Long term outcome of unilateral pallidotomy: follow up of 15 patients for 3 years

P K Pal, A Samii, A Kishore, M Schulzer, E Mak, S Yardley, I M Turnbull, D B Calne

Abstract

Objectives—With the advent of new antiparkinsonian drug therapy and promising results from subthalamic and pallidal stimulation, this study evaluated the long term efficacy of unilateral pallidotomy, a technique which has gained popularity over the past decade for the management of advanced Parkinson’s disease.

Methods—The 15 patients reported here are part of the original cohort of 24 patients who underwent posteroventral pallidotomy for motor fluctuations and disabling dyskinesias 3 years ago as part of a prospective study. Evaluation scales included the unified Parkinson’s disease rating scale, the Goetz dyskinesia scale, and the Purdue pegboard test.

Results—When compared with the pre-pallidotomy scores, the reduction in the limb dyskinesias and off state tremor scores persisted on the side contralateral to pallidotomy at the end of 3 years (dyskinesias were reduced by 64% (p<0.01) and tremor by 63% (p<0.05). Other measures tended to deteriorate. The dosage of antiparkinsonian medications did not change significantly from 3 months pre-pallidotomy to 3 years post-pallidotomy.

Conclusions—Although unilateral pallidotomy is useful in controlling the contralateral dyskinesias and tremor 3 years after surgery, all other early benefits disappear and activities of daily living continue to worsen.

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Keywords: Parkinson’s disease; stereotactic pallidotomy; dyskinesia

In less than a decade after the reintroduction of posteroventral pallidotomy for the treatment of advanced Parkinson’s disease, the beneficial effects of this procedure have been reported world wide. The results of these studies are variable—with an impressive improvement in contralateral dyskinesias and somewhat less improvement in tremor, bradykinesia, and rigidity. Except for a few most of the studies have reported the short term (<2 years) outcomes of pallidotomy. With the emergence of new antiparkinsonian drugs, pallidal and subthalamic deep brain stimulation (DBS), and dopaminergic tissue transplants, it is appropriate to reappraise pallidotomy and examine carefully the long term outcome of this procedure.

Long term clinical evaluation of pallidal surgery results is difficult, as follow up examination often involves assessments by several neurologists, and the motor evaluation protocols used are subject to interobserver variations. Moreover, the number of patients available for follow up is often reduced, as they move away, become too disabled to travel to the clinic, or opt for newer treatments such as deep brain stimulation. Given these constraints, we present the results of the 3 year follow up on 15 of our original 24 patients who underwent pallidotomy.

Methods

SUBJECTS

The 15 patients (eight men, seven women) in the present report are part of the original cohort of 24 patients who were prospectively followed up after pallidotomy. Details of them have been described elsewhere. All patients had clinically definite Parkinson’s disease by our criteria and their suitability for pallidotomy was determined by a neurologist experienced in movement disorders (DBC) and a neurosurgeon (IMT) experienced in stereotactic surgery for Parkinson’s disease. Thirteen patients had motor fluctuations with disabling dyskinesias and two patients had severe tremor that had not responded to drug therapy. They were on stable antiparkinsonian medications for at least 3 months before surgery.

SURGICAL PROCEDURE

The details of the procedure have been described earlier. Pallidotomy was performed contralateral to the side with more severe dyskinesia, or if dyskinesia was not troublesome, contralateral to the more severe tremor. If the motor symptoms were symmetric, pallidotomy was done contralateral to the dominant hand. Before surgery, all antiparkinsonian medications were withheld for at least 12 hours so that the patient’s physical signs were not masked. We did not use intraoperative microelectrode recording and our method has been confirmed by others.

CLINICAL ASSESSMENT

The patients were assessed using the complete unified Parkinson’s disease rating scale (UPRDS) version 3.0, subset I (mental, behaviour, and mood), subset II (activities of daily living (ADL) in on and off states), subset III (motor performance in on and off states), subset IV (complications of therapy: A—dyskinesias, B—clinical fluctuations), and subset V (modified Hoehn and Yahr staging). The motor skills in both upper and lower limbs were scored using the Unified Parkinson’s Disease Rating Scale (UPDRS) version 3.0, subset I (mental, behaviour, and mood), subset II (activities of daily living (ADL) in on and off states), subset III (motor performance in on and off states), subset IV (complications of therapy: A—dyskinesias, B—clinical fluctuations), and subset V (modified Hoehn and Yahr staging).

