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Research Article

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Anesthetic Management for Deep Brain Stimulation Surgery in Parkinson's Disease

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Abstract

Parkinson's disease is the second most common neurodegenerative disease, treatment consists of a combination of drugs, physiotherapy and advanced therapies, which seek to improve the quality of life of these patients, such as deep brain stimulation. Although anesthetic management is varied, it has been considered that the most appropriate technique taking into account the risks / benefits is the one consisting of asleep / awake / asleep, since it allows the interaction of the patient with the multidisciplinary team to guarantee correct placement of the stimulation electrodes. Due to the studies carried out for the use of anesthetic drugs, the use of propofol and dexmedetomidine has been implemented, not finding significant differences when choosing one or the other drug, but showing positive effects in improving the quality of life of these patients.

Keywords: Parkinson's, Anesthesia, Deep Brain Stimulation Surgery

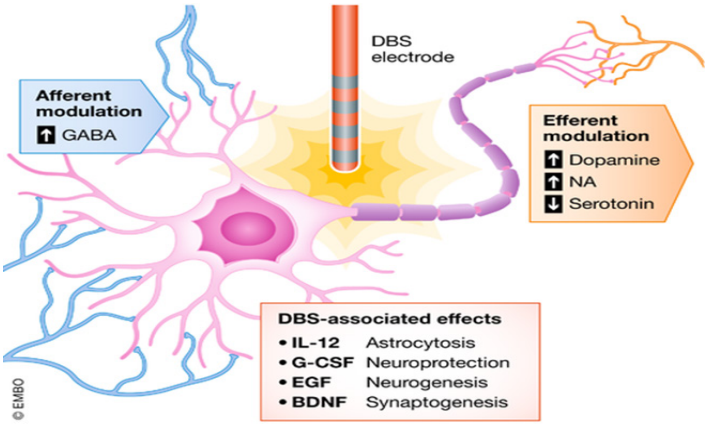
Introduction

Parkinson's disease (PD) is a neurodegenerative disease characterized by a loss of dopaminergic neurons in the substantia nigra of the basal ganglia and a decrease in dopamine production. The diagnosis and clinical features of Parkinson's disease are: tremor at rest, muscle stiffness, bradykinesia, and loss of postural reflexes. Treatment includes the use of L-dopa or dopamine receptor agonists. Some patients receive anticholinergics that interfere with the production or uptake of the neurotransmitter acetylcholine. These medications help reduce tremor and muscle stiffness. Patients with PD often receive antidepressants, due to the high incidence of this disease in them. Treatment, in addition to pharmacological measures, includes physiotherapeutic rehabilitation and psycho-neurocognitive stimulation. Another alternative to improve quality of life is the placement of intracerebral electrodes (Deep Brain Stimulation (DBS) technique). This is used to correct abnormal electrical activity in the brain that causes movement disorders. Its main indication is in patients who have symptoms that are not controlled with medication DBS is safer and more effective than older surgery for movement disorders, which left lesions on the brain [1].

The efficacy of deep brain stimulation of the subthalamic nucleus for Parkinson's disease has been well documented and has become a standard treatment for patients who have suffered from medication-related side effects. This consists of an invasive procedure, which involves the placement of an electrode and stimulation of the thalamic nuclei surgically. In awake patients under local anesthesia the most precise neural characteristics in subthalamic nuclei for localization, which could explain why most centers still prefer electrode implantation under local anesthesia, and most patients can endure the whole process. Awake deep brain stimulation procedures can lead to several limitations. we have that most patients have to endure the entire operation, and a meta-analysis revealed that the implantation of deep brain stimulation under local anes-

thesia caused more complications than with general anesthesia, including intracranial hemorrhage [2].

For the use of this alternative, adequate and optimal medical care planning is required that takes into account the years of evolution of the disease, pharmacological anamnesis, duration of the surgical procedure to be performed, the use of anesthetic agents and the risks inherent to these. There are also other limitations such as anxiety, pain and fear can lead to restlessness of the patient, movement, and hemodynamics, such as hypertension and tachycardia, can lead to reduced surgical success [3,6].



