

## Stereotactic Pallidotomy for Dystonia, Outcome and Complications

Zeiad Y. Ibraheem, MD; Mohamed W. Samir, MD;  
Hamdy Ibrahim MD; Mohammad Alaa Fakhr

Neurosurgery Department, Faculty of Medicine, Ain Shams University

### ABSTRACT

**Introduction:** The term dystonia refers to twisting movements that are sustained at their peak and frequently repetitive. As stereotactic techniques improved over the previous decades, basal ganglia surgery was performed for a variety of movement disorders including dystonia. This study was done to evaluate the outcome and complications of stereotactic pallidotomy procedure for treatment of generalized dystonia. **Patients and Methods:** This is prospective study done on 10 patients with generalized dystonia treated by MRI guided stereotactic pallidotomy. They were selected according to inclusion and exclusion criteria among all patients presented with movement disorder to Ain Shams University hospital from January 2002 to January 2006. Fahn-Mersden (BMF) scale was used for assessment of the degree of dystonia in the preoperative examination and during each follow up visits. **Results:** The patients' age at the time of surgery ranged from 10 years to 39 years old with a mean age of  $20.3 \pm 6.8$ . There were six female and four male patients. Six patients were diagnosed as secondary dystonia. The mean preoperative dystonia score for all patients according to BFM scale was 67.3. There was a statistically significant decrease in dystonia score in both early and late follow ups in comparison to the pre-operative score in both primary and secondary dystonia. **Conclusion:** Although most patients with generalized dystonia should be dealt with multidisciplinary approach of all the involved specialties, including the neurologist, neurophysiologist, and physical therapist, the neurosurgeon can help also those patients by many procedures including stereotactic pallidotomy that was proved to be effective and safe modality of treatment.

### INTRODUCTION

The term dystonia refers to twisting movements that are sustained at their peak and frequently repetitive<sup>(7)</sup>. They often progress to prolonged abnormal postures<sup>(1)</sup>. Because in some subjects dystonia may progress to a life threatening stage or become a major fixed handicap, and given the limited efficacy of drug management in dopa-non responsive dystonia, alternative solutions have been sought since the early 1940s, including surgical treatment<sup>(3)</sup>.

As stereotactic techniques improved over the previous decades, basal ganglia surgery was performed for a variety of movement disorders including dystonia. Cooper in the year

1976, reported the largest early series using thalamotomy for dystonia, more recently pallidotomy regained popularity as a treatment of dystonia<sup>(12)</sup>.

#### Aim of the work

Aim of this study is to evaluate the complications, efficacy and outcome of stereotactic pallidotomy procedure for treatment of generalized dystonia.

#### Patients and methods

This is a prospective study done on 10 patients with generalized dystonia treated by stereotactic pallidotomy. They were selected among all patients presented with movement disorder to Ain Shams University hospital from January 2002 to January 2007. Criteria for selection for those patients were the following; inclusive criteria that

include established diagnosis of dystonia by a neurologist, sufficient period with sufficient doses of medical treatment, medical intractability in the form of either failure of medical treatment, or side effects and intolerance of medications. Also failure of Dopa challenge test was a pre-requested step in all cases of generalized dystonia to diagnose or exclude Dopa responsive dystonia (DRD). It is done by giving the patient 400 mgs levodopa - carbidopa for at least 4 weeks.

Exclusion criteria included; high risk patients for general anaesthesia and surgery, coagulopathy, anticoagulant or antiplatelet therapy and dementia or marked affection of the mental state except if the patients' relatives accept the procedure for only more convenience caring of their patients. Also patients with severe fixed deformities, contractures or extensive joint diseases from long standing dystonic postures were excluded from the study except after increase range of passive joint movement by orthopedic intervention.

All patients were dealt with multidisciplinary approach of all the involved specialties, including the neurologist, neurophysiologist, physical therapist and the neurosurgeon. They were subjected to complete medical history and full general and neurological examination with special emphasis upon prenatal and developmental history in pediatric patients. Also history of medications including types of drugs used to control dystonia and history of any

interventions for treatment of dystonia including the orthopedic surgery were taken.