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Hand separately (uPP) and then bilaterally with both hands simultaneously (bPP). Dyskinesias were scored during the on state using the rating scale developed by Goetz et al. Most, but not all motor evaluations (UPDRS, subset III) and dyskinesia ratings were recorded on videotape.

The definitions of off and on states were according to the CAPIT (Core Assessment Program For Intracerebral Transplantation). For all patients, and at each follow up, the off state motor evaluation was performed between 0800 and 0900 hours after at least 12 hours off all antiparkinsonian medications (18 hours for controlled release levodopa/carbidopa). The patients were then given their usual morning doses of antiparkinsonian medications (standard Sinemet was used in a dose that approximated to the controlled released preparation) and examined 1–2 hours later in the optimal on state.

Detailed records of all antiparkinsonian medications were kept throughout the 3 year period. For the analysis, doses of 100 mg levodopa in standard Sinemet were regarded as equivalent to 130 mg levodopa in controlled release Sinemet. The doses of pramipexole and ropinirole were expressed as equivalent doses of bromocriptine (1 mg pramipexole=10 mg bromocriptine, and 1 mg ropinirole=2 mg bromocriptine). The conversion factor for ropinirole is derived from the study by Korczyn et al and that for pramipexole was from our own experience.

All UPDRS evaluations and dyskinesia ratings were performed by three neurologists experienced in using these scales (AK, AS, and PKP). The assessments before and up to 1 year postsurgery were performed by examiner I (AK), up to 2 years by examiner II (AS), and at 3 years by examiner III (PKP). The PPBT assessments at all visits were conducted by the same nurse clinician (SY) who was experienced in conducting this test.

Samii et al were able to follow up 20 of the original 24 patients at 2 years and we could examine only 15 of these 20 patients at 3 years. The reasons for the drop out of the four patients at 2 years have already been described. The other five patients could not be examined for the following reasons: two patients opted for pallidal deep brain stimulation on the contralateral side of pallidotomy due to their persistent tremor/dyskinesia ipsilateral to the pallidotomy; and three patients moved to long term care facilities/places too far away for follow up. From anecdotal reports we think that the contralateral dyskinesias are unchanged since they were evaluated at 2 years. We compared these five patients with the 15 patients of the present study in terms of (1) the clinical characteristics, and (2) the degree of change in the mean scores of dyskinesias and contralateral off state tremor between pallidotomy and 2 years.

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Table 1 Comparison of the 15 patients of the present study (group I) with the five patients who dropped out 2 years postpallidotomy (group II)

<table>
<thead>
<tr>
<th></th>
<th>Group I (n=15)</th>
<th>Group II (n=5)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Age at surgery (y)</td>
<td>64.7 (7.4)</td>
<td>49.6 (12.0)</td>
</tr>
<tr>
<td>Horn and Yahr stage:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off state</td>
<td>3.2 (0.8)</td>
<td>3.3 (0.7)</td>
</tr>
<tr>
<td>On state</td>
<td>2.4 (0.5)</td>
<td>2.5 (0.5)</td>
</tr>
<tr>
<td>Duration of disease (y)</td>
<td>14.5 (9.0)</td>
<td>14.0 (2.7)</td>
</tr>
<tr>
<td>Duration of treatment (y)</td>
<td>11.9 (6.3)</td>
<td>13.4 (2.9)</td>
</tr>
<tr>
<td>Duration of fluctuations (y)</td>
<td>7.4 (5.1)</td>
<td>7.4 (2.5)</td>
</tr>
<tr>
<td>Duration of dyskinesias (y)</td>
<td>5.8 (4.6)</td>
<td>5.8 (5.7)</td>
</tr>
<tr>
<td>Dose of levodopa/carbidopa (mg)</td>
<td>1000 (395)</td>
<td>1340 (450)</td>
</tr>
<tr>
<td>Improvement in CL dyskinesia at 2 years (score)</td>
<td>2.6 (2.1)</td>
<td>2.7 (1.4)</td>
</tr>
<tr>
<td>Dose of dopamine agonist (mg)</td>
<td>26.0 (21.5)</td>
<td>36.0 (18.5)</td>
</tr>
<tr>
<td>Duration of fluctuations (y)</td>
<td>6.8 (4.6)</td>
<td>5.8 (5.7)</td>
</tr>
<tr>
<td>Duration of fluctuations (y)</td>
<td>7.4 (5.1)</td>
<td>7.4 (2.5)</td>
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<td>26.0 (21.5)</td>
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</tr>
</tbody>
</table>

CL=Contralateral; improvement=(mean score prepallidotomy)−(mean score at 2 years) (see text). Group I versus group II: p=0.032 for age at surgery; rest of the p values are not significant.

