

Bilateral contemporaneous posteroventral pallidotomy for the treatment of Parkinson's disease: neuropsychological and neurological side effects

Report of four cases and review of the literature

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✓ The authors report the underestimated cognitive, mood, and behavioral complications in patients who have undergone bilateral contemporaneous pallidotomy, as seen in their early experience with functional neurosurgery for Parkinson's disease (PD) that is accompanied by severe motor fluctuations before pallidal stimulation.

Four patients, not suffering from dementia, with advanced (Hoehn and Yahr Stages III–IV), medically untreatable PD featuring severe “on–off” fluctuations underwent bilateral contemporaneous posteroventral pallidotomy (PVP). All patients were evaluated according to the Core Assessment Program for Intracerebral Transplantations (CAPIT) protocol without positron emission tomography scans but with additional neuropsychological cognitive, mood, and behavior testing.

For the first 3 to 6 months postoperatively, all patients showed a mean improvement of motor scores on the Unified Parkinson's Disease Rating Scale (UPDRS), in the best “on” (21%) and worst “off” (40%) UPDRS III motor subscale, a mean 30% improvement in the UPDRS II activities of daily living (ADL) subscore, and 60% on the UPDRS IV complications of treatment subscale. Dyskinesia disappeared almost completely, and the mean daily duration of the off time was reduced by an average of 60%. Despite these good results in the CAPIT scores, one patient experienced a partially regressive corticobulbar syndrome with dysphagia, dysarthria, and increased drooling. No emotional lability was found in this patient, but he did demonstrate severe bilateral postoperative pretarsal blepharospasm (apraxia of eyelid opening), which interfered with walking and which required treatment with high-dose subcutaneous injections of botulinum toxin. No patient showed visual field defects or hemiparesis, but postoperative depression, changes in personality, behavior, and executive functions were seen in two individuals. Postoperative abulia was reported by the family of one patient, who lost his preoperative aggressiveness and drive in terms of ADL, speech, business, family life, and hobbies, and became more sleepy and fatigued. One patient reported postoperative mental automatisms, such as compulsive mental counting, and circular thoughts and reasoning during off phases; postoperative depression was found in two patients. However, none of the patients demonstrated these symptoms during intraoperative microelectrode stimulation. These findings are compatible with previous reports on bilateral pallidal lesions. A progressive lowering of UPDRS subscores was seen after 12 months, consistent with the progression of the disease.

Bilateral simultaneous pallidotomy may be followed by emotional, behavioral, and cognitive deficits such as depression, obsessive–compulsive disorders, and loss of psychic autoactivation–abulia, as well as disabling corticobulbar dysfunction and apraxia of eyelid opening, in addition to previously described motor and visual field deficits, which make this surgery undesirable even though significant improvement in motor deficits can be achieved.

KEY WORDS • bilateral pallidotomy • Parkinson's disease • cognitive impairment • abulia • apraxia • obsessive–compulsive disorder • depression • side effect

UNILATERAL pallidotomy is now widely recognized as one alternative in the treatment of severe Parkinson's disease (PD) that features medically intractable fluctuations, especially in young patients.^{13,29,40,51,55,57,61–66,74,78,81–84,93,96,97,108,110,112,113} Improvement has been reported in parkinsonian signs and levodopa-induced dyskinesias, especially in bradykinesia and rigidity, but less in tremor or gait abnormalities and is probably the result of some restoration of the thalamocortical activation function.^{14,28,31,32,77,100} Bilateral pallidotomy is probably more efficient than unilateral lesioning but has a high percentage of side effects including 25 to 30% dysarthria and cor-

ticobulbar syndromes.^{37,40,56,66,78} Bilateral pallidal stimulation according to Siegfried's technique^{4,5,38,44,58,103} yields similar results with reversible or controllable side effects.