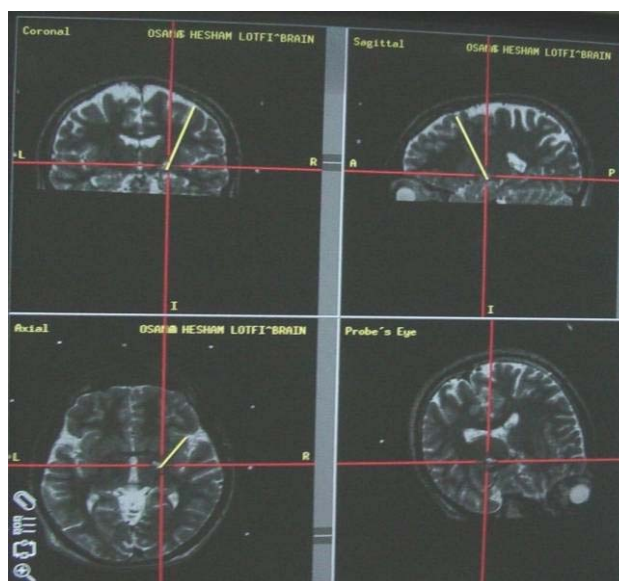
Joint range of motion (ROM) that was measured by the number of degrees from the starting position of a segment to its position at the end of its full range of the movement was assessed in every patient. Modified Ashworth scale (MAS), was used for muscle tone measurement. Fahn-Mersden (BMF) scale was used for assessment of the degree of dystonia in the preoperative examination and during each follow up visits.

In addition to the routine preoperative lab examination, all patients had preoperative MRI brain. When there was confusion in diagnosis between dystonia and spasticity in some patients, Electromyographic (EMG) examination was done. Other investigations were tailored for each patient as measurement of serum copper and ceruloplasmin in suspected dystonia secondary to Wilson's disease.

The stereotactic procedures were done under local anesthesia when it is feasible otherwise general anesthesia was used. (Figure 1) All the procedures were MRI guided targeting the globus pallidus internus (GPi). The stereotactic coordinate used was 18-22mm lateral to mid-commissural point, inferior to it by 2-6mm and 2-3 mm anterior. Comparison between the calculated target and an anatomical target in a digital form of Schaltenbrandt and Wahren stereotactic atlas was done in every case. (Figure 2)



*Figure (1): Application of the stereotactic frame under local anesthesia*



*Figure (2): Planing of the target and trajectory with the use of the stereotactic soft ware*

In procedures done under local anesthesia verification of the target by the macrostimulation was done with motor stimulation at 2 Hz frequency and sensory stimulation at 50 Hz. Current intensity is increased gradually up to maximum 2 V and if no capsular motor responses or visual phosphores were obtained at less than 2.0v, it was considered safe to begin lesioning.

Once the target location was verified, a test lesion was made at 45°C for 60 seconds (if the procedure again was under local anesthesia). Then patient was evaluated for any evidence of motor, sensory, visual, or speech impairment. If there were no deficits, a permanent lesion was made at 75°C for 30 seconds, the electrode

was then withdrawn 2 mm and a second lesion made at 75° for 60 seconds and on withdrawing another 2.0mm a final lesion was made at 75° for 90 seconds. In bilateral lesioning in the same session the third lesion was made for only 60 seconds.

All patients should be subject to intense preoperative and post operative periods of physical rehabilitation. Follow up was done to all cases for at least one year. Descriptive and analytical statistics were performed on IBM-compatible computer by using SPSS 14.0 software package under windows XP operating system. Graphic presentation of data was performed by using Excel XP software package. Continuous data were presented in the form of mean  $\pm$  SD

(median). Categorical data were presented in the form of number and percentage. Paired Samples Test was used in comparison the pre-operative and the post-operative dystonia scores and Power of significance (probability) were non significant if  $p$  value  $\geq 0.05$ , significant if  $p < 0.05$  and highly significant if  $p$  value  $< 0.01$ .

## RESULTS

The patients' age at the time of surgery ranged from 10 years to 39

years old with a mean age of  $20.3 \pm 6.8$ . There were six female and four male patients. Six patients were diagnosed as secondary dystonia. The underlying etiologies of the secondary dystonia were reported in table (1). There were four patients with primary generalized dystonia; two of them were tested positive for the DYT1 gene while the other two were not tested. Gender distribution and mean age of patients among the different type of dystonia were showed in table (2).

**Table (1): Types and proposed causes of dystonia in this study.**

Types of dystonia	Underlying pathology	Number of patients
Primary	DYT1 gene positive	2 patients
	DYT1 gene not tested	2 patients
Secondary	Post anoxic	1 patient
	Post kernecteric	4 patients
	Post encephalitic	1 patients
Total		10 patients

**Table (2): Gender distribution and mean age of patients among the different type of dystonia.**

	Primary dystonia patients	Secondary dystonia patients
Female	Two patients	Two patients
Male	Two patients	Four patients
Mean age	18.2- year	20- year

The mean preoperative dystonia score for all patients according to BFM scale was 67.3. It was  $78.5 \pm 5$  in primary dystonia patients while it was  $59.9 \pm 6.8$  in secondary dystonia.

