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Different Targets in Ablative Surgery in Management of Parkinsonian Disease

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ORIGINAL ARTICLE

Different Targets in Ablative Surgery in Management of Parkinsonian Disease

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Abstract

Background: ***Surgical options for Parkinson's disease (PD) consist of ablative procedures and deep brain stimulation (DBS). The targets for ablation are the VIM, the globus pallidus, and the subthalamic nucleus.***

Aim: ***To assess efficiency, complications & safety of variable targets in ablative surgery in Parkinsonian disease.***

Methods: ***This Retrospective research was conducted on 20 Parkinsonian individuals in 2022. All patients were subjected to the Unified PD Rating Scale (UPDRS), with special attention to the motor score (part III).***

Results: ***This study demonstrated improvement in the Unified PD Rating Scale (UPDRS) between preoperative and 6-month postoperative motor symptoms in twenty patients. There were very statistically substantial (P-value < 0.01), which is highly significant; there was a significant decrease in (UPDRS) from preoperative (40.30 ± 13.48) to 6 months postoperative (12.85± 7.73) as regards Chi-square test and Fisher exact test for comparison of two groups with qualitative data and Independent t-test for comparison between two independent groups with quantitative data and parametric distribution.***

Conclusions: ***Ablative surgery can be considered a safe & effective therapy option for PD.***

Keywords: Ablative Surgery; Different Targets; Parkinsonian Disease

1. Introduction

An estimated 1% of the world's population s uffers from Parkinson's disease (PD), a chronic, progressive neurological disorder characterized by degeneration of nigrostriatal fibers, and this is the primary neuropathological finding that results in tremors, rigidity and bradykinesia. [1]

The medical treatment and neuromodulation that include ablation and (DBS) are the way of management.

In ablation, the motor thalamus, globus pallidus, & sub thalamic nucleus are the target nuclei . [2]

Currently, DBS is the ideal option for PD. However, the cost of DBS is expensive, leaving neuro ablation as a reasonable alternative in low socioeconomic countries .[3]

Neuroablation destroys a specific grey matter using thermos, cryo-coagulation, radiofrequency, or radiation. [4]

The work aimed to assess the efficiency, complications, and safety of variable targets in ablative surgery for parkinsonian disease.

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2. Patients and methods

This Retrospective research was conducted on 20 Parkinsonian cases during the year 2022. This study includes Parkinson's patients who suffered from motor symptoms mainly and Includes patients with unstable medical conditions, Parkinson-plus syndromes, uncontrolled psychiatric disorders, severe cognitive dysfunction, severe postural instability, and risk of intracerebral hemorrhage.

Clinical assessment: The Unified PD Rating Scale (UPDRS) with special attention on the motor score (part III) for evaluating dopaminergic responsiveness. The scale covers mood, activities of daily living, motor signs, & complications. Part I: 0 – 16; Part II: 0 – 52; Part III: 0 – 108; Part IV: 0 – 23 Total score: 0 – 199. It was done before surgery and on the first postoperative day, and they returned for follow-up 6 months after surgery.

Surgical Technique: Two frames were used, Leksell and CRW, with the case in the sitting position; the frame is placed as parallel as possible to the anterior commissure(AC) & posterior commissure(PC) line. Screws are used for anchoring the frame to the calvaria.

Imaging: Before surgery, an MRI brain lab protocol is obtained, and a CT scan is then obtained on the day of surgery.

Targets and trajectory planning:

In our study, we determined the targets by brain lab software, which is universal software by which we upload stereotactic c. t and MRI brain lap protocol with the aid of a brain atlas. Then, we chose the best trajectory and target. Once images are uploaded into the brain lab software, the best trajectories may be calculated based on the entrance and ablation targets. The pallidotomy target is normally located 2–3 mm anterior to the mid-commissural point, 4–6 mm below the inter-commissural line, and 19–22 mm lateral to the midline of the third ventricle. However, these measures are changed depending on the individual's unique anatomy. The VIM nucleus, which is the target of thalamotomy, is typically located around 25 percent of the AC-PC length anterior to the PC point, 11 millimeters laterally to the wall of the third ventricle, and at the same level as the AC-PC. The dorsolateral motor area is the ideal subthalamic nucleus (STN) target, and it is located 2–3 mm posterior to the mid-commissural point, 11–12 mm laterally to the AC-PC plane, and 4–5 mm inferior to the AC-PC plane.