Table 2 Significant correlations in the scoring patterns of parkinsonian deficits among the three examiners

<table>
<thead>
<tr>
<th>Parkinsonian deficit</th>
<th>Examiners</th>
<th>r</th>
<th>p Value</th>
<th>Examiners</th>
<th>r</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off state CL bradykinesia</td>
<td>I vs I</td>
<td>0.681</td>
<td>0.015</td>
<td>I vs II</td>
<td>0.629</td>
<td>0.009</td>
</tr>
<tr>
<td>Off state IPS bradykinesia</td>
<td>I vs I</td>
<td>0.670</td>
<td>0.017</td>
<td>I vs II</td>
<td>0.786</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>On state CL bradykinesia</td>
<td>I vs I</td>
<td>0.612</td>
<td>0.034</td>
<td>I vs II</td>
<td>0.704</td>
<td>0.003</td>
</tr>
<tr>
<td>On state IPS bradykinesia</td>
<td>I vs I</td>
<td>0.723</td>
<td>0.008</td>
<td>I vs II</td>
<td>0.742</td>
<td>0.001</td>
</tr>
<tr>
<td>Off state CL resting tremor</td>
<td>I vs I</td>
<td>0.845</td>
<td>&lt;0.001</td>
<td>I vs II</td>
<td>0.553</td>
<td>0.033</td>
</tr>
<tr>
<td>Off state IPS resting tremor</td>
<td>I vs I</td>
<td>0.898</td>
<td>&lt;0.001</td>
<td>I vs II</td>
<td>0.944</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Off state gait</td>
<td>I vs I</td>
<td>0.821</td>
<td>0.001</td>
<td>I vs II</td>
<td>0.808</td>
<td>&lt;0.001</td>
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<tr>
<td>Off state posture</td>
<td>I vs I</td>
<td>0.739</td>
<td>0.006</td>
<td>I vs II</td>
<td>0.583</td>
<td>0.018</td>
</tr>
<tr>
<td>Off state postural stability</td>
<td>I vs I</td>
<td>0.843</td>
<td>&lt;0.001</td>
<td>I vs II</td>
<td>0.895</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CL dyskinesia</td>
<td>I vs I</td>
<td>0.777</td>
<td>0.003</td>
<td>I vs II</td>
<td>0.652</td>
<td>0.006</td>
</tr>
<tr>
<td>IPS dyskinesia</td>
<td>I vs I</td>
<td>0.706</td>
<td>0.010</td>
<td>I vs II</td>
<td>0.675</td>
<td>0.004</td>
</tr>
<tr>
<td>Axial dyskinesia</td>
<td>I vs I</td>
<td>0.841</td>
<td>&lt;0.001</td>
<td>I vs II</td>
<td>0.866</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total dyskinesia</td>
<td>I vs I</td>
<td>0.665</td>
<td>0.018</td>
<td>I vs II</td>
<td>0.826</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Off state modified Hoehn and Yahr stage</td>
<td>I vs I</td>
<td>0.739</td>
<td>0.006</td>
<td>I vs II</td>
<td>0.693</td>
<td>0.003</td>
</tr>
</tbody>
</table>

r=Correlation coefficient; CL=contralateral; IPS=ipsilateral.

