

Non-Destructive Pallidal Disruption for Management of Parkinsonism and a Pre-DBS Maneuver

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BACKGROUND: The pallidum is a target for stereotactic surgery either by lesioning or deep brain stimulation (DBS) and it plays an important role in the functional stereotactic neurosurgery. DBS is a high cost method for treatment of parkinsonism especially for low income countries like Egypt, but it is reversible. On the contrary, ablation is a low cost method but it is irreversible.

OBJECTIVE: The aim of this study was to introduce a novel application for mechanical pallidotomy by air concussion and intermittent inflation and deflation for treatment of parkinsonism and as a pre-DBS maneuver.

PATIENTS AND METHODS: We operated on 6 patients with parkinsonism.. We injected 2ml of hypertonic saline through 5ml syringe at the pericapsular area using Leksell stereotactic frame.

RESULTS: Five cases (83.3%) showed good response to the maneuver with disappearance of the tremors for 1-6 months, while only one patient 16.7% showed no response.

CONCLUSION: Non-destructive pallidal disruption for management of parkinsonism is a safe and effective transient maneuver. We are planning to apply microballoning and air concussion techniques to make it permanent and our future directions is to include more cases. We can use this maneuver as a pre-DBS stage to ensure the patient is a good candidate for DBS.

KEYWORDS: Microballoning, Pallidotomy, Parkinson's disease, Pericapsular.

INTRODUCTION

Pallidotomy refers to a lesioning procedure of the internal segment of the globus pallidus (GP) (the integral part of the cortico-basal ganglia-thalamic loop), by which some of the abnormal motor manifestations produced due to its malfunction, will be relieved. It is considered the oldest stereotactically performed functional neurosurgical procedure for various movement disorders, and its acceptance and adoption in the functional neurosurgery societies has seen several ebbs and flows through the decades.¹⁻⁵

The first reported procedure was a pallidotomy for Huntington's disease. However, pallidotomy was adopted for Parkinson's disease worldwide soon after.⁶⁻¹⁰ Thalamotomy abandoned pallidotomy in the late 1950s, because thalamotomy had a more striking effect on treatment of tremors.⁶ The advent of levodopa restricted all surgery for Parkinson's disease. Laitinen et al., in the mid-1980s, reintroduced the posteroventral pallidotomy of Leksell, and thanks to its efficacy on most parkinsonian symptoms including levodopa-induced dyskinesias this procedure spread worldwide. The procedure relied on basic to basic

scientific work confirming the role of the globus pallidus internus (GPi) in the pathophysiology of Parkinson's disease.^{10,11} With the advent of DBS of the subthalamic nucleus (STN), pallidotomy was again abandoned,^{12,13} and even DBS of the GPi has been overshadowed by subthalamic nucleus-deep brain stimulation (STN DBS). In the late 1990s, the GPi reemerged as a major stereotactic target for DBS in dystonia disorder,¹⁴⁻¹⁶ and, lastly, in Tourette syndrome.^{17,18}

Lately, lesioning of the GPI has been proposed to treat refractory status dystonicus or to treat DBS withdrawal syndrome in Parkinson's disease (PD) patients.¹⁹⁻²¹ Hence, the pallidum as a stereotactic target for either lesioning or DBS has been the phoenix of functional stereotactic neurosurgery, constantly abandoned and then rising again from its ashes.^{6,12}

In 1953, Narabayashi et al., made a mechanical lesion in the globus pallidus using procaine oil-wax and to their surprise, tremor and rigidity disappeared immediately without motor paresis.²² This unfortunately was associated with complications because of the procaine oil-wax materials.

DBS is a high cost method for treatment of parkinsonism especially for low income countries like Egypt but it is reversible. On the contrary, ablation is a low cost method but it is irreversible. We aim to introduce a low cost and reversible (non-destructive) procedure for treatment of parkinsonism.

