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Case Report

Complications of Deep Brain Stimulation in the Treatment of Parkinson's Disease

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Abstract: Objectives: To study the therapeutic effect and complications of deep brain stimulation (DBS) to Parkinson's disease (PD). Patients and Methods: A retrospective analysis of DBS performed on 44 patients with Parkinson's disease who had complications in the post-operation. Results: 1). A stimulation effect was observed in all PD patients during the operation, with the most obvious effect being relief of muscular tension, followed by improvement in tremor and bradykinesia. 2). The implantable pulse generator was activated from 3 days to 1 month after the implantation of the stimulation electrode, and then had an obvious effect. 3). Clinical follow-up was performed from 3 months to 2.5 years post-implantation. The symptoms assessed using the UPDRS score were significantly improved. 4). Two cases of cerebral hemorrhage and vesicular effusion were related to surgical methods. There were several cases of pneumonia in the postoperative fever and two cases of urinary system infection. One case of traverse fracture also occurred. Postoperative electrode exposure and local infection occurred in 1 case. There were 3 cases of lethargy, 2 cases of hallucinations. In the postoperative period, intelligence decreased further in 1 case. One patient had no obvious improvement in rigidity. 5). One case had difficulties in eye opening within 1 month. One case of PD had poor rigidity control. There was also decrease memory after stimulation in 2 cases. Conclusion: Proper selection of patients, appropriate DBS surgical methods and reasonable adjustment of stimulation parameters can effectively prevent and treat related complications.

Keywords: DBS, PD, Complications, Surgery

1. Introduction

Deep brain stimulation (DBS) is one of the most effective ways to treat motor disorders. There is evidence that DBS can significantly improve the motor symptoms of patients with Parkinson's disease (PD) and thereby improve the quality of life of patients [1-3]. Similarly, DBS can stimulate the nucleus accumbens, the ventrolateral region of the thalamus [4, 5] or the subthalamic nucleus [6, 7] to improve different types of dystonia and essential tremor.

Although DBS can significantly improve the quality of life of patients with different types of dystonia and essential tremor, it is also accompanied by complications and various problems that can negatively affect the progression of the disease. In fact, the patient's actual benefit from the DBS surgery, such as improved quality of life and patient satisfaction, depends largely on the avoidance of adverse reactions. Among the adverse reactions caused by surgery, such as bleeding, infection [8, 9], neurological disorders [10] and especially

psychological adverse reactions [11], such as depression [12]. In this study, the complications and adverse reactions in 44 cases (88 electrodes) of DBS use in the treatment of dystonic diseases were summarized.

2. Patients and Methods

The data from 44 patients who received a brain pacemaker implantation in the Department of Neurosurgery in the second affiliated hospital of Nanchang University was collected from April 2016 to September 2018. These patients were comprised of 21 males and 24 females, aged from 47 to 76 with an average age of 64.05 ± 7.48 years old. The target of stimulation was the subthalamic nucleus (STN, bilateral) in 44 cases (Table 1).

Magnetic resonance imaging (MRI) microelectrodes were localized, and a Leksell stereotactic frame (Germany) was installed under local anesthesia. The target coordinates were calculated by combining the image direct localization with coordinate value localization. Two bore holes were made under local anesthesia, and extracellular discharge was recorded by the microelectrodes.

The implantation electrode was implanted along with the stimulation electrode. The electrode was stimulated using a temporary pulse generator to observe the stimulation effect and adverse reactions of different voltages and different contacts.

Table 1. *Clinical characteristics of 44 patients receiving deep brain stimulation.*

Characteristics		N	%
Age at operation, y	＞60	30	68
	＜60	14	32
Sex	male	21	48
	female	23	52
Number of leads	unilateral	88	100
	bilateral	0	0

If the implanted pulse generator was satisfactorily tested and there were no obvious adverse reactions, the patient was exposed to general anesthesia. The implanted pulse generator was then implanted under the subclavian bone of the right chest, and the subcutaneous wire was used to connect the pulse generator and the implanted electrode in the brain.

Postoperative curative effect follow-up was performed after an in vitro control to observe any curative effects, complications and adverse reactions. The unified Parkinson's disease evaluation scale (UPDRS) exercise score was calculated under the states of both "on" and "off" for the pulse generator, and the following motor symptom improvement rate score was calculated: motor symptom improvement rate = (UPDRS exercise score when off - UPDRS exercise score when on) / UPDRS exercise score when off - 100%.

3. Results

The 44 patients with PD had observed a significant positive effect after microelectrode recording or after electrode implantation, specifically decreased muscle tone, decreased tremor and flexible limb movement. When the temporary pulse generator was turned on, all PD patients observed the stimulation effects, of which the decreased muscle tone was the most obvious. Specifically, all limbs with previously increased muscle tone showed decreased muscle tone after the stimulation. After this, tremor and bradykinesia improved as well.

The stimulation effect was observed in all patients when the temporary pulse generator was turned on, and thus all patients received implantation of the pulse generator under general anesthesia. The pulse generator was activated 3 days to 1 month after implantation of the stimulation electrode.

