
Has clear clinical indications	8 (33)*	11 (85)*

Values indicate supporters (% agreement). * $p < 0.05$.

Ablative versus Neuromodulatory Interventions

Respondents were asked about the clinical applicability of either ablative (n = 22) or neuromodulatory (n = 14) interventions for neuropsychiatric indications. No statistically significant differences were found between groups that answered questions about interventions within either surgical category. Nearly all participants agreed that ablative and neuromodulatory interventions have the potential to improve the quality of life for properly selected patients (ablation, 92%; neuromodulation, 93%). Most respondents indicated that they remain optimistic that ablative and neuromodulatory procedures will be accessible to patients in need (ablation, 71%; neuromodulation, 79%) as these treatments evolve and that these procedures can help physicians and researchers to better understand the neurological basis of psychiatric disease pathology (ablation, 67%; neuromodulation, 71%). Only 42% of clinicians asked about ablation and 36% of those

Table 3. Perceived barriers for patients and clinicians when considering psychiatric neurosurgery

	PNS (n = 19)	Non-PNS (n = 19)	≥15 years of experience (n = 16)	<15 years of experience (n = 22)	Total (n = 38)
Concerns about adverse effects	19 (100)	18 (95)	16 (100)	21 (95)	37 (97)
The historic misuse of psychosurgery	18 (95)	17 (89)	15 (94)	20 (91)	35 (92)
Uncertainty about when psychiatric neurosurgery should be utilized	18 (95)	17 (89)	16 (100)	19 (86)	35 (92)
Reluctance of psychiatrists to refer	18 (95)	16 (84)	14 (88)	20 (91)	34 (89)
Stigma surrounding psychiatric disease	18 (95)	13 (68)	10 (63)*	21 (95)*	31 (82)
No barriers exist	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Values indicate supporters (% agreement). * $p < 0.05$.

asked about neuromodulation agreed that these treatments constitute last resort interventions for psychiatric conditions. Very few respondents agreed that ablative (13%) or neuromodulatory (7%) interventions present a high risk of surgical complications. Finally, although opinions were evenly split as to whether some applications of ablation are unethical, only 29% of participants agreed that some applications of neuromodulation can be ethically contentious.

Attitudes towards the Use of Psychiatric Neurosurgery for OCD and Depression

Respondents were asked to consider the clinical applicability of psychiatric neurosurgery for the treatment of either depression (n = 24) or OCD (n = 13; Table 2). Functional neurosurgeons largely agreed that for either psychiatric condition, neurosurgical interventions are safe. However, opinions significantly diverge when respondents considered medical efficacy and the strength of clinical indications warranting the use of psychiatric neurosurgery for these conditions. All respondents agreed that psychiatric neurosurgery was a medically effective treatment for OCD; however, only two-thirds (67%) agreed that psychiatric neurosurgery for depression was medically effective (OR 0, p = 0.03242, two-sided Fisher's exact test). In addition, surgeons much more readily supported the clinical justification for using psychiatric neurosurgery as a treatment for OCD (85%) than for depression (33%, OR 0.09775, p = 0.005137, two-sided Fisher's exact test). More surgeons considered psychiatric neurosurgery to be a cost-effective treatment for OCD (92%), but not for depression (58%); however, this difference was not statistically significant (OR 0.1226, p = 0.05735, two-sided Fisher's exact test).

Barriers and Predictions

Clinicians unanimously agreed that barriers exist for both patients and clinicians when considering the use of psychiatric neurosurgery. The potential for adverse effects is the most ubiquitous barrier surrounding psychiatric neurosurgery procedures (97%), followed by similarly strong endorsements of uncertainty about when to resort to surgical methods in neuropsychiatry (92%) and the historic misuse of psychosurgery (92%). Eighty-two percent of all respondents agreed that stigma towards psychiatric disease presents a barrier towards the adoption of these interventions; however, participants with less experience in the field are more likely than those with more experience to consider stigma to be an important hurdle (<15 years of experience, 95%; ≥15 years of experience, 63%, OR 0.08503, p = 0.02838, two-sided Fisher's exact test). Future predictions regarding the use of psychiatric neurosurgery were not significantly different among respondents on the bases of current psychiatric neurosurgery practice or experience level within the field. Half of all respondents agreed that psychiatric neurosurgery will contribute to a larger component of their own clinical practice in the future. Overall, two-thirds of participants agreed that psychiatric neurosurgical procedures will increase over time (Table 3).

Discussion

The present study provides an up-to-date examination of applications, attitudes, and predictions regarding psychiatric neurosurgery among North American clinicians following nearly a decade of continued innovation in the field. Similar to benchmark surveys on this topic, we found that half of respondents engage in some form of

psychiatric neurosurgery, predominantly DBS, with an emphasis on the treatment of OCD [5, 7]. Recent reports of public aversion towards irreversible, ablative procedures prompted us to inquire further about the permissibility and clinical utility of lesioning procedures in modern psychiatric neurosurgery [11].

