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### ► To cite this version:

Mylène Honorat Meyer, Sébastien Montel, Sophie Colnat-Coulbois, Jérôme Lerond, Jevita Potheegadoo, et al. Neurosurgery in Parkinson's disease: Social adjustment, quality of life and coping strategies\*. *Neural Regeneration Research*, 2013, 8 (30), pp.2856 - 2867. 10.3969/j.issn.1673-5374.2013.30.008 . hal-01794143

**HAL Id: hal-01794143**

**<https://hal.univ-lorraine.fr/hal-01794143>**

Submitted on 17 May 2018

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doi:10.3969/j.issn.1673-5374.2013.30.008 [http://www.nrronline.org; http://www.sjzsyj.org]

Meyer M, Montel S, Colnat-Coulbois S, Lerond J, Potheegadoo J, Vidailhet P, Gospodaru N, Vespignani H, Barroche G, Spitz E, Schwan R. Neurosurgery in Parkinson's disease: social adjustment, quality of life and coping strategies. *Neural Regen Res.* 2013;8(30):2856-2867.

## Neurosurgery in Parkinson's disease: Social adjustment, quality of life and coping strategies\*

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### Research Highlights

(1) Subthalamic nucleus deep brain stimulation can significantly improve the motor features of the Parkinson's disease in carefully selected patients. However, effects of subthalamic nucleus deep brain stimulation on the social adjustment, coping strategies and mental health-related quality of life of these patients remain unclear.

(2) Some French scholars studied the social maladjustment in Parkinson's disease patients following subthalamic nucleus deep brain stimulation.

(3) The preoperative expectations of Parkinson's disease patients who received subthalamic nucleus deep brain stimulation should be carefully considered because postoperative social maladjustment is often observed in a few patients. Therefore, effective strategies are searched to avoid the disappointments from these patients and their relatives and improve patients' quality of life.

### Abstract

Subthalamic nucleus deep brain stimulation has become a standard neurosurgical therapy for advanced Parkinson's disease. Subthalamic nucleus deep brain stimulation can dramatically improve the motor symptoms of carefully selected patients with this disease. Surprisingly, some specific dimensions of quality of life, "psychological" aspects and social adjustment do not always improve, and they could sometimes be even worse. Patients and their families should fully understand that subthalamic nucleus deep brain stimulation can alter the motor status and time is needed to readapt to their new postoperative state and lifestyles. This paper reviews the literatures regarding effects of bilateral subthalamic nucleus deep brain stimulation on social adjustment, quality of life and coping strategies in patients with Parkinson's disease. The findings may help to understand the psychosocial maladjustment and poor improvement in quality of life in some Parkinson's disease patients.

### Key Words

neural regeneration; Parkinson's disease; subthalamic nucleus; deep brain stimulation; quality of life; coping; social adjustment; reviews; neurodegenerative diseases

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Received: 2013-04-15

Accepted: 2013-05-18

(N20121024005)

**Acknowledgments:** We would like to thank Schüpbach M, Department of Neurology, Pitié-Salpêtrière Hospital, Paris, France, for his precious comments.

**Author contributions:** Meyer M designed this study, participated in data collection and interpretation, and wrote the manuscript. Montel S, Schwan R and Spitz E co-contributed to study conception and were responsible for the critical revision of the manuscript. Colnat-Coulbois S, Barroche G, Vespignani H, Vidailhet P, Gospodaru N, Lerond J, and Potheegadoo J provided critical revision of the manuscript for intellectual content. All authors approved the final version of the paper.

**Conflicts of interest:** None declared.

**Author statements:** The manuscript is original, has not been submitted to or is not under consideration by another publication, has not been previously published in any language or any form, including electronic, and contains no disclosure of confidential information or authorship/patent application disputations.