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Figure 1 Off and on state contralateral and ipsilateral limb bradykinesia. Error bars indicate 1 SEM. Significant p values after adjustment for multiple comparisons. Contralateral off state—2 v 3 years: p=0.015. Ipsilateral off state— prepallidotomy v 3 years: p=0.001; 2 v 3 years: p=0.001. Ipsilateral on state— prepallidotomy v 3 years: p=0.026.
Table 3 Changes in the UPDRS motor scores and dyskinesia scores

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% of Prepal scores at</th>
<th>p Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 y</td>
<td>3 y</td>
</tr>
<tr>
<td>Dyskinesias (on):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CL</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>IPS</td>
<td>88</td>
<td>99</td>
</tr>
<tr>
<td>AX</td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>TOT</td>
<td>61</td>
<td>78</td>
</tr>
<tr>
<td>Resting tremor (off):</td>
<td></td>
<td></td>
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<tr>
<td>CL</td>
<td>13</td>
<td>38</td>
</tr>
<tr>
<td>IPS</td>
<td>69</td>
<td>109</td>
</tr>
<tr>
<td>Limb brady (off):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CL</td>
<td>91</td>
<td>117</td>
</tr>
<tr>
<td>IPS</td>
<td>105</td>
<td>144</td>
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<tr>
<td>Limb brady (on):</td>
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<td></td>
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<tr>
<td>CL</td>
<td>98</td>
<td>113</td>
</tr>
<tr>
<td>IPS</td>
<td>115</td>
<td>140</td>
</tr>
<tr>
<td>Modified Hoehn and Yahr stage</td>
<td>108</td>
<td>120</td>
</tr>
</tbody>
</table>

Prepal=Prepalidotomy; CL=contralateral; IPS=ipsilateral; AX=axial; TOT=total; brady=bradykinesia. Increases in percentage imply worsening.
p Values apply to the mean values of measurements, and are adjusted for multiple comparisons (see Methods).

Figure 2 Scores of off state tremor, gait, posture, postural stability, and modified Hoehn and Yahr stage. Error bars indicate 1 SEM. Significant p values after adjustment for multiple comparisons. Contralateral tremor—prepalidotomy v 2 years: p=0.003 (improved); prepallidotomy v 3 years: p=0.019 (improved). Gait—prepalidotomy v 2 years: p=0.004 (worsened); prepallidotomy v 3 years: p=0.005 (worsened). Posture—prepalidotomy v 3 years: p=0.016 (worsened); 2 v 3 years: p=0.013 (worsened).

STATISTICAL ANALYSIS

Because the sequential examinations of our patients involved three neurologists, we had to adjust for interrater differences in motor scoring among the examiners. To combine data from different time points, we compared the scoring patterns among the examiners on all the 15 patients, using videotape recordings from the prepalidotomy assessment (recorded by examiner I) and 2 year assessments (recorded by examiner II). Examiner III reviewed these videotaped assessments, blinded to the scores assigned by examiners I and II, and provided motor scores using the UPDRS subset III (except for rigidity, which cannot be assessed from videotapes), UPDRS subset V (modified Hoehn and Yahr staging) and dyskinesia ratings. Examiner III also assigned scores on videotapes available for only seven of the 15 patients assessed by examiner I at the 6 month follow up.

Using paired t tests and correlation analyses, the scores provided by examiner III (from videotape findings) were compared with the scores originally provided by examiners I and II (from direct observations). To allow for a consistent analysis of the evolution of the patients’ scores over the follow up time, we limited the heterogeneity in the data at different time points due to interexaminer variability by two methods. One approach analysed the original measurements at each time point as they were recorded by the corresponding examiner, provided that the paired t test at that point indicated no significant difference between the scores taken by that examiner and those assessed from the corresponding videotapes by examiner III. In the other approach, we imputed the missing scores for examiner III at prepalidotomy, 6 months, and 2 years, from the corresponding regression equations relating examiner III’s scores to those originally recorded at that time by observer I or II, provided that a significant correlation was noted between these two sets of measurements (p<0.05). There was a poor correlation for most of the scores at the 6 month level, possibly as a result of the small number (seven of 15) of videotapes available for scoring at this time point. Therefore we did not use the evaluation data at 6 months for the analysis. We used the imputed values for examiner III for the UPDRS motor scores (subset III), UPDRS subset V, and dyskinesia scores at times 0 (prepalidotomy) and 2 years, and the observed values of examiner III at 3 years.

The scores for ADL and complications of therapy depend predominantly on answers to standard questions provided by the patients, and PPBT was performed by one examiner throughout the study. Therefore, interobserver adjustments by correlation analyses were not needed for these measures.