Despite the excitement around DBS as a potential alternative to the more permanent effects of surgical ablation, a majority of clinicians in the field of psychiatric neurosurgery report using ablative procedures to varying extents when treating psychiatric disorders. This proportion is slightly larger than results reported by Lipsman et al. [5], and may be attributed to the still experimental status of DBS for most psychiatric disorders, evolutions in stereotactic radiosurgery protocols for OCD that have curtailed instances of adverse events, or by new research interests directed at advancing MRgFUS as a fast-acting, minimally invasive alternative to other ablative procedures [16–19].

Functional neurosurgeons in this cohort more readily endorsed psychiatric neurosurgery as a medically effective and clinically indicated treatment for OCD than for depression. This may be a reflection of the humanitarian device exemption granted by the FDA in 2009 for the use of DBS in treatment-resistant OCD, as well as the limited success of DBS for treatment of refractory depression in large controlled clinical trials [20, 21]. However, some members of the stereotactic and functional neurosurgical community suggest that DBS for depression was tested prematurely using a randomized sham-controlled trial design [22].

We found that functional neurosurgeons associate minimal risks and few complications with ablative and neuromodulatory interventions overall and view them as safe interventions for patients diagnosed with treatment-refractory OCD and depression. Nevertheless, respondents advance concerns about adverse effects as the most substantial barrier faced by clinicians and patients when considering the use of psychiatric neurosurgery. These findings are certainly in contrast with those of Lipsman et al. [5] who reported that 51% of neurosurgeons have no problem offering DBS for healthy individuals. In particular, if neurosurgeons already have substantial concerns around adverse effects of these interventions for disease groups, these concerns arguably could only be exacerbated for cognitive or mood enhancement of healthy individuals.

Findings around perceptions of stigma are similar to previous surveys [5, 7]; however, we also found that these perceptions varied with respect to clinicians' experience level. This finding lends itself to future research, as little work has been done to examine whether factors such as age or professional medical experience alter perceptions of stigma faced by those with mental illness.

Most participants surveyed do not view psychiatric neurosurgery procedures as last resort options for psychiatric patients. Considering the disease burden of psychiatric illness and the urgent need for effective treatments for patients for whom front-line treatments have failed, the results support timelier interventions for mental health disorders as a clinical priority.

We found that some respondents consider the use of ablative surgery for certain applications as unethical; less of a disposition in this regard for neuromodulatory procedures. While this modality-based difference was not statistically significant, the difference may be due in part to value-laden device features like reversibility and adjustability [13].

Finally, predictions today regarding the future use of psychiatric neurosurgery are not as enthusiastic as those captured in 2011. In the time that has elapsed since the initial survey by Lipsman et al. [5], functional neurosurgeons in North America have yet to see the therapeutic promise of psychiatric neurosurgery. The lack of strong evidence for the efficacy and safety of neurosurgical treatments puts into question the credibility of the field. However, in the past months, one new study has shed light on the role for both pulse width and amplitude titration in optimizing clinical outcomes in patients with treatment-resistant depression [23]. A second study reports sustained antidepressant response to subcallosal cingulate DBS over the long term [24]. There are also difficulties in establishing partnerships between psychiatrists and neurosurgeons, challenges around patient selection, and a lack of knowledge about patient treatment preferences that may be further contributing factors in the unmet therapeutic promise of psychiatry neurosurgery. In spite of this, as put by Bari et al. [22] "the stereotactic and functional neurosurgical community maintains a realistic view of the challenging road ahead but at the same time remains committed to searching for solutions to these devastating problems."

Limitations

Interpretation of the data is constrained by the relatively low number of responses. ASSFN membership is around 300, which would indicate a response rate of just over 12%. A 10–15% response rate to an online physician-directed survey is common [25] (e.g., Mendelsohn et al. [7] survey also had a response rate of 12%). It is possible

that because we are not principally a neurosurgical group like Lipsman's group, we were unlikely to capture similar responsivity from a shared professional group. ASSFN only represents North America; as such, the lack of representation of other countries outside Canada and the United States limits the generalizability of the data to other geographies and culturally diverse populations.

Conclusion

Ablative surgery continues to play an important role in the renaissance of psychiatric neurosurgery from the perspective of clinicians in the field, despite reported aversion to it by the public. Medical and social barriers have persisted throughout the last decade that may continue to limit the accessibility of these procedures to those in need. Given the potential benefits of these interventions for patients with treatment-refractory illnesses, increased public education, including mental health providers, and continued innovation in the field of psychiatric neurosurgery with meaningful ethical oversight is an imperative. Ethical oversight should focus on issues such as the medical need for research over non-health goals and scientific patience for reproducible results prior to the launch of large multisite clinical trials.

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Statement of Ethics

The authors have no ethical conflicts to disclose.

Disclosure Statement

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Author Contributions

L.Y.C.: substantial contribution to conception; L.Y.C., C.C., J.I., and Z.H.T.K.: designed survey; L.Y.C. and C.C.: contribution in acquisition of data; L.Y.C., C.C., and J.I.: interpretation of data; C.C.: analysis of data and drafted the article. All authors reviewed manuscript critically for important intellectual content and approved final version to be published.

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