Fourteen stereotactic procedures were done for the ten patients in this study as four patients had bilateral procedures. All bilateral procedures were done in two separate sessions separated by a period of 6 months at least. The stereotactic procedures' steps, including MRI scanning, were carried under local and neuroleptic anesthesia. All patients were followed for at least one year and the mean follow up period was  $18.62 \pm 6.833$  months. In follow up, comparison of the dystonia scores between early (one

month after the procedures) and late (one year after the procedures) was done.

Generally there was decrease in the dystonia score in both early and late follow ups in comparison to the pre-operative score. In primary dystonia patients the early follow up showed decrease in the score from a mean value 78.5 to 32 (60% improvement) and further decrease of the score in late follow up to 27 (66% improvement). While in secondary dystonia patients the early follow up showed decrease in the score from a mean value 59.9 to 40.3 (33% improvement) but in late follow up there was some decrease in this improvement to 28%. (Figure & Table 3).

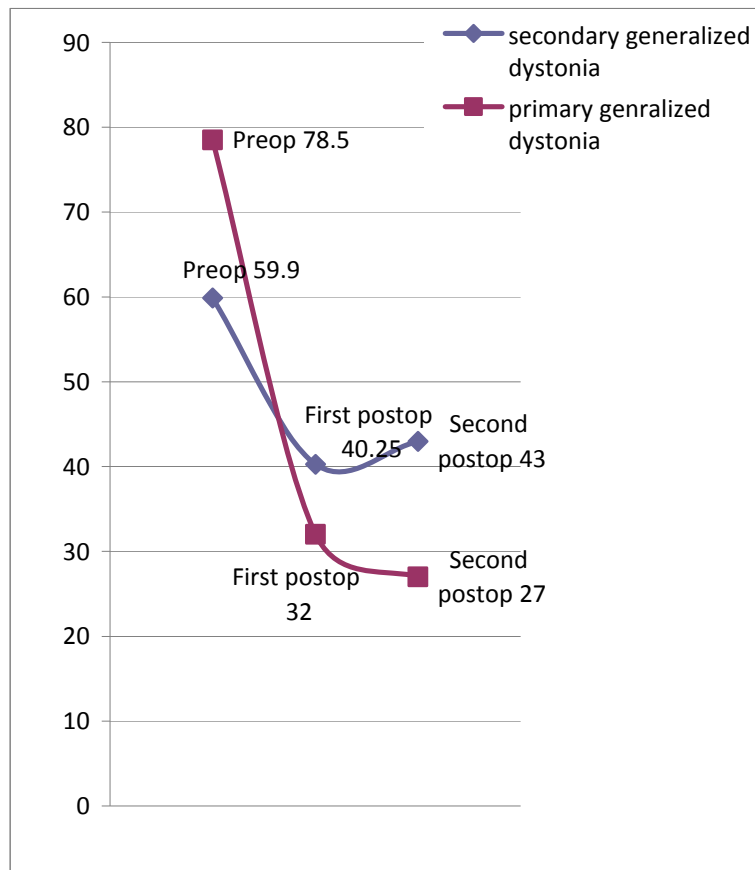


Figure (3): Decrease of dystonia score in follow up.

Table (3): Descriptive Statistics for both primary and secondary generalized dystonia

Dystonia score	Minimum	Maximum	Mean	Std. Deviation
<b>Primary Dystonia</b>				
Pre-operative Score	72.00	84.00	78.5000	5.00000
Early follow up	26.00	38.00	32.0000	5.88784
Late follow up	18.00	38.00	27.0000	8.86942
<b>Secondary Dystonia</b>				
Pre-operative Score	48.00	70.00	59.8750	6.77047
Early follow up	8.00	64.00	40.2500	19.57951
Late follow up	18.00	62.00	43.0000	17.59870

Paired Samples T test was done to know if these changes in the dystonia score were statistically significant or not. It was found that even in the late follow up in secondary dystonia patients (those who showed increase in

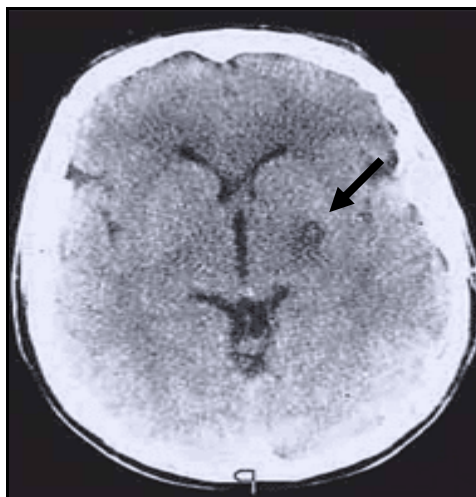
the score in late follow up in comparison to early follow up) the improvement in the dystonia score was always statistically significant (p value < 0.05) (Table 4).