## INTRODUCTION

Parkinson's disease is a neurodegenerative disease associated with motor symptoms, *i.e.*, tremor, rigidity and bradykinesia, and non-motor features including cognitive and neuropsychiatric disorders such as mood, anxiety and apathy. Parkinson's disease patients are generally treated with levodopa or other dopamine agonists, although for the past 15 years, deep brain stimulation has become the gold standard in advanced forms of the disease<sup>[1-3]</sup>. Indeed, bilateral subthalamic nucleus deep brain stimulation has emerged as a treatment of choice and proven to have an undisputed effect on motor symptoms, allowing reduction of drug treatment and its side effects<sup>[1]</sup>. Abundant evidence has demonstrated the efficacy of neurosurgery, specifically on motor symptoms and on health related quality of life<sup>[1, 3]</sup>.

However, an important concern has been that most studies have reported no improvement in social adaptation after subthalamic nucleus deep brain stimulation in some Parkinson's disease patients<sup>[4-7]</sup>. Furthermore, the lack of postoperative improvement in the psychosocial dimension of health-related quality of life and its link to coping strategies is still unclear.

We propose herein the first review on social adjustment, coping and health-related quality of life in patients with Parkinson's disease after subthalamic nucleus deep brain stimulation. Indeed, given the relatively recent interest for this issue in neurostimulated Parkinson's disease patients, only a handful of publications are currently available. Although neurosurgical targets have been explored in Parkinson's disease, the present review will intentionally focus on subthalamic nucleus deep brain stimulation.

## HEALTH RELATED QUALITY OF LIFE AND SUBTHALAMIC NUCLEUS DEEP BRAIN STIMULATION

According to Martínez-Martín<sup>[8]</sup>, health-related

quality of life in Parkinson's disease refers to the patients' perceptions and their own evaluation of the impact and consequences of the disease in their life. Thus, the evaluation of health-related quality of life is subjective, individual, multi-dimensional, self-administered and varies over time. With regard to subthalamic nucleus deep brain stimulation for Parkinson's disease, various scales are used to measure health-related quality of life. Currently, the most popular scale is the 39-item Parkinson's disease Questionnaire (PDQ-39)<sup>[9-10]</sup>, a specific scale, or its initial version, the Parkinson's disease Questionnaire (PDQL)<sup>[11]</sup>. These scales offer not only the advantage of being adapted to Parkinson's disease, but also of separating "physical" and "mental" health-related quality of life. They are also sensitive to the changes induced by the progression of the disease, or by a change in treatment dose or drug entity<sup>[10]</sup>. However, generic scales are also highly used to explore health related quality of life in Parkinson's disease, notably the Sickness Impact Profile (SIP)<sup>[12]</sup>, the 36-item Short-Form Health Survey (SF-36)<sup>[13]</sup>, and the Nottingham Health Profile (NHP)<sup>[14]</sup>.

There are abundant literatures on the changes in health-related quality of life after subthalamic nucleus deep brain stimulation. The most relevant data indicate that after neurosurgery, general health-related quality of life is clearly improved in advanced Parkinson's disease, with motor complications related to side effects of the treatments<sup>[15-19]</sup>. Generally, improvements in health-related quality of life measured by PDQ-39 are discernible at 6 months<sup>[3, 15, 20]</sup> and 12 months<sup>[16, 18]</sup> respectively after deep brain stimulation. At these follow-up times, evaluation of health-related quality of life can be considered equivalent to health-related quality of life measured in the least affected patients. According to Drapier *et al*<sup>[21]</sup>, postoperative health-related quality of life is equivalent to health-related quality of life measured in Parkinson's disease patients with a clinical history of less than 5 years, with mild symptoms and effective treatments.

Table 1 Health-related quality of life and coping strategies after bilateral subthalamic deep brain stimulation (DBS) in Parkinson's disease (PD) patients

