Awake versus Asleep Deep Brain Stimulation for Parkinson's Disease: A Comprehensive Meta-Analysis

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Introduction

Given recent advancements in stereotactic techniques and intraoperative imaging for deep brain stimulation (DBS) for Parkinson's disease (PD), high levels of anatomic precision in terms of electrode placement can be obtained with patients under general anesthesia (GA) that may obviate the need for traditional awake intraoperative physiologic monitoring. Proponents of asleep DBS argue that greater patient comfort, decreased complication rates and operative times can be achieved without sacraficing anatomic precision and ultimate clinical outcomes. However, many studies have demonstrated the utility of microelectrode recording (MER) during awake procedures for optimal placement and improved outcomes of DBS for PD.

Methods

We conducted a literature review and meta-analysis of all published DBS for PD studies (N = 2276) on PubMed from 2006 to present day. Inclusion criteria included patient N > 15, report of precision and/or clinical outcomes data, and at least one year follow-up (N = 131, 13 of which were under GA). Results were stratified by type of anesthesia (GA versus local). Data were pooled using an inverse-variance weighted, random effects meta-analytic model for observational data.

Table 1

Table 1: Demographics – Pooled Values

Patient Characteristics	Awake N	Awake mean	Awake SD	General Anesthesia N	General Anesthesia mean	General Anesthesia SD	Difference (p-value)
Age	5442	59.328	3.8241	548	57.602	7.1223	0.194
Duration of disease (yrs)	4770	12.538	1.6808	415	11.8	2.6012	0.284
# of Leads inserted per patient	4688	1.8692	0.7016	548	1.9763	0.0537	0.614
Length of follow-up (mos)	4601	14.525	10.234	287	11.969	5.6204	0.418

N = number of observations

Demographics - Pooled Values

Table 2

Table 2: Outcomes of surgery – Pooled Values

Outcome Category	Awake N	Awake mean	Awake SD	General Anesthesia N	General Anesthesia mean	General Anesthesia SD	Difference (p-value)*
Maximum Error/lead	1444	2.109	0.6501	344	1.317	0.4387	**0.014**
# Passes/lead	2240	2.168	0.5791	550	1.743	1.0367	0.066
incidence ICH/lead	4177	0.034	0.0149	516	0.029	0.0526	0.501
incidence Infection/lead	2666	0.056	0.041	516	0.035	0.0297	0.197
Time/case (min)	341	270.65	87.912	362	286.13	70.587	0.293
% change postoperatively							
UIII off	3984	48.7	15	299	53.5	9.03	0.349
UIII on	2343	24.9	16.07	136	20.4	7.35	0.584
UPDRSII off	725	48.3	12.9	162	45.8	28.47	0.283
UPDRSII on	360	23.5	19.26	82	7.2	3.6	0.37
UPDRSIV off	406	78.6	5.4	80	59.7	16.17	**0.019**
UPDRSIV on	268	61.3	37.52	0	No data		No data
UPDRSTotal off	291	36.0	13.5	99	39.2	8.8	0.77
UPDRSTotal on	179	8.1	6.12	82	14.8	0.41	0.368
HYSS off	343	21.8	10.32	50	26.3	16.6	0.564
HYSS on	435	24.3	17.76	30	61.6	16.3	**0.036**
LEDD	3064	47.9	17.67	389	53.7	7.37	0.43

N = total number of observations (cases or leads, whichever is relevant)
* significant differences shown in boldface

Outcomes of surgery – Pooled Values

Results

In terms of anatomic precision, there was a statistically significant difference in mean target error (1.317mm GA vs 2.109mm local, p = 0.596) but not mean number of lead passes (1.743 GA vs 2.168 local, p = 0.778) between the two different modalities. However, it must be noted, that mean target error was calculated in all studies in relation to planned preoperative anatomic trajectory. Many times in awake DBS, MER leads to adjustment away from this preoperative trajectory in order to optimize intraoperative physiologic result. In terms of clinical outcomes, change in UPDRS-III scores on and off medication were very similar (20.4% and 53.5% respectively for GA vs 24.9% and 48.7% for local respectively), as were decreases in levodopa equivalent doses (LEDD) (53.7% GA vs 47.9% local). Neither of these differences was statistically significant.

The rate of complications in terms of intracerebral hemorrhage or infection were similar between the two cohorts (incidence of ICH: 0.034 local vs 0.029 awake; incidence of infection: 0.056 local vs 0.035 awake) with no statistically significant differences. Length of surgery was also not significantly different between the two modalities (270.65min local vs 286.13min GA, p=0.293).

Conclusions

Though there still exists a paucity of outcomes data associated with DBS for PD procedures under GA, our comprehensive meta-analysis demonstrates no significant differences in anatomic precision and clinical outcomes between the two techniques. Thus, DBS under GA can be considered in patients who are not candidates for traditional awake DBS.

Learning Objectives

By the conclusion of this session, participants should be able to:

1) Describe the latest DBS techniques for Parkinson's under both general and local anesthesia
2) Understand the evidence behind asleep DBS with intraoperative imaging and awake DBS with intraoperative physiologic monitoring
3) Understand the current clinical equipoise within the literature and lack of more definitive asleep DBS outcomes data to help inform preferences between the two techniques

References

Zrinzo et al. J Neurosurg. 2012 Jan;116(1):84-94.
McClelland Mov Disord. 2011 Jul;26(8):1422-7.
Bour et al. Acta Neurochir (Wien). 2010 Dec;152(12):2069-77.
Chrastina et al. Br J Neurosurg. 2013 Oct;27(5):676-82.
Starr et al. J Neurosurg. 2010 Mar;112(3):479-90.
Burchiel et al. J Neurosurg. 2013 Aug;119(2):301-6.
Mirzadeh et al. Mov Disord. 2014 Dec;29(14):1788-95.