**Table (4): Results of the Paired Samples Test both types of dystonia.**

Paired Samples Test Differences in						t	Df	P value
Primary Dystonia	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference				
Pre-operative/ Early post-operative Score	46.50	5.97	2.99	36.996	56.00	15.57	3	.001
Pre-operative/ Late post-operative Score	51.50	7.19	3.59	40.06	62.94	14.33	3	.001
Secondary Dystonia	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference		t	Df	P value
Pre-operative/ Early post-operative Score	19.63	22.79	8.06	0.57	38.68	2.44	7	.045
Pre-operative/ Late post-operative Score	16.88	14.63	5.17	4.64	29.11	3.26	7	.014

Amongst the fourteen stereotactic procedures, there was neither permanent morbidity nor mortality. Asymptomatic small intracerebral hematoma along the track of the lesioning electrode was noticed in one patient (10%). Another patient (10 %) had transient hemiparesis on the 3 rd postoperative day following left pallidotomy which resolved within one week. As the post-operative CT brain for this patient showed no definite abnormality; it was assumed that this

deficit was secondary to peri-lesional edema that resolved with dehydrating measures. The site of the lesion was visualized only in late (at least one month after the procedure) follow up CT brain. While in MRI it was easy to see the lesion or its surrounding edema in as early as the first day post operative MRI brain. (Figures 4 & 5) Those patients who had bilateral pallidotomy showed no adding neurological risk with the second lesion.



**Figure (4): CT brain axial cut showing left pallidotomy**



**Figure (5): MRI brain axial slice T2 weighted image with bilateral pallidotomy**

## DISCUSSION

The studies performed on dystonia patients are usually very difficult to interpret due to multiple factors. The most important is the extreme heterogeneity of the patient samples including various types as regards etiology and distribution. The second important factor is that many of these patients actually require more than one treatment modality, which makes it difficult to assess or compare the relative efficacies of these modalities. So in this series it was tried to unify patients criteria of selection into generalized dystonia and sub grouped into primary and secondary. All patients had the same treatment modalities; stereotactic pallidotomy.

Some series reported either thalamotomy or pallidotomy for the management of secondary dystonia, with a small margin of advantage for thalamotomy, however the higher rate of complications especially with the need of bilateral procedures encouraged us to use pallidal target as a primary target.

In this study all the stereotactic procedures were done under MRI guidance and with the use of sedation because of the abnormal movement and posture. In a study to determine whether magnetic resonance imaging (MRI), compared with computed tomography (CT), provides consistent and accurate target localization for pallidotomy, it was found that less than 2 % of the cases the differences between MRI- and CT-derived coordinates was relatively large (greater than 4 mm and up to 8mm)<sup>(4)</sup>. So especially with the presence of image fusion one can reduce the procedures' time by doing stereotactic CT and match it with the pre-operative non stereotactic MRI.

Out of the ten patients who received stereotactic procedures, eight patients ( 67%) showed moderate to marked improvement (more than 50%) with statistically significant reduction in their BFMS score up to 89% with a mean of 43 % ( p value = 0.001). The course of improvement was interesting, motor tone improved immediately but the improvement of dystonic postures was not noticed before 2 to 6 days after surgery. This is in striking contrast to patients with Parkinson's disease, in whom the benefits are seen immediately, indeed intraoperatively. Similar course was seen by some authors<sup>(2,11)</sup>. The reason for this delay is not entirely clear. There may be musculoskeletal factors in patients with severe deformity that require time and training to improve. There may be a requirement for transsynaptic changes to occur to see maximal benefit. Finally, there may be a requirement for motor learning or relearning in patients who have not had normal motor function for prolonged periods of time<sup>(2,5,11)</sup>.

