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Dexmedetomidine and Remifentanil in Deep Brain Stimulation Surgery: A Case Series

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Abstract

Introduction: Dexmedetomidine has been demonstrated to provide successful sedation without impairment of electrophysiologic monitoring in functional neurosurgery. We present a case series comparing the safety and efficacy of dexmedetomidine and remifentanil in patients undergoing DBS surgery.Case description: In the study, a 48-year-old male received dexmedetomidine; a 53-year-old female received remifentanil. Dexmedetomidine patients scored 3 on the OAA/S scale, remifentanil patients scored 2. Dexmedetomidine maintained blood pressure at 160 mmHg, while remifentanil maintained it at 120 mmHg. No adverse events were reported for either drug. Dexmedetomidine required fentanyl rescue in the second hour of surgery. Median recovery time was 15 minutes for all patients. Dexmedetomidine patients recovered in 2 hours, remifentanil patients in 4 hours. Both groups had similar 24-hour VAS scores for pain intensity.Conclusions: Both dexmedetomidine and remifentanil were well-tolerated during surgery. Dexmedetomidine induced moderate sedation, with faster recovery times. Future research should explore optimal dosing and recovery factors.

Keywords: *Dexmedetomidine, remifentanil, deep brain stimulation, safety, efficacy*

Introduction

Dexmedetomidine and remifentanil are both used in deep brain stimulation (DBS) surgery for patients with movement disorders such as Parkinson's disease (PD).(Nakajima et al., 2021; Rozet et al., 2006; Vanhauwaert et al., 2021) Dexmedetomidine, an alpha-2 adrenergic agonist, is frequently used for sedation during DBS surgery.(Reel & Maani, 2024) It has been shown to have a regulatory role in decreasing inflammatory mediators after surgery and exert brain-protecting effects. Additionally, dexmedetomidine has been reported to affect subthalamic nucleus (STN) activity, making it an ideal anesthetic drug for patients undergoing DBS surgery.(Nakajima et al., 2021; Reel & Maani, 2024) Furthermore, dexmedetomidine has been demonstrated to provide successful sedation without impairment of electrophysiologic monitoring in functional neurosurgery.

On the other hand, remifentanil is also used in the anaesthetic management of patients undergoing DBS surgery. It has been recommended due to its ability to minimize the hypertensive response to tracheal intubation and surgical stimulation in various types of surgery.(Moman et al., 2024; Ramos-Matos et al., 2024) Moreover, a study reported the successful use of remifentanil sedation in a noncompliant patient undergoing DBS surgery

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for Holmes tremor.

Dexmedetomidine is preferred for postoperative pain management as it effectively reduces shivering, nausea, and vomiting.(Reel & Maani, 2024) On the other hand, remifentanil is favored for fast-track anesthesia due to its ability to facilitate a shorter extubation time during surgery.(Ramos-Matos et al., 2024) Each medication offers distinct advantages depending on the specific needs and goals of the surgical procedure and postoperative care plan.

In a study involving pediatric patients, a sedative/anesthetic technique with dexmedetomidine, ketamine, remifentanil, and nicardipine provided excellent surgical conditions, unimpaired neuroelectrophysiological signals, hemodynamic stability, and a smooth, prompt emergence from anesthesia, allowing immediate neurological assessment after long DBS procedures.(Bromfalk et al., 2023) Here, we present a case series comparing the safety and efficacy of dexmedetomidine and remifentanil in patients undergoing DBS surgery.

Case Series

Informed consent was obtained from both cases discussed, who underwent DBS surgery for advanced PD. One patient received dexmedetomidine, while the other received remifentanil. The surgery was performed by a single surgeon, and all patients had an ASA physical status classification of II and were scheduled for DBS surgery. None of the patients had a history of dystonia, severe heart failure with an ejection fraction below 30%, obstructive sleep apnea, renal failure with a creatinine level exceeding 2 mg/dL or known allergies to α-2 agonists and propofol. Additionally, neither patient was currently using α-2 agonist medications such as clonidine.

The DBS surgery began with the patient positioned supine in a stereotactic frame, followed by thorough A and antisepsis using betadine and alcohol. Ropivacaine was administered through a scalp block at six points (the supraorbital notch, supratrochlear notch, temporalis muscle, greater occipital nerve, auriculotemporal nerve, and the frontal branch of the facial nerve) on both the left and right sides, with a dosage of 2.5 mg per injection and a volume of 3-4 cc per injection site. Lidocaine was infiltrated, and a "C" shaped incision was made for access. Dissection was performed, involving the creation of two bur holes. Subsequently, the right dura was incised, followed by corticotomy and the insertion of the right MER needle with specific coordinates. Identification of STN wave and macrostimulation were conducted, resulting in improved rigidity evaluation, absence of weakness, and satisfactory eye movement. The DBS electrode was inserted, confirmed using C-Arm imaging. A similar process was carried out on the left side, with incision, corticotomy, MER needle insertion, STN wave identification, and macrostimulation. Rigidity evaluation on this side also showed improvement, with no observed weakness and good eye movement. Subcutaneous extension cable tunneling was performed and connected through a connector. The extension cable was then linked to the IPG, and impedance was checked, indicating satisfactory results. Finally, the surgical wound was closed layer by layer, and the operation was successfully completed.

