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BRIEF

Difference in the effectiveness of subthalamic nucleus and globus pallidus deep brain stimulation in Parkinson's disease

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Abstract

Deep brain stimulation (DBS) is regarded as a feasible Parkinson's disease (PD) treatment option. The subthalamic nucleus (STN) and globus pallidus (GPi) are the two most common sites for DBS. The following criteria were used to select studies that examined the Unified PD Rating Scale (UPDRS) III: (1) had at least three months of follow-up; (2) compared both GPi and STN-DBS; (3) each group included at least five individuals; (4) were conducted after 2010. The majority of studies found no statistically significant difference in UPDRS score improvements between groups. Although there were some encouraging findings in terms of action tremor, rigidity, and urinary symptoms, indicating that STN-DBS would be a better alternative, GPi appeared to be better in terms of side effects; nonetheless, it cannot be said that it is superior. Other larger randomized clinical trials with longer follow-up periods and control groups are required to determine which target is more effective for stimulation and has fewer negative side effects on patients.

Keywords: Deep brain stimulation, globus pallidus, Parkinson's disease, subthalamic nucleus, UPDRS

Parkinson's disease (PD) is the most common mobility condition, as well as the second most common progressive, debilitating, and neurodegenerative disease, with 12.9 million cases projected by 2040 [1-4]. Slow motions, rigidity, and low amplitude movements without antecedent automaticity characterize PD. In 1911, the dopamine precursor levodopa was developed for the first time [5]. It has been used as an effective PD treatment for more than 50 years, although its efficacy has been demonstrated to decrease as the disease advances [6, 7]. The deep brain stimulation (DBS) technique was first used in 1987 to treat movement disorders by targeting the ventral intermediate nucleus of the thalamus [8, 9]. DBS is a frequent and effective surgical treatment for motor symptom relief. It was first used roughly three decades ago and is now used on a variety of new brain targets, including the subthalamic nucleus (STN) and globus pallidus (GPi) [10-12]. According to studies, the efficacy of these two targets is varied. It has been suggested that in PD, there is chronic beta-band oscillation coordination, and short-term bursts of these oscillations demonstrate normal sensory and motor processing. In PD, DBS can shorten bursts and enhance movement [13].

Embase, Cochrane Library, and PubMed databases were searched for potentially relevant English-language papers published between 2010 and 2021. We looked for studies that included both the targets (GPi and STN) as well as their associated characteristics. DBS [MeSH term] or a combination of the following keywords: controlled clinical trial [Publication Category], randomized controlled trial [Publication Category], globus pallidus internus [MeSH term], globus pallidus [MeSH term], GPi [MeSH term], STN [MeSH term], and PD [MeSH term].

We included clinical studies that (1) evaluated the unified PD rating scale (UPDRS) III before and after DBS; (2) compared GPi-DBS and STN-DBS for PD; (3) recruited more than five subjects in the GPi and STN groups; (4) had a description of adverse events; (5) had a follow-up period of more than three months; (6) were available in English full text. The main characteristics of the studies are shown in Table 1.

Odekerken *et al*. found that the GPi group had a lower change in UPDRS score during the off-drug phase than the STN group, and the GPi group had less dyskinesia during the on-drug period than the STN group. The reduction in time was similar in both phases, however, it was only significant in the off-phase (P = 0.02) [14]. Troche *et al*. found that both groups' UPDRS scores improved

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Table 1. Main characteristics of studies.