Repeated measures analyses of variance were performed on examiner III’s scores in combination with the earlier scores taken by examiners I and II (when applicable), as well as in combination with examiner III’s imputed scores on previous occasions. These analyses were carried out on UPDRS motor scores, modified Hoehn and Yahr stage, and dyskinesia scores, at prepalidotomy, and at 2 and 3 years postpalidotomy, and for medication dosages, PPBT scores and ADL scores at 6 months, 2 and 3 years postpalidotomy. Multiple contrasts were used to compare the prepalidotomy scores with postpalidotomy scores, as well as analyses among postpalidotomy scores at different time points. Bonferroni’s corrections were used to adjust for the multiple comparisons. For all statistical analyses, a p value<0.05 was considered to be significant.

Mann-Whitney tests were applied to compare the clinical characteristics, and the degree of changes in dyskinesias and contralateral off state tremor at 2 years, between the five patients who dropped out and the 15 patients of this study.
Results

Table 1 summarises the clinical characteristics of the 15 patients of this study and of those five patients who dropped out of the study between 2 and 3 years. Except that the patients in the drop out group were significantly younger than the other group (p=0.032), the other characteristics at prepallidotomy, and the improvement in contralateral dyskinesias and off state contralateral tremor at 2 years (compared with prepallidotomy) were not significant (table 1).

There was a good correlation between the video based scores assigned by examiner III and the directly observed scores assigned by examiner I in the prepallidotomy assessments and by examiner II at the 2 year assessments. Paired t tests were generally not significant whenever a significant correlation was found between the video based scores assigned by examiner III and the directly observed scores assigned by examiners I or II. This applied to the following measurements: ipsilateral (to pallidotomy) and contralateral limb bradykinesia in both off and on states; ipsilateral and contralateral resting tremor in the off state; posture, gait, and stability in the off state; off state modified Hoehn and Yahr stage; and the scoring of dyskinesias (contralateral, ipsilateral, axial, and total) (table 2).

The other components of the UPDRS motor examination and on state modified Hoehn and Yahr staging lacked good correlation and therefore were excluded from analyses. We report here the results of the correlational analyses. Analyses based on the combined measures showed analogous results.

UPDRS MOTOR SCORES

Bradykinesia

On the side contralateral to pallidotomy, there were no significant changes in the on state scores from baseline to those found at 2 and 3 years, whereas in the off state, there was a worsening at 3 years compared with 2 years (fig 4, table 2). The ipsilateral bradykinesia had worsened at 3 years, and was more noticeable in the off state (prepallidotomy v 3 years and 2 years v 3 years: p<0.001, adjusted for multiple comparisons). The ipsilateral on state bradykinesia had worsened at 3 years (p=0.026) compared with the prepallidotomy level.

Off state tremor

The initial improvement in contralateral off state tremor after pallidotomy11 was maintained at 2 and 3 years (fig 2). Though there was a trend towards an increase in the severity of tremor at 3 years (an increase of 185% compared with the 2 year level), this was not significant and was still 38% of the prepallidotomy level. The ipsilateral off state tremor however had worsened by 35% at 3 years compared with that found at 2 years, and was slightly worse than at prepallidotomy (109%), although these differences were not significant (table 3).

Posture, postural stability, and gait

There was worsening of gait (29%), posture (53%), and postural stability (39%) at 3 years compared with prepallidotomy, but this was only statistically significant for gait (p=0.005) and posture (p=0.016, fig 2).

DYSKINESIA

On the side contralateral to pallidotomy, the improvement in dyskinesia was preserved, with a reduction by 84% at 2 years (p=0.001) and 64% at 3 years (p=0.003) over the prepallidotomy scores (fig 3, table 3). Although there was a 126% increase in dyskinesia at 3 years compared with the scores at 2 years, this difference was not significant. There was no worsening of ipsilateral, axial, or total dyskinesias at 3 years—the scores were still lower than prepallidotomy but higher than at 2 years (differences were not significant).

ACTIVITIES OF DAILY LIVING

The activities of daily living are illustrated in fig 4 and table 4.)
The initial improvement of off state ADLs documented by Kishore et al. was also obvious in the 15 patients at 6 months, even after adjustment for multiple comparisons (33% improvement over prepallidotomy; p=0.014). The off state total ADL scores at 2 years (109%) and 3 years (123%) were not significantly different from the prepallidotomy scores. However, when compared with the scores at 6 months postpallidotomy, there was significant deterioration, both at 2 years (162%; p<0.001) and 3 years (182%; p<0.001), even after adjustment for multiple comparisons.