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METHODS

Best results for movement disorder procedures are at the lateral thalamus and the medial GP (pericapsular). We operated on 6 patients and injected 2ml of hypertonic saline through 5ml syringe at the pericapsular area using Leksell stereotactic frame at Al Azhar University Hospitals and Al Doah Hospital by awake burr hole surgery. We used the computed tomography (CT) to localize the GPi in all our 6 cases. The anatomical coordinates for the GPi were 22.2 ± 1.6 mm lateral to midline; 0.7 ± 1.5 mm anterior to the mid-commissural point (MCP); 4.7 ± 1.3 mm ventral to intercommissural plane. Then we checked for intraoperative response and clinical improvement. Postoperative follow up continued for 6 months.

We are planning to use the mechanical pallidotomy by air concussion and intermittent inflation and deflation in the future. This can be achieved through insertion of a reservoir like ommaya reservoir (microballooning) with its end at the GPi to produce more long standing effect.

Ethical Committee approval and written informed consent were obtained from all participants.

RESULTS

Five of our patients (83.3%) showed intraoperative tremor improvement and showed no postoperative deficits. On the follow up periods they showed different responses; one patient showed recurrence of symptoms after 4 weeks, another one showed recurrence of symptoms after 3 months, three patients showed recurrence of symptoms after 6 months. Only one patient showed no postoperative improvement (16.7%), this patient's CT brain showed prominent brain atrophy mostly causing secondary parkinsonism (Chart 1).

Case 1:

A 45 years old male with left hemiparkinsonian static tremors was operated by using the mechanical pallidotomy technique. We noticed immediate abortion of the tremors intraoperatively on just ablation of the GPi and the improvement continued for 6 months postoperatively with no postoperative neurological deficits (Fig. 1).

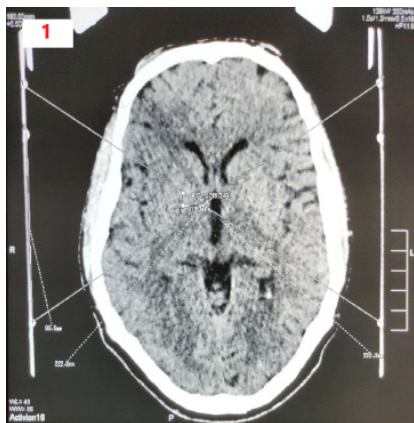


Fig 1: Stereogram of case 1 showing the target area for the maneuver (preoperative).

Case 2:

A 50 years old male patient presented with left hemiparkinsonian static tremors and was operated by using the mechanical pallidotomy technique. We noticed immediate abortion of the tremors intraoperatively on just ablation of the GPi and the improvement continued for 6 months postoperatively with no postoperative neurological deficits (Fig. 2).

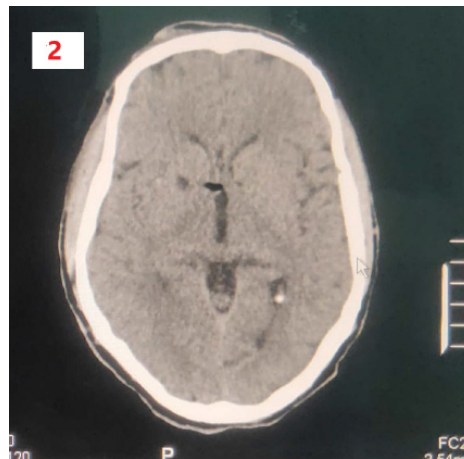


Fig 2: Case 2 with postoperative CT image showing the target area for the maneuver.

Case 3:

A 50 years old female patient presented with right hemiparkinsonian static tremors and was operated by using the mechanical pallidotomy technique. We noticed immediate abortion of the tremors intraoperatively on just ablation of the GPi and the improvement continued for 3 months postoperatively with no postoperative neurological deficits (Fig. 3).

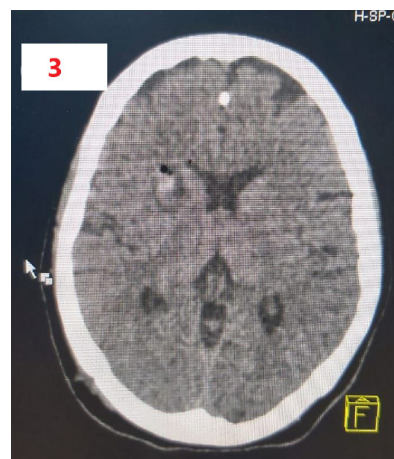


Fig 3: Case 3 with postoperative CT image showing the target area for the maneuver.