In the literature on pallidotomy, the effect of the treatment on parkinsonian symptoms such as tremor, rigidity, and bradykinesia is generally reported to be good opposite unilateral lesions, with some benefit ipsilaterally, but the effect on gait is more variable.^{13,29,37,40,51,56,61–66,76,78,81–84,96,97,104,108,110,112,113} Because of the differences in technique, site and size of lesions, accuracy of targeting, surgical approaches (frontal or temporal), method of evaluating the results, differences in terminology, and unclear reporting of results,

TABLE 1

Characteristics in four patients with medically intractable PD who underwent PVP

Characteristic	Case No.			
	1	2	3	4
age (yrs)	60	62	63	64
sex	M	F	F	M
duration of disease (yrs)	10	18	12	21
Hoehn & Yahr stage (on/off)	III/IV	III/IV	III/IV	III/IV
mean off time (%)	25	25	50	50
mean levodopa dose/day (mg)	375	1500	1500	725
Blessed Scale A score	2	3	2	5
handedness	rt	rt	rt	rt

it is difficult to obtain a consistent picture of the complications. Moreover, especially in early papers, it was not even clearly indicated which patients underwent unilateral and which underwent bilateral lesioning and what the differences were between these groups of patients.^{9,15,16, 20–23,25,53,86}

If one tries to summarize the neurological complications described in patients who have undergone pallidotomy, especially when bilateral treatments are reported (mostly performed at two different operating times),^{11,13,15,20–22,36,39,52,53,55,59,61–65,80,88,89,91,95,99,101–103,108,109} one finds no side effects,^{9,20–24,43,45,66,88,89,91} transient or permanent hemiparesis or hemiplegia,^{10,15–25,53,61–65,91,94,95,105,108,109} visual field defects,^{7,61–65,91,96,108,109} corticobulbar syndrome,^{10,12,13,16, 23,25,52,61–65,86,88,91,101,108} ataxia,²⁵ oculomotor nerve palsies,²⁵ hypersalivation,⁸⁶ gait abnormalities (such as “a tendency to adduction in the gait and some difficulty in the automatism of walking”),⁹¹ delayed epileptic seizures,¹⁰⁹ hyperthermia,^{16,47} postoperative apnea,³⁴ or incontinence.⁸⁶ Cognitive deficits, even dementia, are not described in great detail, and terminology is imprecise; for example, “no significant quantitative changes in the postoperative mental function”¹⁵ as tested using Wechsler Adult Intelligence Scale and Rorschach tests, “no psychological or intellectual deficit,”¹⁶ transient or permanent “mild dementia,”^{47,87,108} “mental confusion,”^{16,23,26,53,54,86} hallucinations,^{16,25,52} “transient psychic syndromes,”⁵³ disinhibition, or psychosis.¹⁰² More focal cognitive dysfunctions have also been reported, such as decreases in verbal and full scale intelligence quotient scores (as a result of pallidotomy on both sides), performance scores, picture arrangement, block designs, object assembly (right-sided lesioning),^{80,95,99} digit span, arithmetic and digit symbol tests, sentence learning, and vocabulary^{80,98,99} (left-sided lesioning). “Aphasia,”^{16,23,25,34,91,98,99} “anomia”^{12,23} “mutism,”¹⁶ modest decline in category fluency,⁷⁹ agraphia and alexia,¹² and subjective memory loss¹⁰⁹ can also be found. Laitinen^{62,63} described improved scores in the Stroop Color Word Test after unilateral pallidotomy but said nothing about results in the nine patients who underwent bilateral pallidotomy. Neuropsychological improvements after pallidotomy are also mentioned. Funfgeld³⁶ mentions “mental improvement;” Cooper, et al.,²³ describe “rebirth of interest for the outside world,” and a “change from pessimism to optimism and tranquility.” McFie⁸⁰ and Riklan and colleagues^{98,99} also mentioned improvement in scores

on tests such as picture arrangement (left-sided lesions) and sentence learning (right-sided lesions).

In most recent articles or abstracts^{35,43,60,75,79,85,111} there is no mention of neuropsychological side effects after unilateral pallidotomy. We report our early experience (1993–1994) performing functional stereotactic surgery in four patients who were chosen to undergo bilateral contemporaneous pallidotomy. Whereas most reports are focused on the improvements in motor scale scores, we focus on the side effects of this treatment.