Reference	Target	Age	Sample size	UPDRS on-period-baseline	UPDRS off-period-baseline	Follow up period	Location
Odekerken [14]	GPi STN	59.10 ± 7.80 60.90 ± 7.60	62 63	16.00 ± 8.00 17.00 ± 9.90	43.80 ± 13.50 44.40±15.50	12	Europe
Troche [15]	GPi STN	64.26 ± 8.79 66.50 ± 7.02	19 14	23.13 ± 6.73 23.43 ± 10.64	39.89 ± 11.06 35.93 ± 8.98	6	Asia
Odekerken [16]	GPi STN	59.10 ± 7.80 60.90 ± 7.60	43 47	N/A	43.00 41.00	36	Europe
Gong [17]	GPi STN	63.20 ± 9.10 62.30 ± 10.40	28 36	26.20 ± 7.50 29.00 ± 10.00	N/A	4	Asia
Fan [18]	GPi STN	60.43 ± 8.44 59.65 ± 9.11	23 20	N/A	50.68 ± 15.36 47.85 ± 14.95	12	Asia
Celiker [20]	GPi STN	54.00 ± 4.51 56.16 ± 9.60	6 6	22.50 ± 6.65 22.16 ± 6.55	49.00 ± 13.57 47.00 ± 14.01	24	Asia
Okun [21]	GPi STN	60.10 ± 5.50 58.00 ± 10.70	14 16	20.80 ± 8.68 21.30 ± 7.56	40.50 ± 11.20 41.20 ± 9.32	12	USA
Wong [19]	GPi STN	63.00 ± 8.12 61.00 ± 10.33	31 57	N/A	47.32 ± 11.79 44.12 ± 10.45	12	USA

Note: Data presented as mean ± SD.

significantly in the off-medication state before and after surgery ($P < 0.001$) [15]. Odekerken *et al*. found that the STN group showed larger improvements in the off-drug phase UPDRS-ME score after three years ($P = 0.04$), whereas there were no between-group differences in the on-drug phase [16]. Gong *et al*. found that four months after DBS, all patients experienced improvement (≥ 30%) in UPDRS score in off-period, and pain symptoms improvement rate was 79% ± 27% and 75% ± 27% in STN and GPi groups, respectively [17]. In the drug off-phase, Fan *et al*. found that the mean improvement of UPDRS in the STN and GPi groups was 41.50% and 43.56%, respectively, with no significant difference between the groups ($P = 0.609$). GPi-DBS also demonstrated anti-dyskinesia effects directly [18]. When compared to GPi-DBS, Wong *et al*. found that STN-DBS was associated with a statistically significant decrease in bradykinesia and rigidity at six months ($P < 0.001$ and $P = 0.025$, respectively). In terms of tremor results, however, there was no significant difference between groups [19]. Celiker *et al*. found that on-phase UPDRS motor scores decreased considerably in both the STN and GPi groups ($P < 0.05$) and that STN-DBS improved bladder symptoms better. Furthermore, both groups experienced reduced sleep issues following surgery [20]. Okun and colleagues looked at the effects of unilateral and staged bilateral STN and GPi-DBS. They discovered that off-phase UPDRS motor scores improved considerably after four and twelve months of follow-up in both unilateral and staged bilateral modes [20].

In terms of adverse events, Odekerken *et al*. found no statistically significant difference between groups ($P > 0.05$) [14]. According to Troche *et al*., mean penetration-aspiration (PA) scores did not change substantially for participants who got GPi surgery ($P = 0.857$) but significantly worsened for those who received STN-DBS ($P = 0.007$), indicating that STN-DBS has a negative influence on swallowing performance. In contrast, unilateral GPi-DBS does not have this negative effect [15]. In the study by Fan *et al*., 50% of patients in the STN group showed dyskinesia caused by stimulation. In ten of these patients, the direct anti-dyskinesia effect of STN-DBS was also noticed [18]. Okun *et al*. found relatively minor effects on mood and apathy that were not significant [21]. Odekerken *et al*. revealed no significant differences in adverse events between the two groups in another trial, only mild incidents were noted [16]. The most prevalent adverse events, according to Wong *et al*., were difficulties with DBS lead hardware and bleeding, both of which were small and controlled easily [22]. The results of this study should be viewed with caution. Both STN-DBS and GPi-DBS are potential stimulation sites, but this has not been confirmed. STN, on the other hand, had better results in terms of urinary symptoms, discomfort, dyskinesia, and action tremor.

Declarations

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