Case 4:

A 58 years old male patient operated for tremors secondary to Parkinson's disease by using the mechanical pallidotomy technique. We noticed no improvement at all either intraoperative or postoperative, despite that the desired area for pallidotomy was targeted as shown in

the CT. This patient had brain atrophy on CT scan which may result in PD (**Fig. 4**). The clinical and radiological findings supposed that this patient had the tremors secondary to Parkinson’s disease however, he showed no improvement at all.



Fig 4: Postoperative CT showing the target area for our maneuver, this patient showed no improvement of tremors.

Case 5:

A 65 years old female patient presented by left

hemiparkinsonian static tremors and we used the mechanical pallidotomy technique to treat her. Post-operatively, the patient showed improvement for one month and then the tremors started to appear again.

Case 6:

A 59 years old male was complaining of right side parkinsonian tremors. After the mechanical pallidotomy technique, the tremors improved for 3 months then started to appear again.

The periods of improvement in our 6 patients was ranging from 0-6 months (**Chart 1**).

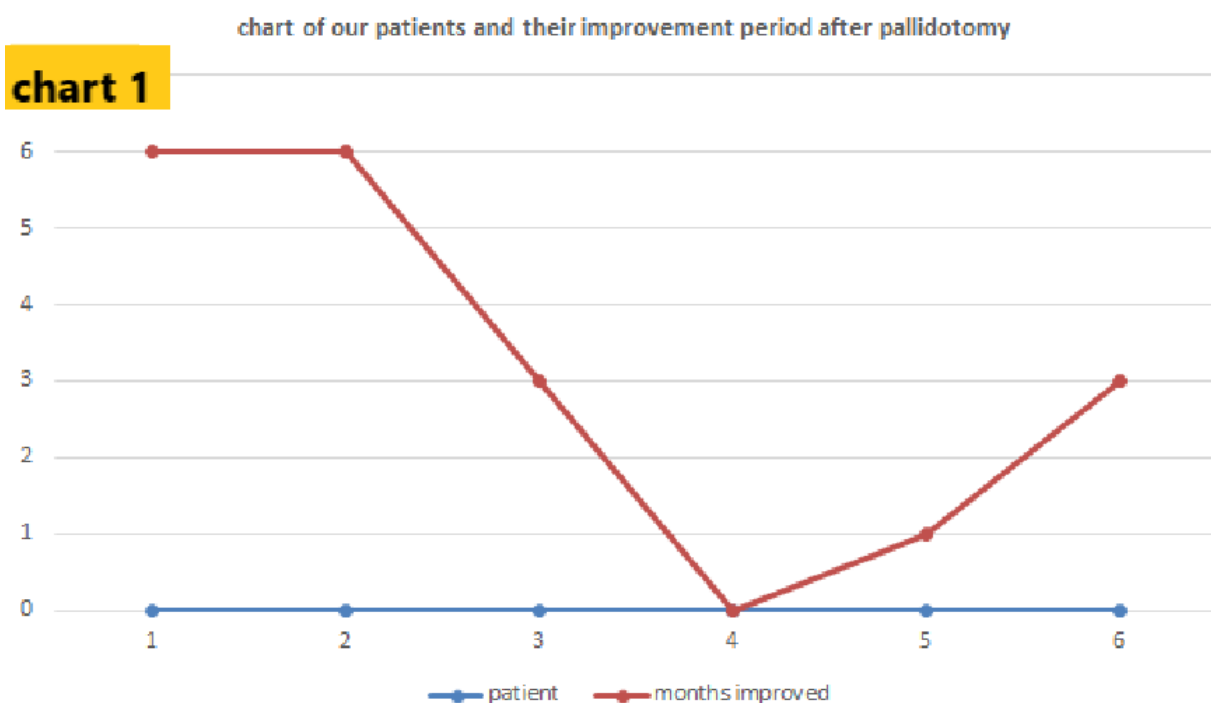


Chart 1: Chart showing our cases in relation to their postoperative improvement period.