Surgical procedure: Radiofrequency lesioning was used to produce unilateral lesioning in Gpi, VIM and subthalamic nucleus.

Initial steps: The frame is attached to the Mayfield with coronal suture at the highest point. The scalp is numbed with a local anesthetic before incision is performed to position the burr hole, which is determined Ed by brain lab software. After that, the position of the stereotactic arc is determined, and the electrode guide tube is inserted into the burr hole.

In the end, the galea and skin are closed in a watertight fashion.

Specific steps: Anatomical localization: T2-weighted and MRI scans both allow for direct orientation of STN and GPi. A radiofrequency lesion generator, Stockert Neuro N50, was used for microstimulation and lesioning. During surgical procedures, impedance recording is employed to distinguish between grey and white matter. A radiofrequency thermocouple electrode was induced in the brain, 12 mm superior to the target. Impedance is monitored. A gradual approach is taken to the aim while the effect is evaluated.

GPi, which is used with rigidity predominance PD, stopped the electrode 0.6 cm superior to the estimated target, and microstimulation was utilized to start outlining the best spot. The motor thresholds were determined by first stimulating at (two Hz) & then progressively increasing the voltage until fine, rhythmic contractions occurred in the face and upper limb. The thresholds dropped when the electrode was moved closer to the target. Contralateral stiffness and bradykinesia, which were evaluated, as well as speech, often improved after receiving high-frequency stimulation (100 Hz). High-frequency stimulation was also used once the electrode was placed 2 mm above the target to determine visual thresholds. White light flashes were the normal response. Motor threshold values between 3 & 5 V were often appropriate at the final target coordinates. The optic tract was protected by keeping the visual threshold at 2 V . After that, the complete microstimulation was performed again until sufficient target threshold values were attained. After that, a test lesion was performed at a temperature between 46 C for 60 seconds. The individual had a second round of evaluation to check for the preceding signs again. If there were no deficiencies, a permanent lesion was created by heating the tissue to temperatures of 80 ˚C for 60 seconds.

VIM: This is used with symmetrical tremors that predominate with PD; in this case, we employed microstimulation to verify that our focus was properly placed. The patient's contralateral arm was exposed while monitoring facial expressions and proceeded to employ low-frequency stimulation. Muscle contraction in the opposite arm may be induced with a current of 1-2 V. For a more medial target location, a lower stimulation threshold suggests that the target is closer to the internal capsule.

The second stimulation (50Hz, 2-msec square-

wave pulses, 0–5 V) was employed to evaluate the distance to the optic tract, the likelihood of speech impairment, and the improvement of symptoms. Typically described as a moderate tingling sensation, paresthesias are reported by the case. The location of the electrode point within the ventral caudal nucleus is denoted by a lower sensory threshold (< 1.0 V). Conversely, significantly higher thresholds indicate that the electrode is positioned excessively anteriorly. The third stimulation trial was performed at a frequency of 200 Hz to suppress tremors. With an appropriate electrode placement, this stimulation has the potential to inhibit tremor at current intensities equal to or less than 0.5 V.

Once the probe was in place, stimulation at 50 Hz at 0.5 - 1.0 V usually made tremors worse, but stimulation at 100 Hz usually stopped them. Minimally acceptable stimulation for speech and motor is > 2 mA at 5 Hz and for sensory > 1 mA at 100 Hz.

Subthalamic nucleus: used with asymmetrical severe tremors predominance PD with dyskinesia; this electrode's measurements of impedance in the STN area are It is safe to lesion when stimulation at 100 Hz, 1.0 ms pulse width eliminates contralateral parkinsonian symptoms such stiffness, bradykinesia, and tremor at 0.5 - 1.5 V, and when there are no capsular effects at 2.0 V and 2 Hz. This is then confirmed by creating a transient lesion for 60 seconds at 45 C. Three lesions are then placed at 75 C for 60 seconds, 2.0 mm beyond the target, at it, and 2.0 mm above it. In every instance, lesions are executed unilaterally in a single sitting. The dorsolateral STN is primarily targeted at coordinates 2–4 mm behind the mid-commissural point, 12–13 mm lateral, and 4–5 mm below the inter-commissural plane, despite some variation between groups.

Postoperative c. t: was taken to verify lesioning and to exclude hemorrhage.