Report of Cases

We studied four patients (Table 1) with severe long-lasting PD. These four presented with severe motor “on–off” fluctuations, mostly of the yo-yoing type (Stage III in “on” and IV in “off” according to the Hoehn and Yahr scale⁵⁴). No patient suffered from dementia, and all presented with invalidating fluctuations despite optimum treatment. All patients underwent the surgical procedure after informed consent was obtained. The operation was performed according to the technique described by Laitinen, et al.^{64,65} Bilateral contemporaneous neurosurgical procedures were performed. Patients were evaluated using the Core Assessment Program for Intracerebral Transplantations (CAPIT) protocol without positron emission tomography scanning,^{33,67} with the addition of a neuropsychological examination in which a standardized battery of tests was used (Table 2).^{30,38} In this battery, the patients’ scores are compared with those of a control group matched for age, gender, educational level, and first language of the local population, and the cutoff scores are fixed for performance below the sixth percentile rank or below two standard deviations from the mean. Additional scales were: the Blessed Dementia Scale A,⁸ the Hamilton Depression Rating Scale (HDRS),⁵⁰ behavioral syndromes scale for dementia,²⁷ Habib’s score for loss of psychic autoactivation (in retrospect only, because it was not available before 1995),⁴⁸ the Obsessive–Compulsive Disorder (OCD) Inventory,^{26,41} and clinical assessment of disorders of impulse control, anxiety, environment dependency, frontal disinhibition syndrome, mental or behavioral repetitive or automatic behaviors such as echo-, palli- and coprophobia, and executive dysfunctions.

Case 1

History. This 60-year-old man’s PD was categorized as Hoehn and Yahr Stage III/IV (on/off); he suffered severe on–off fluctuations of the yo-yoing type (grotesque choreoballic movements alternating with freezing). On preoperative neuropsychological examination, we found only mild dysarthric festinating speech; no formal speech, praxic, or gnosic deficits were present. The patient also showed moderate impairment in verbal memory as indicated by a below-normal score in retrieval from the Rey Auditory Verbal Learning Test (RAVLT); he also had below-normal scores for Raven’s Progressive Matrices. At 3 months after the operation, his Unified Parkinson’s Disease Rating Scale (UPDRS) global and motor off scores had improved by 50%; his ability to perform activities of daily living (ADL) had improved by 40%, with complete loss of dyskinesia and freezing; his levodopa requirement

TABLE 2
Main CAPIT scores showing time course of response and complications in four patients with medically intractable PD*