A 48-year-old male patient receiving dexmedetomidine, with a body weight of 62 kg and a height of 162 cm, resulting in a BMI of 23.6 kg/m2. The patient has comorbidities of hypertension and intracranial acute ischemic stroke. Conversely, a 53-year-old female patient administered remifentanil, weighing 46 kg and standing at 161 cm, resulting in a BMI of 17.7 kg/m2. The female patient does not have any documented comorbidities, and both patients are categorized as ASA physical condition II. Detailed comparisons were displayed in **Table**

1.

Table 1. Comparison of demographic and intraoperative details between dexmedetomidine and remifentanil administrations.

	Dexmedetomidine	**Remifentanil**
	Demographic details	
Sex	Male	Female
Age, years	48	53
Body weight, kg	62	46
Height, cm	162	161
BMI, kg/m2	23.6	17.7
Comorbid	Hypertension, intracranial acute ischemic stroke	None
ASA physical status	II	II
	Intraoperative details	
HR, x/min	71 (63 – 82)	83 (67 – 89)
RR, x/min	18 (17 – 19)	19 (18 – 20)
BP, mmHg	160 (100 – 200)	120 (80 – 170)
Surgical duration, min	415	315
Apneic episodes	0	0
Adverse events	None	None
VAS	2	2

ASA: American Society of Anaesthesiologists; BMI: Body mass index; BP: Blood pressure; HR: Heart rate; min: minutes; RR: Respiratory rate; VAS: Visual analog scale

The study employed a modified version of the Observer's Assessment of Alertness/Sedation (OAA/S) scale, which utilized a scale ranging from 0 to 5. A score of 0 indicated no response to noxious stimuli, while a score of 5 signified responsiveness to a name spoken in a normal tone. Patients administered dexmedetomidine achieved a score of 3, indicating a moderate level of alertness/sedation, whereas those receiving remifentanil scored 2, suggesting a slightly lower level of sedation.

During dexmedetomidine administration, intraoperative blood pressure remained within the 100 to 200 mmHg range, with a recorded value of 160 mmHg. No instances of apnea or reported adverse events were observed. Similarly, remifentanil administration maintained intraoperative blood pressure at 120 mmHg, within the expected range of 80 to 170 mmHg, without any reported apneic episodes or adverse events. These findings indicated that both medications were well-tolerated, with no significant adverse effects on blood pressure or respiratory function during the surgical procedure.

It is noteworthy that the patient receiving dexmedetomidine required fentanyl rescue during the second hour of surgery. Following the discontinuation of the study drug infusion, the median recovery time, indicated by an Aldrete score of ≥ 9, remained consistent at 15 minutes across all treatment groups. However, the duration until patients were transferred to the inpatient department varied between groups. Patients administered dexmedetomidine had a recovery period of 2 hours, whereas those receiving remifentanil required 4 hours. Both patients exhibited comparable levels on the 24-hour VAS, indicating similar pain intensity.

Discussion

In the context of PD, the effects of dexmedetomidine on STN activity during DBS surgery are not well known, underscoring the necessity for additional research in this area. Furthermore, investigations into the impact of anesthesia, including dexmedetomidine, on the firing rate and activity of the STN in patients with PD have been conducted, emphasizing the importance of understanding how anesthetic agents influence neural activity during DBS surgery.(Reel & Maani, 2024; Sassi et al., 2013) Additionally, studies have reported the preservation of microelectrode recordings during DBS surgery in children using non–GABAergic drugs, including dexmedetomidine. This underscores the potential benefits of specific anesthetic agents in maintaining neuroelectrophysiological signals and facilitating prompt emergence from anesthesia.(Sassi et al., 2013)

The comparison of dexmedetomidine and remifentanil in postoperative pain management, particularly in the context of PD patients undergoing DBS surgery, is an area of interest and may benefit from further research and clinical trials to establish the most effective approach. One study found that dexmedetomidine displayed superior efficacy in alleviating pain and in postoperative pain management for 48 hours after surgery.(Chakrabarti et al., 2014) Our study found that both dexmedetomidine and remifentanil were well-tolerated during surgery, maintaining stable blood pressure. Dexmedetomidine induced moderate sedation, with faster recovery times. Our case series showed that during the administration of dexmedetomidine, the intraoperative blood pressure consistently stayed at 160 mmHg, which is within the anticipated range of 100 to 200 mmHg. Conversely, when remifentanil was administered, the intraoperative blood pressure was maintained at 120 mmHg, which also fell within the expected range of 80 to 170 mmHg. This suggests that both medications effectively regulated the patients' blood pressure within acceptable limits during the DBS surgery. Additionally, highlighted the use of dexmedetomidine in DBS surgery, indicating its potential role in such procedures.