Statistical analysis

Data were collected, revised, coded and entered into the Statistical Package for Social Science (IBM SPSS) version 20. The qualitative data were presented as numbers and percentages, while quantitative data were presented as mean, standard deviations and ranges when their distribution was found to be parametric. The comparison between the two groups with qualitative data was done using the Chi-square test and Fisher exact test instead of the Chi-square test when the expected count in any cell was found to be less than 5. The comparison between two independent groups with quantitative data and parametric distribution was done using an independent t-test. The confidence interval was set to 95%, and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following:

P > 0.05 = non-significant (NS).
P < 0.05 = significant (S).
P < 0.001 = highly significant (HS)

3. Results

there were 13 Cases were male and 7 were female and their ages ranged from 38 to 75 years (mean 59.65 years) all cases were diagnosed with PD.

According the Surgical target there were six cases target Unilateral Vim, four cases target Unilateral GPi, nine cases target Unilateral GPi + Vim and one case target Unilateral STN.

There were 14 cases (70%) with minimal pneumocephally which resolved spontaneously, 2 cases with minute contusion, one case were hemiparesis, speech proplem hardware failure (5%) each and they were resolved spontaneously and ocuur as aresult of prelesional oedema .

Table 1. Distribution of the studied individuals in accordance with UPDRS: III “Off Meds” Pre-operative and 6 mo Post- operative.

PARAMETERS	UPDRS:III “OFF MEDS” PRE-OP			UPDRS:III “OFF MEDS” 6 MO POST-OP		
SPEECH	1.55 ± 0.89	1.50 (1 – 2)	0 – 3	0.70 ± 0.47	1.00 (0 – 1)	0 – 1
FACIAL EXPRESSION	1.60 ± 0.94	1.50 (1 – 2)	0 – 3	0.90 ± 0.55	1.00 (1 – 1)	0 – 2
TREMOR AT REST	5.70 ± 2.99	5.00 (4 – 8)	1 – 10	1.45 ± 2.04	1.00 (0 – 2)	0 – 8
ACTION OR PSTURAL TREMOR	-	-	-	1.10 ± 1.29	1.00 (0 – 1)	0 – 5
RIGIDITY	8.00 ± 4.01	8.00 (5 – 11)	2 – 15	1.90 ± 1.41	2.00 (1 – 3)	0 – 5
FINGER TAPS	3.30 ± 1.26	3.00 (2 – 4)	1 – 6	1.25 ± 0.85	1.00 (1 – 2)	0 – 3
HAND MOVEMENTS	3.30 ± 1.30	3.00 (2 – 5)	1 – 5	0.85 ± 0.93	1.00 (0 – 1)	0 – 4
RAPID ALTERNATING MOVEMENTS OF HANDS	3.20 ± 1.36	3.00 (2 – 4)	0 – 5	1.15 ± 1.04	1.00 (1 – 2)	0 – 4

LEG AGILITY	2.85 ± 1.27	3.00 (2 – 4)	1 – 5	0.90 ± 0.72	1.00 (0 – 1)	0 – 2
ARISING FROM CHAIR	2.25 ± 1.37	2.00 (1 – 3)	0 – 5	0.70 ± 0.66	1.00 (0 – 1)	0 – 2
POSTURE	1.95 ± 1.32	2.00 (1 – 2)	0 – 5	0.80 ± 0.70	1.00 (0 – 1)	0 – 2
GAIT	3.30 ± 4.39	2.00 (2 – 3)	0 – 21	0.80 ± 0.52	1.00 (1 – 1)	0 – 2
POSTURAL STABILITY	1.75 ± 1.16	1.50 (1 – 3)	0 – 4	0.50 ± 0.51	0.50 (0 – 1)	0 – 1
BRADYKINESIA	2.55 ± 1.10	3.00 (2 – 3)	0 – 4	0.55 ± 0.51	1.00 (0 – 1)	0 – 1
TOTAL	40.30 ± 13.48	42.00 (30 – 51)	17 – 59	12.85 ± 7.73	14.00 (7 – 17)	1 – 36

The UPDRS: III “Off Meds” Pre-operative ranged from 17 to 59 (mean 40.30 and Median 42.0). 6 mo Post-operative ranged from 1 to 36 (mean 12.85 and Median 14.00) and this indicate significant improvement . Table 2