Score or Complication & Case No.	CAPIT Scores in On/Off States†					
	Preop	1 Mo	3 Mos	6 Mos	12 Mos	24 Mos
Hoehn & Yahr stage						
1	III/IV	III/III	III/III	III/III	III/III	III/III
2	III/IV	III/IV	III/IV	III/V	III/V	III/V
3	III/IV	III/IV	III/IV	III/IV	III/IV	III/IV
4	III/IV	III/III	III/III	ND	ND	ND
UPDRS total						
1	58/105	54/NA (7/51)	58/NA (0/55)	57/NA (2/55)	57/NA (2/55)	57/NA (2/54)
2	92/187	90/130 (2/31)	76/137 (18/27)	84/140 (19/26)	81/141 (12/25)	80/140 (14/26)
3	80/135	51/88 (37/35)	53/89 (34/35)	52/89 (35/35)	56/95 (30/30)	60/110 (25/19)
4	48/68	29/35 (40/49)	26/31 (46/55)	ND	ND	ND
UPDRS motor						
1	29/65	33/NA (–1.4/51)	36/NA (–24/45)	36/NA (–24/45)	36/NA (–24/45)	36/NA (–24/45)
2	45/112	45/72 (0/36)	43/78 (4/31)	42/81 (6/28)	39/81 (14/28)	36/79 (20/30)
3	44/80	26/49 (41/39)	27/51 (39/37)	26/53 (41/34)	25/54 (43/33)	26/54 (41/33)
4	22/32	11/15 (50/54)	11/15 (50/54)	ND	ND	ND
UPDRS ADL						
1	9/20	12/NA (40/0)	13/NA (35/0)	12/NA (40/0)	12/NA (40/0)	12/NA (40/0)
2	22/45	22/40 (0/12)	22/39 (0/14)	22/39 (0/14)	22/39 (0/14)	22/39 (0/14)
3	18/35	15/29 (17/18)	14/23 (23/35)	14/24 (23/32)	14/25 (23/29)	14/25 (23/29)
4	16/24	12/14 (25/42)	11/12 (32/50)	ND	ND	ND
UPDRS mental						
1	6/6	9/NA (–50/0)	9/NA (–50/0)	9/NA (–50/0)	9/NA (–50/0)	9/NA (–50/0)
2	6/11	10/10 (–66/10)	10/10 (–66/10)	10/10 (–66/10)	10/11 (–66/0)	10/11 (–66/0)
3	2/4	2/2 (0/50)	2/2 (0/50)	2/2 (0/50)	5/7 (–150/–75)	4/6 (–100/–50)
4	2/4	1/1 (50/75)	1/1 (50/75)	ND	ND	ND
complications						
1	14	0 (100)	0 (100)	0 (100)	0 (100)	0 (100)
2	19	13 (32)	10 (48)	10 (48)	10 (48)	12 (37)
3	16	8 (50)	9 (44)	10 (38)	12 (25)	12 (25)
4	8	5 (38)	3 (63)	ND	ND	ND
dyskinesia score						
1	4/0	0 (100)	0 (100)	0 (100)	0 (100)	0 (100)
2	4/0	1/0 (75)	1/0 (75)	1/0 (75)	2/0 (50)	3/0 (25)
3	4/0	1/0 (75)	1/0 (75)	1/0 (75)	—	—
4	3/0	2/0 (33)	1/0 (66)	ND	ND	ND
mean % of day in off state						
1	25	0 (100)	0 (100)	0 (100)	0 (100)	0 (100)
2	25	10 (60)	10 (60)	25 (0)	0 (100)	0 (100)
3	50	20 (60)	20 (60)	50 (0)	50 (0)	50 (0)
4	50	20 (60)	20 (60)	ND	ND	ND
mean levodopa dose (mg/day)						
1	725	725	187.5 (75)	187.5 (75)	187.5 (75)	187.5 (75)
2	1500	1500	1500	1500	1500	1500
3	1500	1500	1500	1500	1500	1500
4	725	725	500	ND	ND	ND

* Timed test not reported. Abbreviations: NA = not applicable: patient did not return to off state postoperatively; ND = not done: patient died after 3-month follow up; — = patient lost to follow up.

† Numbers in parentheses represent percentages of improvement in CAPIT scores.

had decreased fourfold. Results of his postoperative neuropsychological examination revealed a deficit in attention (as indicated by below-normal scores on digit span and Corsi's Block Design tests), increased dysarthria, palilalia, impaired naming on the Boston Naming Test (BNT), impairment in both encoding and retrieval in relation to verbal memory on the RAVLT, difficulty in programming the copy of the Rey's complex geometric figure, a severe deficit in executive functions (verbal fluency, Stroop, graphomotor, and gestural sequences), a major lack of spontaneity, constructional apraxia, and a deficient asso-

ciative judgment (Columbia University Scale); however, no deficits in memory or visual gnosias were found (Tables 3 and 4). Although this patient's outcome may be considered a success by the standards of the CAPIT examination, he was severely handicapped by major apraxia of eyelid opening, resulting in almost complete functional blindness, for which he attained only partial improvement after injections of botulinum toxin. He was also disabled by a corticobulbar syndrome that resulted in dysarthria, dysphagia, and hypophonia. His wife noted that his personality had changed: he had formerly managed a garage

TABLE 3
Results of additional tests in four patients with PD

Scale & Case No.	Preop	3 Mos
HDRS		
1	4	4
2	12	30
3	10	32
4	2	3
Leyton Obsessional Inventory (symptom score)		
1	0	0
2	5	15
3	4	4
4	0	0
Yale-Brown OCD Scale		
1	0	0
2	1	26
3	1	1
4	0	0
Habib's Scale		
1	3	96
2	9	9
3	0	0
4	12	12

employing more than 20 workers, but he completely lost interest in his business, slept most of the time, doing nothing unless prompted by his wife, and remained in a state of mental emptiness for most of the day. When we discovered Habib's scale in 1995 and assessed the patient accordingly, he scored the maximum number of points, and a retrospective completion of the family questionnaire clearly indicated that this was a postoperative effect. The main scores for all patients are reported in Tables 1 to 4.