The exact mechanism of how DBS alleviates the symptoms of PD is not yet fully understood. Several hypotheses partially explain its mode of action: inhibition of cell bodies close to the electric field, axonal excitation, release of neurotransmitters, such as adenosine and glutamate, dilation of arterioles and increased regional blood flow and changes in local field potentials that influence in oscillatory patterns in β and θ bands [4].

The application of intraoperative microelectrode recording (ERM) favors target definition, but traditionally requires an awake and cooperative patient. Some PD patients must undergo STN-DBS surgery under a sleeping condition due to severe anxiety, stiffness, and dystonia in the off-drug phase. Several DBS centers always perform surgery under general anesthesia. Different general anesthesia methods are used in different ECB centers, such as inhalation anesthesia, sedation with dexmedetomidine or intravenous propofol-based anesthesia, and it has also been shown in several articles that techniques performed with general anesthesia managed to demonstrate significant improvement of clinical results and reduction of complications compared to conventional techniques carried out under local anesthesia [5, 7].

Dexmedetomidine is an excellent agent for achieving adequate sedation and analgesia and allows the patient to respond to commands. Adequate patient preparation and effective team communication is essential. The anesthesiologist plays an active role in this type of surgery. Dexmedetomidine has been shown to provide successful sedation without impaired electrophysiological monitoring in functional neurosurgery [1].

Propofol can cause dyskinesia and abolish tremor. Short-acting opioids have minimal effect on the effects of microelectrodes, but high doses can cause worsening of stiffness. Benzodiazepines are not recommended as they can abolish the response to the electrodes and interfere with pacing tests. The sedation regimen used achieved the objective of minimizing any effect on subcortical activity, thus optimizing the recording of the microelectrodes and the clinical tests [1].

Materials and Methods

A detailed bibliographic search of information published since 2017 is carried out in the databases pubmed, Elsevier, scielo, Update, medline, national and international libraries. We use the following descriptors: Parkinson's disease, Deep brain stimulation. The data obtained oscillate between 6 and 26 records after the use of the different keywords. The search for articles was carried out in Spanish and English, limited by year of publication, and studies published since 2014 were used.

Results

The use of deep brain stimulation (DBS) as a therapeutic tool in Parkinson's disease (PD) began in 1987 with the work of a team led by doctors Alim Louis Benabid and Pierre Pollak, in Grenoble, France. Its efficacy quickly became evident, which is why it is now considered an essential therapeutic tool in the treatment of advanced PD [8].

Taking into account that this has traditionally been based on awake surgery under local anesthesia to facilitate intraoperative monitoring through microelectrode recording (MER) and stimulation of tests. However, with recent advances in stereotactic techniques and intraoperative imaging, the number of centers that have implemented this technique of deep brain stimulation under general anesthesia (GA) has increased [9].

A study conducted from January 2010 to December 2014, 16 PD patients who underwent bilateral STN-DBS at Tzu Chi General Hospital, Hua- lien, Taiwan, of whom eight were assigned to the general anesthesia group (GA) and received desflurane GA with endotracheal intubation during bilateral STN electrode implantation, and eight patients were assigned to the local anesthesia (LA) group and received regional scalp anesthesia. The analysis did not reveal a significant difference in the effectiveness of STN-DBS between groups. Taking into account that the two had comparable preoperative disease severity (disease duration, scores for UPDRS parts I-IV, and Hoehn and Yahr staging), at the last post-operative follow-up, both groups showed a significant improvement of the bilateral STN-DBS in the UPDRS total scores and the scores of parts I-IV (Table 1) A significant reduction of superelevation was also shown in the equivalent daily dose of Levodopa (LEDD) and a reduction in motor complications (UPDRS part IV) in both groups. The analysis did not reveal a significant difference in the efficacy of STN-DBS between groups. Postoperative neuropsychology (GA vs. LA) showed similar results for the MMSE (25.8 ± 4.0 vs. 27.7 ± 1.4), CASI-II (84.7 ± 14.6 vs. 91.3 ± 10.0), and BDI (12.0 ± 8.2 vs. 16.7 ± 14.6) [10].