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On state

Although there was a 42.8% improvement in the on state ADL at 6 months compared with the prepallidotomy scores, this was not statistically significant. There was a progressive worsening of the scores at 2 and 3 years postpallidotomy. At 2 years the ADL scores were 170% of the prepallidotomy scores (p=0.01) and 269% of the 6 month scores (p<0.001) and at 3 years the ADL scores were 194% of the prepallidotomy scores (p=0.019) and 339% of the 6 month scores (p<0.001). Neither the off nor the on state ADL scores differed significantly at 2 and 3 year examinations.

ADL improvement index (ADLII)

This was calculated as improvement in the ADL in the on state over off state after administration of antiparkinson medications, expressed as a fraction of the off state score. There was a non-significant improvement at 6 months, followed by a significant deterioration at 2 and 3 years compared with the scores prepallidotomy and 6 months postpallidotomy.

OTHER UPDRS SCORES

Complications of treatment

The complications of treatment are illustrated in fig 5 and table 4.

There was no significant change in motor fluctuations between prepallidotomy and the postpallidotomy examinations. The severity of dyskinesias, as rated by patients, improved to 23% of the prepallidotomy score (p=0.002) at 6 months. Thereafter the scores worsened to 92% of prepallidotomy score (NS) and 402% of the 6 month score (p=0.008) at 2 years and to 100% of the prepallidotomy score (NS) and 436% of the 6 month score (p=0.005) at 3 years.

Mental, behaviour, and mood changes

The initial 57% improvement in these scores at 6 months was not significant after multiple comparisons (table 4). At 3 years, the scores had worsened to almost four times those derived at 6 months (p=0.009).

Modified Hoehn and Yahr stage

Although there was a trend towards worsening of Hoehn and Yahr scores scores both at 2 and 3 years, these changes were not significant (fig 2, table 3).

Purdue pegboard

The off and on state uPP scores contralateral to the pallidotomy improved significantly at 6 months compared with the prepallidotomy scores (p=0.005 for off state and p=0.004 for on state, adjusted for multiple comparisons). There was worsening of contralateral and ipsilateral uPP and bPP, both in off and on states at 3 years compared with the scores at 6 months as well as 2 years (fig 6, table 5).

Drug treatment

All patients were taking levodopa/carbidopa (controlled release, standard, or a combination). At 3 years, 11 patients were on dopamine

![Figure 5](https://www.jnnp.com/)

**Figure 5** Scores of off and on state Purdue pegboard test (PPb). Error bars indicate 1 SEM. Significant p values are given in table 5.
agonists—eight on bromocriptine, two on ropinirole, and one on pramipexole. Thirteen patients were originally on bromocriptine—in one patient it was discontinued 1 year postpallidotomy, and in another patient 2 years postpallidotomy. One patient who was originally on bromocriptine switched to ropinirole a few weeks before the 2 year evaluation, and another patient who was not originally taking a dopamine agonist began taking ropinirole a few weeks before the 2 year evaluation. Another patient who was on bromocriptine at the time of pallidotomy, switched to pramipexole 30 months later. Overall, there were no significant changes in the dosages of antiparkinsonian medications from 3 months pre pallidotomy to 3 years postpallidotomy (fig 7).

**Discussion**

Various degrees of improvement in bradykinesia, tremor, speech, gait, mental performance, and levodopa induced dyskinesias have been reported in short follow up studies of pallidotomy.1 3 4 7–15 19 21–24 We13 previously reported that the benefits derived from this surgery using radiological localisation and electrical stimulation in the original cohort of 24 patients were similar to the results reported with pallidotomy using MRI and cellular recording for target localisation.2 4 16–18 Recently Dewey et al19 have reported a favourable outcome in patients who had pallidotomy using methodology similar to ours. Moreover, our patients had fewer complications, probably due to shorter operative time, than those reported in pallidotomy using cellular recording for target localisation.2 8