Case 2

History. This 62-year-old woman's PD was categorized as Hoehn and Yahr Stages III/IV; she had on-off fluctuations of the yo-yoing type that were unresponsive to optimal medication. On preoperative neuropsychological testing, we found only mild slowing, but no deficit in verbal, memory, praxic, or gnosis scores, and no executive function impairment. After the posteroventral pallidotomy (PVP) was performed, there was an average improvement of 30% in the global and motor UPDRS off scores, as well as the ADL scores in the off state. Dyskinesia was markedly improved (from 4 to 1), but for 10% of the day the patient was still frozen in the off state. She entered into an immediate depressive state postoperatively. On neuropsychological testing performed at 3 months postoperatively, hypophonia and dysarthria were noted, with no formal language impairment. An executive function deficit was found, as assessed by below-normal scores in verbal fluency, Stroop, graphomotor and gestural sequences tests, and Raven's Progressive Matrices, but no deficits were found in attention, memory, praxic, or visual gnosis scores. The postoperative period was essentially marked by problematic off states, in which the patient had circular thoughts, believing that she did not have PD and that she did not need medication, which she threw away or hid. She also had ideas of suicide and demonstrated negativism and compulsive counting of objects. All these symptoms disappeared entirely when she returned to the on

state, without manic, euphoric, or hallucinatory episodes. This patient had a high score on the OCD Inventory during her off phases, and the benefit of the operation was essentially lost after 6 months.

Case 3

History. This 63-year-old woman's PD was categorized as Hoehn and Yahr Stages III/IV; she had on-off fluctuations of the yo-yoing type that were resistant to optimal medication. On preoperative neuropsychological testing, her language, attention, memory, praxic, gnosis, and executive functions were all within the normal range. After the PVP was performed, although the UPDRS global and motor off scores improved by 40%, dyskinesia was not lost completely, and disabling freezing (10%) was still occasionally observed during the day. Her postoperative phase was essentially marked by a depressive state with a high HDRS score. On neuropsychological examination performed 3 months postoperatively, no change was observed. No compulsive features or loss of psychic autoactivation was seen, but the patient was lost to follow up after 6 months.

Case 4

History. This 64-year-old man's PD was categorized as Hoehn and Yahr Stages III/IV; he had suffered for more than 20 years from familial levodopa-responsive PD with on-off fluctuations of the yo-yoing type. On preoperative neuropsychological examination we noted dysarthria, mild impairment in naming on the BNT, no apraxia, impaired fine visual organization (Hooper 14.5/20), an attention deficit on the digit span and Corsi's Block Design tests, normal memory scores, a mild executive function impairment (on verbal fluency and Stroop tests) and below-normal scores on Raven's Progressive Matrices. After the operation, the patient demonstrated a mean improvement of 40 to 50% in the UPDRS global and motor off scores, a progressive decrease in dyskinesia, and 60% improvement in on time. On neuropsychological examination conducted 3 months postoperatively, changes were only found in memory (severe impairment even on hidden objects). No change was seen in his personality or behavior, but unfortunately his follow-up review was very limited because he died 3 months postoperatively of a heart infarction.

Discussion

All four patients showed a clear motor improvement after PVP, as determined by a significant decrease in dyskinesia, UPDRS motor scores in on (0–50%) and off states (24–54%), ADL on (0–40%) and off scores (28–50%), and a mean increase of 60% in on time. This is consistent with our present understanding of motor circuitry in the basal ganglia^{1,2,42} and is probably the result of restoration of the thalamocortical activating feedback.