Table 1: (%) Effectiveness of STN-DBS between the preoperative and postoperative state in both groups.

	GA	Pa	LA	Pa
Part I	36.2 ± 31.7	0.0127 *	35.7 ± 15.9	0.0053 **
Part II	41.8 ± 51.0	0.0102 *	49.2 ± 26.6	0.0028 **
Part III	41.5 ± 35.8	0.0008 **	45.8 ± 26.2	0.0003 **
Brady	31.0 ± 10.1	0.0013 **	33.5 ± 25.8	0.0016 **
Tremor	69.8 ± 38.5	0.0082 **	76.2 ± 38.1	0.0085 **
Rigidity	59.0 ± 1.9	0.0028 **	61.3 ± 38.2	0.0056 **
Posture & Gait	29.7 ± 32.8	0.0080 **	33.3 ± 33.2	0.0199 *
Axial	34.0 ± 35.0	0.0109 *	31.9 ± 40.3	0.0094 **
Part IV	43.3 ± 0.6	0.0050 **	39.5 ± 4.9	0.0100 *
Total	38.5 ± 41.7	0.0013 **	46.0 ± 30.9	0.0006 **
Hoehn & Yahr Stage	28.1 ± 23.7	0.0050 **	32.2 ± 20.2	0.0479 *
SEADL score	73.8 ± 11.9	0.0038 **	86.3 ± 10.6	0.0035 **

Data are presented as mean ± standard deviation.
* p <0.05.
** p <0.01.

GA 1⁄4 general anesthesia; H&Y 1⁄4 Hohen and Yahr; LA 1⁄4 local anesthesia; SEADL 1⁄4
Schwab and England Activities of Daily Living Scale; STN-DBS 1⁄4 deep brain stimulation of the subthalamic nucleus.

A The pevalue represents a comparison with the preoperative state. In the evaluation of clinical effects, a meta-analysis showed that there was no significant difference between the GA and LA groups in the improvement of the motor section of the Unified Parkinson's Disease Rating Scale (UPDRSIII) (SMD 0.06; CI of the 95%: -0.16 to 0.28, p = 0.60, I 2 = 0%, p = 0.48) and LEDD (SMD -0.17, 95% CI: -0.44 to 0 , 12; p = 0.23; I 2 = 0%; p = 0.62), this included a total of 309 patients in a subgroup analysis, 162 in the non-ERM sleep surgery group and 147 in the non-ERM group. routine awake surgery MER. There were no significant differences between the 2 groups in UPDRSIII improvement (SMD 0.04, 95% CI -0.26 to 0.35, p = 0.79, I2 = 26%, p = 0.25) and postoperative LEDD (SMD -0.09, 95% CI -0.41 to 0.22, p = 0.56, I 2 = 0, p = 0.55) [11].

In the study Neurophysiological comparisons of subthalamic deep-brain stimulation for Parkinson's disease between patients receiving general and local anesthesia, carried out in Taiwan, it was found that there were significant reductions in the equivalent daily dose of levodopa, which is the most important element that predicts the response to deep brain stimulation and a reduction in motor complications in the groups of patients who received local and general anesthesia [10].

In the study "Inhibitory concentration of propofol in combination with dexmedetomidine during microelectrode recording for deep brain stimulator insertion surgeries under general anesthesia" carried out in Taiwan, it was found that the combination of dexmedetomidine and propofol for maintaining general anesthesia in deep brain stimulation surgery can suppress neural activities and interfere with the processing of microelectrode recordings.When dexmedetomidine is infused at a dose of 0.4 μgkg - 1h - 1, the IC50 (concentration inhibitory) of Ceprop was 1.29 μg • mL - 1 using the modified Dixon UDM. Through probit analysis, it was found that the estimated values of IC05, IC50 and IC95 were 1.17, 1.28, and 1.40 μg • mL - 1, respectively. [12].