Our results confirm the sustained benefit of contralateral dyskinesias and off state tremor, reported previously by Lang et al13 in 11 patients followed up for 2 years. In the latter study, the improvements in the off state contralateral bradykinesia, rigidity, and ADLs were also sustained at 2 years and almost similar conclusions were reached by Fazzini et al in their study reporting 3 year follow up in 10 patients and 4 year follow up in five patients. We were unable to document any of these beneficial effects in our patients at their 2 year follow up and there was a further deterioration in these scores at 3 years. The worsening of ADL can be partly attributed to the disease progression and also to the worsening/reappearance of dyskinesias (especially on the ipsilateral side). From the patients’ standpoint, the persistent improvement in contralateral dyskinesia was insufficient to compensate for the deterioration in axial and ipsilateral dyskinesia and this was reflected in the worsening of the subjective dyskinesia scores to the same levels as before surgery.

From our current understanding of the natural history of Parkinson’s disease, patients require regular increases in the dose of dopaminomimetic drugs unless they undergo interventions which arrest the progression or change the natural history of the disease—treatments not yet available. In our patients the mean dose of dopaminomimetic drugs remained unchanged from 3 months pre pallidotomy up to the end of 3 years. Similar observations have been made in other studies.3 13 However, we think that this finding is not robust enough to conclude that effectiveness of the antiparkinsonian drugs is maintained at the same dosage or that this is a long term positive
Long term outcome of unilateral pallidotomy: follow up of 15 patients for 3 years

343

scoring using the scale provided by Goetz 

good interrater correlation in the dyskinesia 

less influenced by interrater variability. The 

long term follow up of patients, as they will be 

validates our previous finding.20

The overall reliability of UPDRS is 

adequate.35 39–41 Richards 

The overall reliability of UPDRS is 

validating our previous finding.20

The overall reliability of UPDRS is 

good to excellent agreement for speeded repeated movements, resting tremor, arising from a 

chair, and gait, and moderate agreement for 

rigidity, posture, postural stability, and brady- 

kinesia. However, this study did not specify 

whether the UPDRS examination was per- 

formed in the off or on state. As we used video 
tapes from prior examinations to compare the 
score of the three examiners, we had to 
eliminate the assessment of rigidity from the 

analysis. We found good correlation in most 
categories of motor scoring with the exception 
of on state tremor, gait, posture, and stability, 

which we therefore eliminated from the analy- 
sis. The lack of agreement between the observ- 
ers in most of the on state items compared with 

off state items is probably related to reduced 

accuracy in scoring when the patients are in the 
on state and signs are less prominent (even 

more difficult on video assessments). We there- 
fore think that the off state UPDRS motor 
scores should be given more weight than the on 

state scores in follow up of long term studies with 
multiple evaluators. The conclusions drawn 
from the UPDRS scoring of limb bradykinesia were similar to those obtained from the performance on PPB, which is an objective method of measuring bradykinesia and has a good correlation with striatal fluoro- 
dopa uptake on PET.14 Therefore, PPB or 
similar objective tests are more desirable in 

the long term follow up of patients, as they will be 

less influenced by interrater variability. The 
good interrater correlation in the dyskinesia 
scored using the scale provided by Goetz et al. 

validates our previous finding.20

It may be argued that the five patients who 
dropped out of the study between 2 and 3 years 
had a less favourable outcome of pallidotomy. 

We tried to account for their drop out and 
showed that these five patients maintained 

improvement in the contralateral dyskinesias and 
off state tremor to a similar degree as the 

others at 2 years and their clinical status at pre- 
pallidotomy was not different from that of oth- 

ers.

In summary, we have shown that the early 

beneficial effects of unilateral pallidotomy on 

cntrolateral dyskinesias and tremor persist at 

the end of 3 years, whereas all other symptoms 

progress. Moreover, there is a trend towards a 

worsening of dyskinesias on both the sides, and 

the patients perceive that their dyskinesias have 

worsened. Although the dosages of antiparkin- 

sonian drugs remained unchanged, this may be 

a result of caution on the part of both the 

patient and physician to prevent worsening of 

ipsilateral dyskinesias, rather than a beneficial 
effect of pallidotomy. The degree of improve- 
ment of ADL with drugs also reduced over 
time. We think that disabling dyskinesias 

remain the only indication of a long term ben- 

efit from pallidotomy.

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