The range of improvement varied largely according to whether it was primary or secondary dystonia. The outcome of pallidotomy for primary dystonia was statistically superior ( $P = 0.0481$ ) to the outcome for secondary dystonia; this was also reported in the similar series<sup>(2,5,6,8,9,10,12,13)</sup>.

In this series, the results of pallidotomy in secondary dystonia were much less encouraging than the published results, (one patient of the six patients with secondary dystonia showed improvement more than 25% in his BFMS score). Similar series reported much better results of stereotactic pallidotomy in secondary dystonia; improvement of up to 50 % in more than 50% of patients<sup>(11,13)</sup>.

Statistical analysis performed in an attempt to isolate any other

confounding factors by grouping the patients according to other demographic criteria, such as age at onset of dystonia, age at operation, duration of symptoms before operation, and sex, revealed no significant differences across these groups.

There was no mortality in this series and transient morbidity was 20 % (transient hemiparesis in 10% and small asymptomatic hematoma in another 10%). Reported complications of stereotactic pallidotomy in similar series were hemorrhage in 3 % and neurological deficit in 3.6%<sup>(13)</sup>. Although there was no neurological deficits in bilateral lesioning in this series, yet bilateral pallidotomy always carry adding risk to develop a neurological deficit. However, neurological deficit as persistent speech disturbances that occurred in up to 40% of the patients undergoing bilateral pallidotomies<sup>(2)</sup>, favors the consideration of deep brain stimulation (DBS) if bilateral procedures are considered, especially if performed simultaneously.

## CONCLUSION

Although most patients with generalized dystonia should be dealt with multidisciplinary approach of all the involved specialties, including the neurologist, neurophysiologist, and physical therapist, the neurosurgeon can help also those patients by many procedures including stereotactic pallidotomy that was proved to be effective and safe modality of treatment.

## REFERENCES

1. **Burghaus L, Hilker R, Thiel A et al:** Deep brain stimulation of the subthalamic nucleus reversibly deteriorates stuttering in advanced Parkinson's disease. *J. Neural Transm* 2005.
2. **El Tahawy H, Jean Saint-Cyr, Nir Giladi, et al:** Primary dystonia is more responsive than secondary dystonia to pallidal interventions: outcome after pallidotomy or pallidal deep brain stimulation. *Neurosurgery* 54:613-621, 2004
3. **Herdeen JC, Zweig RM, Delong MR, et al:** Primary dystonias a review of pathology and suggestions of for new directions of study. *Adv Neurol* 1988; 50:123
4. **Holtzheimer PE 3rd, Roberts DW, Darcey TM:** Magnetic resonance imaging versus computed tomography for target localization in functional stereotactic neurosurgery. *Neurosurgery*. 1999 Aug; 45 (2): 290-7;
5. **Iacono R, Kuniyoshi S and Lonser R, et al:** Experience with stereotactics for dystonia: case examples *adv neurol* 1998;76:221-226.
6. **Iacono R, Kuniyoshi S and Lonser R, et al:** Simultaneous bilateral pallidoansotomy for idiopathic dystonia musculorum deformans *pediatr neurol* 1996;14:145-148
7. **Kanner AM:** Deep brain stimulation for intractable epilepsy: which target and for which seizures? *Epilepsy Curr* 2004; 4: 231-232.
8. **Lin JJ, Lin GY, Shih SZ, et al:** Benefit of bilateral pallidotomy in the treatment of generalized dystonia. *J Neurosurg* 1999; 90:974- 976.
9. **Lin JJ, Lin SZ, Lin GY, et al:** Application of bilateral sequential pallidotomy to treat a patient with generalized dystonia. *Eur Neurol*. 1998 Aug;40(2):108-10.
10. **Lozano A, Hutchison W, Kiss Z, et al:** Methods of microelectrode

- guided posteroventral pallidotomy.  
J Neurosurg 1996; 84:194-202.
- 11. Ondo WG, Desalom JM, Jankovic J et al.:** Pallidotomy and thalamotomy for dystonia. In: Krauss JK, Jankovic J, Grossman RG, eds. Surgery for Parkinson's disease and movement disorders. Philadelphia, USA: Lippincott Williams and Wilkins, 2001: 299–306.
- 12. Vitek JL, Zhang J, Evat M et al.:** Gpi pallidotomy for dystonia: Clinical outcome and neuronal activity adv neurol 1998; 78: 211-219.
- 13. Yoshor D, Hamilton WJ, Ondo W, et al.:** Comparison of Thalamotomy and Pallidotomy for the Treatment of Dystonia, Neurosurgery, Vol. 48, No. 4, April 2001 pp 818-823.
-