Table 2 . Comparison between UPDRS: III “Off Meds” before operative and UPDRS: III “Off Meds” 6 mo after operative

UPDRS:III “OFF MEDS”	PRE OPERATIVE	POST OPERATIVE	TEST VALUE*	P-VALUE
SPEECH	1.50 (1 – 2)	1.00 (0 – 1)	-3.213	0.001
	0 – 3	0 – 1		
FACIAL EXPRESSION	1.50 (1 – 2)	1.00 (1 – 1)	-2.913	0.004
	0 – 3	0 – 2		
TREMOR AT REST	5.00 (4 – 8)	1.00 (0 – 2)	-3.830	0.000
	1 – 10	0 – 8		
RIGIDITY	8.00 (5 – 11)	2.00 (1 – 3)	-3.731	0.000
	2 – 15	0 – 5		
FINGER TAPS	3.00 (2 – 4)	1.00 (1 – 2)	-3.558	0.000
	1 – 6	0 – 3		
HAND MOVEMENTS	3.00 (2 – 5)	1.00 (0 – 1)	-3.754	0.000
	1 – 5	0 – 4		
RAPID ALTERNATING MOVEMENTS OF HANDS	3.00 (2 – 4) 0 – 5	1.00 (1 – 2) 0 – 4	-3.750	0.000
LEG AGILITY	3.00 (2 – 4)	1.00 (0 – 1)	-3.897	0.000
	1 – 5	0 – 2		
ARISING FROM CHAIR	2.00 (1 – 3)	1.00 (0 – 1)	-3.804	0.000
	0 – 5	0 – 2		
POSTURE	2.00 (1 – 2)	1.00 (0 – 1)	-3.269	0.000
	0 – 5	0 – 2		
GAIT	2.00 (2 – 3)	1.00 (1 – 1)	-3.570	0.000
	0 – 21	0 – 2		
POSTURAL STABILITY	1.50 (1 – 3)	0.50 (0 – 1)	-3.577	0.000
	0 – 4	0 – 1		
BRADYKINESIA	3.00 (2 – 3)	1.00 (0 – 1)	-3.789	0.000
	0 – 4	0 – 1		
TOTAL	42.00 (30 – 51)	14.00 (7 – 17)	-3.921	0.000

3.1.Case presentation

Case (1)

A PD male 75 years old who was referred for the possibility of surgery . His UPDRS motor subscale (III) score was 43 in the off state. He underwent left sided GPi ablation with improvement of UPDRS-III off state to 19 after surgery. Figure 1

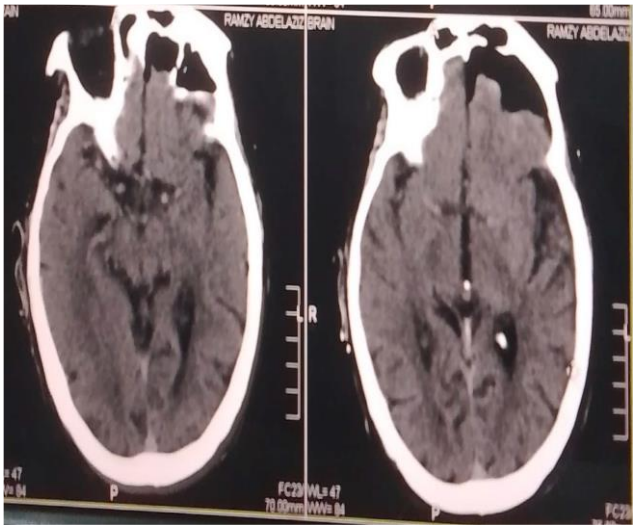

Figure 1.Postoperative left GPI ablation

Case (2)

A woman of 67 years old who was transferred from the neurology clinic because of failure of medical therapy . she then underwent left VIM ablation with excellent outcomes, Her off-UPDS-III motor score dropped from 63 to 18. Figure 2

Figure 2. Postoperative left VIM ablation

Case (3)

A 72-year-old man who transferred from the neurology clinic due to failure of medical treatment.she then underwent Rt STN ablation with excellent outcomes, Her off-UPDS-III motor score dropped from 32 to 6. Figure 3