In the postoperative period, adverse events included symptoms such as headache, dizziness, fatigue and fever. A chest CT examination showed pneumonia in 18 patient, but body temperature was normal after anti-infection treatment with antibiotics (Table 2). Two cases of urinary system infection disappeared after anti-infection treatment. There were 3 cases of lethargy, 2 cases of hallucinations, 2 cases of decreased intelligence scores after surgery, and 1 case of further decreased intelligence after surgery. One patient had no obvious improvement in rigidity. There were also 2 cases of cerebral hemorrhage, with 1 mild case not requiring special treatment, and severe 1 case with coma and poor quality of life after rehabilitation. There were different degrees of fever after the operation. Subcutaneous hydrops near the chest pulse generator was found in 2 cases. In 1 case the battery of the chest pulse generator had to be removed and placed back after 1 year. The electrode caused an infection in 1 case, and subsequently was removed. Two cases of infection occurred at the site of implantation of the pulse generator 4 weeks after surgery, with the infection eliminated after the pulsed generator was taken out, and in one of these cases the pulse generator was re-implanted under the subcutaneous tissue of the contralateral chest one year later. One case of wire fracture occurred and a subsequent wire replacement was performed. Finally, in 1 case, the subcutaneous suture lines were exposed but healed after debridement and suture (Table 2).

Recorded clinical follow-up was performed for between 3 months to 2.5 years. When comparing the "off" state and "on" state, the symptoms of UPDRS scores were significantly improved when the pulse generator was turned on.

Most patients had a transient slight numbness to the side limb when the pulse generator was turned on. One case had difficulty in opening their eyes within 1 month after bilateral STN stimulation. One case of PD had poor rigidity control. Two cases of memory loss occurred after bilateral STN stimulation (Table 2).

Table 2. *Procedure-related complications.*

Complication	No. of patients	Postoperative day	Treatment	Outcome	Classification
Cerebral hemorrhage	2	1	ICU admission, Conservative	Physical disability, resolution	Serious
Vesicular effusion	2	30	Aborted procedure	Successful revision	Serious
Pneumonia	18	3	Application of antibiotics	Symptoms resolution	Non-serious
Urethral infection	2	3	Application of antibiotics	Symptoms resolution	Serious
Traverse fracture	1	90	Replacement electrode	Successful revision	Serious
Electrode and generator infection	3	28	Aborted procedure	Successful revision	Serious
Lethargy	3	21	Conservative	Symptoms resolution	Serious
Hallucinations	2	7	Conservative	Symptoms resolution	Non-serious
Intelligence decreased	1	40	None	Non-resolution	Non-serious
No effective in rigidity	1	30	Conservative	Symptoms resolution	Serious
Eye opening difficulty	1	14	Conservative	Symptoms resolution	Serious
Decrease memory	2	90	None	Non-resolution	Non-serious

4. Discussion

DBS treatment is a functional neurosurgical operation that requires low complications and adverse reactions to obtain satisfactory results. Compared with microelectrode-guided ablative surgery, DBS has great advantages in its less complications and adverse reactions, and the incidence of these reactions are greatly reduced. Therefore, DBS, widely used, has gradually replaced microelectrode-guided ablative surgery. However, as DBS is a surgical operation, severe complications such as postoperative hemorrhage [13, 14], paraplegia, coma and even death occur in our country and worldwide. Intrinsically, hemorrhage is one of the most serious complication of DBS, with a reported incidence of 1-3% [15]. Due to the application of cooperativeness compression, postoperative bed rest and hepatic drugs, pulmonary embolism and limb deep vein thrombosis can easily occur. Therefore, we try to shorten the operation time and encourage patients to move more while in bed and get out of bed as early as possible. In order to reduce the possibility of cerebral hemorrhage, the number of electrode punctures should be reduced as much as possible. The accuracy of anatomic localization should be strengthened to minimize the number of needle tracks induced by microelectrodes. The stimulation electrode should be gently rotated and slowly inserted.

As DBS surgery requires implantation of some foreign objects in patents' body, infection, poor wound healing, electrode displacement [16], and skin burst with infection account for 6.6% of total complications, pulse generator re-implantation accounts for 4.4% in all complications, and electrode re-implantation accounts for 2.2%. In this group, there were 2 cases of subcutaneous infection and pus at the site of implantation of the chest pulse generator, 1 case of hemoglobin at 60g/L that may be related to the patient's anemia, and another case may be related to incomplete hemostat and postoperative exudation (Table 2). Therefore, in the future, the concept of sterility should be strengthened, wound hemostat should be more thorough, and skin suture should be done by layers. In order to avoid the implanted electrode and the subcutaneous wire connection moving up and down, we fixed the wire in the subcutaneous fascia above the back ear. The pulse generator is directly attached to the soft tissue. In this group, the fracture of the joint was happened in one case of half a year after surgery, and the connection wire had to be replaced with a new surgery. Previous studies have reported that 22.7% of patients with PD that underwent DBS developed intellectual disabilities [17, 18]. In patients with preoperative mental decline, memory and intelligence may further decline after bilateral STN stimulation, which requires attention [19]. STN stimulation can occur within a period of a few seconds or hours, but this mental decline is usually temporary. If the abnormality is obvious, it can be overcome by slowly increasing the stimulation voltage daily. If the abnormality is difficult to overcome, it may be related to the over-deep electrode position and the stimulation of the substantia nigra neurons, so the electrode position needs to be adjusted. Numbness to the side of the limb is common when the stimulator is turned on. This numbness is mild and instantaneous, which also indicates the success of the stimulator. The adverse reactions are usually mostly reversible within 4 weeks.

In summary, the current study provides detailed and reliable reference data on postoperative side effects of DBS. These adverse reactions include symptoms of neurological deficits and mental disorders. Most of the short-term side effects are reversible.

Disclosure

This was not an industry-supported study. The authors report no conflicts of interest in this work.

Authors' Contributions

Huang H participated in the study design, data collection, data analysis, fund collection and writing. Mingwei Lu and Suyue Zheng designed and supervised the experiment and contributed to the writing of the manuscript. Liyuan Xie, Min Chen, and Ming Guo performed data collection. All authors read and approved the final manuscript.

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