However, the nonmotor functions^{1–3,6,42,48,49,90,92,106,107,114} of the frontosubcortical circuitry are greatly underestimated in clinical practice, especially when the CAPIT protocol is used.⁶⁷ Despite good motor scores, one of our patients was severely impaired by postoperative pretarsal bleph-

TABLE 4

*Major neuropsychological data in four patients with medically intractable PD who underwent PVP**

Factor	Case 1		Case 2		Case 3		Case 4	
	Preop	Postop	Preop	Postop	Preop	Postop	Preop	Postop
language								
verbal fluency	10	<2	25	<2	<2	<2	<2	<2
BNT	10	<2	50	<2	<2	<2	10	90
praxias								
constructional	N	F	F	F	N	N	N	N
Rey's complex figure copy	10	<2	10	10	10	10	10	10
ideomotor	N	N	N	N	N	N	N	N
gnosias								
Poppelreuter	N	N	N	N	N	N	N	N
Columbia University Scale	N	N	N	N				N
Hooper	10	10	10	10	10	10	10	10
famous faces	N	N	N	N	N	N	N	N
memory								
digit span	10	<2	50	50	10	10	20	20
Corsi's Block Design	10	<2	50	50	20	20	50	50
RAVLT								
learning	10–50	<2	50	50	50	50	<6	F
recognition	10	10	20	50	20	20	70	50
delayed recall	<2	<2	70	50	70	50	>6	<6
Rey's complex figure copy								
immediate recall	10	10	10	10	10	10	10	10
delayed recall	10	30	30	30	20	20	20	20
executive functions								
Stroop Test	<2	<2	50	50	<2	<2	10	10
sequences								
graphomotor	N	F	N	F	F	F	F	F
gestural	N	F	N	F	F	F	F	F
Raven's PM 38	>2	>2	10	50	10	10	<2	<2

* Results are compared with those of age- and education-matched normal volunteers. The scores are reported in percentiles (for example, 10 = 10th percentile of the normal range). For the BNT, RAVLT, and Raven's Progressive Matrices, Assal's shortened version was used. Abbreviations: F = failed; N = normal; PM = Progressive Matrices.

arospasm (apraxia of eyelid opening), which we were the first to describe³⁷ and which interfered with his walking ability and gestures because of intermittent functional blindness. Moreover, he also presented with a major loss of psychic autoactivation and with a severe corticobulbar syndrome that was probably caused by a lesion located too medially so that it impinged on the corticobulbar tract.^{3,6,49,68–72} Such a clinical picture has been reported in association with bilateral pallidal lesions by Laplane and colleagues^{70,73} and Ali-Chérif, et al.,³ and is probably the result of disconnection in the pallidoprefrontal circuit.^{1,2} This also corresponds with a decrease in prefrontal fluorodeoxyglucose metabolism after pallidotomy²⁹ and mirrors assumptions in earlier reports in which states similar to leukotomy were described in some patients.^{80,86} In early reports the authors mention postoperative alterations: “drowsiness,”^{10,16} somnolence,^{16,86} and “obtunding,”¹⁶ but also “apathy,”^{10,37,52,86,101} “indifference,”⁸⁶ “aspontaneity,” “loss of initiative,” and “catatonia;”⁸⁷ “interference with the more immediate mobilization of mental energy required for learning and integration;”^{98,99} “psychic rigidity;”⁸² loss of critical faculties, appearance of autosuggestivity, and loss of distance perception;⁸⁷ and “slow ideation” or an “absent” patient.^{52,53} This clinical picture, which was part of a major postoperative change in our patients, has not been reported in recent papers, perhaps because it was not investigated systematically, in the ab-

sence of any validated scale to quantify this symptomatology. The only scale now available for the evaluation of this syndrome is the one described in 1995 by Habib,⁴⁸ the validation of which has not yet been reported in the English-language literature. Other scales should therefore be developed to assess this particular behavior arising after pallidotomy, as well as other behavioral, mood, and disorders deficits, and these scales should be systematically added to routine evaluations of patients undergoing functional neurosurgery for PD.