DISCUSSION

Low income countries need low cost procedures and facilities to treat tremors. Mechanical lesioning of the globus pallidus was introduced in 1953 by Narabayashi et al using procaine oil-wax and they reported that tremors and rigidity disappeared immediately without motor paresis,²² but later on it was abandoned because of the oil complication on the brain.

We introduced mechanical pallidotomy using hypertonic saline instead of procaine oil-wax to avoid its complications. This does not cause destruction of the neural tissue and avoids injection of non-absorbable material as procaine oil-wax into the GP with its permanent complications, so it is “non-destructive pallidal disruption”. It showed excellent response but unfortunately it was mostly transient.

Five of our patients showed different periods of improvement (83.3%). Only one patient showed no improvement at all postoperatively. This patient had a CT which showed prominent brain atrophy. This brain atrophy may be the cause of secondary Parkinsonism. This unresponsive result of the mechanical pallidotomy may indicate that patient will not respond to DBS (which is very expensive) too. Two common reasons for failure of patients to improve following pallidotomy are supposed to be: 1) the patient does not have idiopathic PD, but instead a parkinsonian syndrome, or 2) the lesion(s) are placed outside of the sensorimotor territory of GPi.

We can use this maneuver as a pre-DBS stage to ensure that the patient is a good candidate for DBS. There is an evidence that more than 30% of patients who were considered DBS failures were actually poor candidates for DBS, suggesting significant variation in physicians’ understanding of surgical indications. In addition to referral of inappropriate candidates for DBS, a poor understanding of surgical indications may prevent referral of many patients who would significantly benefit from DBS and they may miss their chance of treatment. As the indications for DBS broaden to include other neurological and psychiatric conditions, the need to ensure adequate knowledge of surgical candidacy for DBS will become more crucial.²³ Regarding the cost issue in low income countries like Egypt, we are trying to find an alternative modality to DBS or at least we need to ensure more accurate indication for DBS to avoid cost loss if it is available.

Our mechanical pallidotomy technique is safe, all our patients showed no postoperative temporary or permanent neurological deficits. We assume that even if the neurological deficits occur, it will be mostly transient as it is non-destructive pallidal disruption.

The main challenge is that the tremor recovery is transient, so our future direction is to make it permanent recovery. This can be achieved through insertion of a reservoir like ommaya reservoir (microballooning) with its end at the GPi. This deflation and inflation micro ballooning

will be controlled by the surgeon to create bouts of mechanical disruption of low amplitude. This is expected to make the effect of this maneuver more longstanding. Microballooning has many uses in neurosurgery and the term microballooning is not recent in neurosurgery. It was used in endovascular procedures and was also used in 2004 by Cokluk et al. who hypothesized that transparent microballoon dissection could be helpful in the gentle separation of the brain tissue from tumors.²⁴ Currently we are using the hypertonic saline to separate the brain tissues at GPi. However, after absorption of the saline the tissues come back to its place and the concussion occurred there will be recovered and the symptoms will start to appear again.

Air concussion by bouts of air waves of small amount less than the size of any lesioning surgery is also a future direction to make it permanent. Our target is not to destruct but only to separate GPi fibers and to cause neuropraxia not neurotemesis. We are planning to include more cases in our study and to start applying microballooning with air concussion in the next cases and for longer periods of follow up. It could help parkinsonian poor patients to enjoy their lives without tremors with a low cost.

CONCLUSION

Non-destructive pallidal disruption for management of parkinsonism is a safe and effective transient maneuver. We need to apply microballooning and air concussion techniques to make it permanent and need to include more cases. We can use this maneuver as a pre-DBS stage to ensure the patient is a good candidate for DBS.

List of abbreviations

CT: Computed tomography.
 DBS: Deep brain stimulation.
 GP: Globus pallidus.
 GPi: Globus pallidus internus.
 MCP: Mid-commissural point.
 PD: Parkinson’s disease.
 STN: Subthalamic nucleus.
 STN DBS: Subthalamic nucleus deep brain stimulation.

Disclosure

The authors report no conflict of interest in the materials or methods used in this study or the findings specified in this paper.

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