Discussion

ECP is generally very safe but, as with all surgery, there are perioperative risks and complications. A small case series identifies an intraoperative complication rate of approximately 7%. The main complications include intracranial bleeding (0.4% -3.6%), seizures (0.8% -4.5%), stroke, neurological deficit (0.3% -0.6%) and delirium after the process. Other intraoperative complications include airway obstruction (1.6% -5.5%), hypertension, hypotension, or venous air embolism (1.6% -3.5%) [1].

Several randomized clinical studies have shown that deep brain stimulation is superior to medical treatment in improving motor function and quality of life for patients with advanced Parkinson's disease. A meta-analysis of 37 cohorts comprising 921 patients, a controlled multicenter study of 136 patients and a 5-year retrospective study mentioned in the work by Benabid et al, show a general reduction of 52% in UPDRS-III in the off-state state. On-DBS medications after surgery, compared to preoperative off-medication status. A systematic review of DBS clinical outcomes was carried out by Hamani et al, on 471 patients in 38 studies. This work showed a mean improvement for UPDRS-III of 50% at 6 months, 56% at 12 months, and 49% at 5 years. Now, if we analyze each symptom separately at 1 postoperative year, we see that tremor was reduced by 81%, rigidity 63%, bradykinesia 52% and postural instability 69%. Gait improved by 64%. The UPDRS-IV for the evaluation of dyskinesias in ON shows a reduction of 73 to 94% according to different studies at 1 year [7].

Many neurosurgeons and neurologists prefer to avoid sedation in

patients undergoing DBS for PD because some anesthetic drugs can eliminate ERM records and PD symptoms. In a study comparing 24 patients with local anesthesia with 30 who received general anesthesia with propofol (maximum concentration at the effect site 1.5 to 2.3 µg / ml), 16 administration of propofol did not appear to influence the clinical outcome, although ERMs were not analyzed. Elsewhere, low doses of propofol (25 µg · kg-1 · min -1) and fentanyl (25 µg · kg-1 · min-1) were administered to eight patients, which did not significantly interfere with ERM signal; however, the MER signal was compared to that of the contralateral STN, which may not really be comparable. When MER data from the same core were analyzed in patients with and without sedative drugs, a 0.3 mg / kg bolus of propofol had only a minimal effect on action potential discharge activity [3].

A study of 11 consecutive cases of continuous or discontinuous administration of dexmedetomidine during DBS implantation for PD indicated that a maintenance dose greater than 0.4 µg · kg · h Suppressed neuronal firing in the STN; however, this was based on an observational analysis of neuronal activity. In a similar approach, when 11 consecutive cases of unilateral DBS placement for PD with continuous infusion of dexmedetomidine (0.3 to 0.5 µg · kg · h), no interference was evidenced in SRMs based on an observational analysis. Of neuronal activity [3].

Although it has been proposed that there is no benefit to maintaining sedation throughout the procedure, the baseline status of some patients along with the length and discomfort of the procedure may make continuous sedation helpful. In fact, sedation may even be essential to obtain a rested and cooperative patient in some cases.

Conclusion

we can conclude that anesthetic management in deep brain stimulation can be performed with local anesthesia and general anesthesia, studies indicate that between these two types of anesthesia there is no significant difference, however it has been documented that general anesthesia reduces the presentation of complications the main one being intracranial hemorrhage.

We also found that surgery awakens under local anesthesia to facilitate intraoperative monitoring through recording of microelectrodes and stimulation of tests. However, with recent advances in stereotactic techniques and intraoperative imaging, the number of centers that have implemented this deep brain stimulation technique under general anesthesia has increased, taking into account that it is associated with fewer complications.

We found no significant differences in the literature search between RBP-LFP in control and dexmedetomidine (0.2 µg · kg · h-) recordings; however, a significant decrease in LFP activity for each increase in the dose of propofol has been documented. The estimated decrease in beta LFP activity was 12.7% relative to the control log for each 0.5 µg / ml increase in the estimated concentration of propofol at the site of maximum effect. These findings may have relevant clinical implications for improving sedation and management of patients undergoing DBS placement for PD [6].

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