Our second patient experienced marked impairment postoperatively as determined by evaluation of OCD and depressive features in off states. Changes in mood and affects after pallidotomy have also been reported in the literature, and include depression,^{6,15,23,25,34,36,39,60–65,83,86,102,108} “slight changes in affectivity,”²³ “intellectual or emotional deterioration,”³⁹ but also “improvements in emotional reactions,”⁸⁰ improvement on the Beck Depression Inventory,⁷⁹ “decrease in self preoccupation,”²³ increased emotional reactivity,^{98,99} or “euphoria.”^{34,45,46,80,86} Obsessive-compulsive disorder has also been described in association with bilateral pallidal lesions,^{70–73} and positron emission tomography studies have shown an abnormal tracer signal in the basal ganglia in patients with OCDs, mostly indicating increased metabolism.⁹⁰ Quantitative testing and screening for OCD should also be included in global evaluations of these patients.

The occurrence of executive dysfunction that was not present in the preoperative neuropsychological examination has not been reported in recent abstracts,^{43,85} and sometimes marginal improvements in executive function have been found,^{38,43,85} but our findings are certainly compatible with a dysfunction in prefrontosubcortical circuits caused by bilateral pallidotomy and are generally well tested in most studies.

In our recent work, we have used unilateral lesioning of the pallidum combined with contralateral or bilateral pallidal stimulation^{38,39} and have obtained better results with fewer side effects for an equivalent or greater degree of improvement. In one patient who underwent a right-sided pallidotomy, we were able to produce a reversible depressive state and an acute reversible loss of psychic autoactivation with dysarthria when the left electrode was on, especially with high voltage, at levels of stimulation less than the ones that induce dyskinesias; when stimulation was turned off, a total reversal of these side effects was seen within a few minutes. Similarly, during intraoperative pallidal stimulation, apraxia of eyelid opening was reversibly induced in one patient, and abulia with apraxia of eyelid closure in another (when stimulating on the right side with the left electrode already in place); this was not seen again during the postoperative period when the stimulator was functioning.

Dysarthria and corticobulbar syndrome were seen in one of our patients, but visual field defects, facial asymmetry, or hemisyndromes^{13,60–65,108} were not found in any. In the latest largest series of bilateral pallidotomies published by Iacono, et al.,⁵⁵ which consisted of 68 cases, including 49 simultaneous and 19 staged bilateral pallidotomies, no complications such as hemianopsia, dysarthria, or hemiparesis were found, but these deficits were seen in unilateral PVP. There were two cases of bleeding and one abscess, with a total rate of complications of approximately 6 to 7%. No differences in complications were seen between simultaneous and staged bilateral PVP.

Because magnetic resonance images were obtained postoperatively, the location of lesions could be clearly seen in the posteroventral pallidum, and not more laterally, impinging on the putamen (which actually seems to be a safer location with less dysarthria). The lesions may have been slightly too medial in the first patient, involving the corticobulbar tracts. The lesions were of the recommended size (6–10 mm) or even smaller (Cases 2 and 3), and this could explain the progressive loss of benefit after 6 months in these two patients.

Conclusions

The use of pallidotomy, especially when bilateral and contemporaneous, may not only generate a high risk of acute postoperative corticobulbar syndrome, visual field defects, and various degrees of hemiparesis but also non-motor cognitive, mood, and behavioral deficits such as loss of psychic autoactivation, OCDs, postoperative depression, and supranuclear disorders of eyelid opening, which can be major problems and interfere with the otherwise good motor improvement. This procedure should no longer be performed because bilateral pallidal or subthalamic stimulation is now available and yields better or

similar results and far fewer side effects. Evaluation of the effects of pallidal lesions or stimulation should include currently available frontal tests, OCD assessment, and depression scales. A scale to assess loss of psychic autoactivation syndromes, as well as other mood and behavioral scales for frontosubcortical circuits, requires prompt development and validation. Further studies and larger numbers of patients will be needed to compare patients with delayed and bilateral contemporaneous PVP, unilateral PVP, and uni- or bilateral pallidal deep brain stimulation according to the new scales.

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