Dexmedetomidine may have a potential advantage over remifentanil in reducing postoperative pain intensity. A meta-analysis to investigate whether general anesthesia including dexmedetomidine would result in less postoperative pain than general anesthesia including remifentanil.(Li et al., 2017) The study found that dexmedetomidine significantly decreased postoperative pain intensity compared to remifentanil. In addition, dexmedetomidine has been found to significantly lower recovery duration compared to control and alfentanil groups. However, it is important to note that some studies have found conflicting results, such as a study by Mızrak et al (2009), which found that dexmedetomidine did not prolong the recovery time.(Mizrak et al., 2009) On the other hand, remifentanil has been associated with rapid onset, short duration, and rapid recovery, leading to early postoperative catheter-related bladder discomfort following urological procedures and earlier demand for postoperative analgesics.(Bhoyar et al., 2012; Chakrabarti et al., 2014) Additionally, remifentanil has been reported to reduce the incidence of agitation, recovery duration, and induce less pain. Similarly, our study found that despite variations in recovery duration between the two groups, patients in both cohorts reported similar levels of pain intensity as assessed by the 24-hour VAS. This observation underscores the significance of evaluating pain management strategies beyond solely focusing on recovery time. It suggests that achieving effective pain control may not necessarily correlate with the duration of recovery post-surgery.

Practical Implications and Recommendations for Future Research

The research on the use of remifentanil and dexmedetomidine in DBS surgery has significant

practical implications. Dexmedetomidine has been shown to provide comparable surgical conditions with fewer respiratory adverse events compared to propofol-remifentanil during awake craniotomy.(Ghai et al., 2017; Xiong et al., 2022) Additionally, dexmedetomidine has been documented as an ideal anesthetic drug in patients undergoing DBS, allowing for easy awakening and clinical evaluation during surgery.(Goettel et al., 2016; McAuliffe et al., 2018; Viderman et al., 2023) Furthermore, the preservation of microelectrode recordings during DBS surgery in children using non–GABAergic drugs, including dexmedetomidine, has been reported, highlighting the potential benefits of specific anesthetic agents in maintaining neuroelectro physiological signals and prompt emergence from anesthesia.(Li et al., 2017)

Study Limitation

One limitation of this study is its reliance on a case series design, which inherently lacks a control group for comparison. Without a control group, it is challenging to ascertain whether the observed outcomes, such as differences in sedation levels, blood pressure maintenance, need for rescue fentanyl, and recovery times, are directly attributable to the administered medications (dexmedetomidine and remifentanil) or other confounding factors.(Roberts & Priest, 2006) Additionally, the small study size comprising only two cases limits the generalizability of the findings to a broader population.(Khan & Goel, 2021) Therefore, caution should be exercised when interpreting and extrapolating the results of this study to clinical practice.

Future research should investigate the impact of dexmedetomidine and remifentanil on surgical conditions, patient recovery, and neurological assessment during DBS surgery. Specific areas of focus include the effects of dexmedetomidine on STN activity in PD patients undergoing DBS surgery, a comparison of dexmedetomidine and remifentanil on sedation, analgesia, and vital signs during stereotactic brain biopsy, and exploring the influence of anesthesia, particularly dexmedetomidine, on STN activity.(Ard et al., 2005; Wahab et al., 2011) Additionally, studies should determine the optimal combination of dexmedetomidine and remifentanil for improved postoperative pain control and emergence cough suppression in DBS surgery, as well as investigate the impact of procedural sedation on the clinical outcome of microelectrode recording-guided DBS in PD patients

Conclusion

The study found that both dexmedetomidine and remifentanil were well-tolerated during surgery, maintaining stable intraoperative blood pressure without adverse events. Dexmedetomidine induced moderate sedation, while remifentanil resulted in slightly lower sedation levels. Patients administered dexmedetomidine required fentanyl rescue during surgery, and recovery times varied, with dexmedetomidine patients recovering faster than those receiving remifentanil. Both patients exhibited comparable levels on the 24-hour VAS, indicating similar pain intensity. Future research should explore optimal dosing strategies for dexmedetomidine to minimize the need for rescue medication, investigate factors influencing recovery times between different sedative agents, and conduct longitudinal studies to assess long-term outcomes and pain management efficacy post-surgery.

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