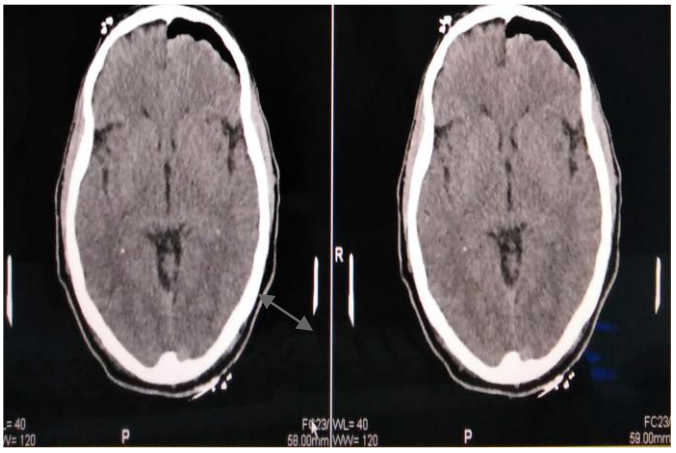

Figure 3. Postoperative Right STN ablation

4. Discussion

In our study, 13 Cases were men, and 7 were women. They varied in age from 38 to 75 (with a mean of 59.65 years). All cases were diagnosed with PD. This goes in line with the Foo (5) study, which revealed that most of the PD patients were males (53.2%).

In the present study, the best response was in combined GPI and VIM, as we did in 45 % of cases. These cases had the maximum decline in UPDRS, which agreed with Iacono [6], who concluded that it's possible that cutting separate neurons with PVP and Vim is responsible for their benefits.

In the current study, there were 14 cases (70.0%) of minimal Pneumocephaly, two cases of minute contusion (10.0%), one case of Hemoparesis, Speech prIn our study, 13 Cases were men, and 7 were women. They varied in age from 38 to 75 (with a mean of 59.65 years). All cases were diagnosed with PD. This goes in line with the Foo (5) study, which revealed that most of the PD patients were males (53.2%).

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In the current study, there were 14 cases (70.0%) of minimal Pneumocephaly, two cases of minute contusion (10.0%), one case of Hemoparesis, Speech problems, hardware failure, and surgical unsatisfaction (5.0%) each, and no cases of Visual impairment, Seizures, Altered consciousness or Mortality.

In the study by Loher [7], there were a total of 16 patients, and six of them had unilateral symptoms. It was found that 12.5% of people in his group experienced difficulties. In previous research with unilateral pallidotomy, the number of individuals who experienced temporary difficulties was reported to range from 7.9% to 69.2%, whereas the number of individuals who experienced chronic issues ranged from 0% to 19.2 percent .[8]

In the present study, according to the surgical target, six cases targeted Unilateral Vim, four cases targeted Unilateral GPi, nine cases targeted Unilateral GPi + Vim, and one case targeted Unilateral STN.

In the current study, the results indicated significant improvements post-operatively across all parameters.

MOUNIR et al.[9] reported significant relief by 45.5 percent in ON stimulation/OFF medication UPDRS III scores. Williams et al. [10] found that at 6 months after surgery, the UPDRS: III “Off Meds” scores were significantly improved in the STN and GPi groups, but the progress was greater in the STN group (48% vs. 39%). According to research, Pallidotomy was shown to be almost as effective as thalamotomy, with fewer problems .[11]

Horak group examined cases in a gait & balance, as well as the results again showed an advantage for the GPi. [12,13] A Meta-Analysis by Laitinen reported that at follow-up, (eighty-nine percent) were improved & ninety-two percent noted relief of hypokinesia. [14] Fytagoridis [15] exhibited a larger decrease in tremor (ninety-two percent) in comparison to the effect of Vim stimulation (sixty percent). Furthermore, a study [16] reported that tremors were completely abolished contralateral to thalamic lesions for three months.

[17]found that in all cases, eighty percent had marked or moderate progress of tremor (eighty-six percent in PD tremor, eighty-three percent in ET).oblems, hardware failure, and surgical unsatisfaction (5.0%) each, and no cases of Visual impairment, Seizures, Altered consciousness or Mortality.

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[17] found that in all cases, eighty percent had marked or moderate progress of tremor (eighty-six percent in PD tremor, eighty-three percent in ET).

5. *Conclusion*

Ablative surgery is a method that can be regarded as both safe & successful in the therapy of PD.

Disclosure

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All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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