Study	Design	Subjects	Age (year)	Duration of disease (year)	Follow-up (month)	Measures	Results
Benabid <i>et al</i> (2009) <sup>[1]</sup>	Review article	—	—	—	—	PDQ-39 summary index; PDQ-39 subscales; SF-36	Improvements in the PDQ-39 summary index (mean 24%) and some PDQ-39 subscales (24 to 38%: mobility, activities of daily living, emotional well-being, stigma, bodily discomfort). Some subscores are less or not improved postoperatively (social support, communications, cognition). Improvements in the physical summary score of the SF-36 (22%)
Castelli <i>et al</i> (2008) <sup>[24]</sup>	Prospective study	25 PD patients undergoing bilateral subthalamic DBS (DBS group) <i>versus</i> 25 PD patients not undergoing neurosurgery (control group)	63.4±5.8 for the DBS group; 63.5±5.5 for the control group	18.6±4.9 for DBS group; 16.9±4.0 for the control group	Pre and 36 months post	BDI; STAI; SCIDII	Postoperative follow-up showed that bilateral subthalamic nucleus DBS, compared with non-stimulated PD patients, did not induce major changes in mood, anxiety and personality in neurostimulated patients.
Deuschl <i>et al</i> (2006) <sup>[15]</sup>	Prospective study	Paircomparison of 78 advanced PD neurostimulated patients <i>versus</i> 78 advanced PD non-stimulated patients	60.5±7.4 for the DBS group; 60.8±7.8 for the non-stimulated group	—	Pre and 6 months post	PDQ-39; UPDRS	Neurostimulation induced a greater improvement in the PDQ-39 summary index (+ 9.5 points) and in the UPDRS-III (+ 19.6 points) compared with drug treatment alone, in most patients. Some subscales of the PDQ-39 were improved from 24 to 38% (mobility, activities of daily living, emotional well-being, stigma, bodily discomfort)
Drapier <i>et al</i> (2005) <sup>[21]</sup>	Prospective study	27 PD patients undergoing bilateral subthalamic nucleus DBS	60.8± 9.3	14.6±4.6	Pre and 12 months post	PDQ-39; SF-36	Postoperative improvements in the PDQ-39 summary index (21.1%) and in some subscores (mobility, activities of daily living, stigma, bodily discomfort). Some subscales presented no changes (emotional well-being, social support, cognition) but subscale "communications" decreased. Only the physical dimensions of the SF-36 improved. It seems that only the physical dimension of quality of life improves after neurosurgery, whereas mental aspects remain stable or worsen
Erola <i>et al</i> (2005) <sup>[16]</sup>	Prospective study	27 advanced PD patients undergoing bilateral subthalamic nucleus DBS	—	—	Pre and 1 and 12 months post	PDQ-39; Finnish version of NHP; UPDRS	PDQ-39 summary index and some subscales improved (emotional well-being, activities of daily living, stigma, bodily discomfort). The subscale "mobility" improved but was not significant, and the subscale "communications" worsened. Also, younger PD patients improved more in activity of daily life than older ones. There was a correlation between PDQ-39 summary index and the UPDRS total score, but no correlation between NHP and UPDRS. NHP shows improvement in dimensions measuring problems of energy, sleep, emotional reaction, social isolation

Table 1 Continued

Study	Design	Subjects	Age (year)	Duration of disease (year)	Follow-up (month)	Measures	Results
Kleine-Fischn <i>et al</i> (2006) <sup>[22]</sup>	Cross-sectional study	—	Age at surgery 58.6±2.4	14.1±1.6	—	PDQ-39	Improvements in nearly all studies in the PDQ-39 summary index (34.5% ±15.3%). Improvements in some dimensions (stigma, emotional well-being, bodily discomfort, mobility, daily living activities) whereas some others showed a modest benefit (social support, communication, cognition)
Martinez-Martin <i>et al</i> (2002) <sup>[19]</sup>	Prospective study	17 advanced PD patients undergoing subthalamic nucleus DBS	60.9 ± 7.7	16.4±8.5	Pre and 6 months post	PDQ-39;HAD; UPDRS; Schwab and England scale	Improvements in the PDQ-39 summary index and in some dimensions (mobility, daily living activities, stigma, emotional well-being, bodily discomfort). The dimensions of social support, cognition and communication did not improve post. Anxiety (pre 7.93±3.90, post 3.93±4.31) and depression (pre 7.93±4.18, post 3.56±4.42) evaluated with HAD decreased significantly. UPDRS scores in section 1 (pre 2.7±2.25, post 1.11±1.45), 2 (pre 29.53±11.20, post 8.29±5.65), 3 (pre 55.7±14, post 20.76±10.5) decreased significantly in off state/on stimulation. Schwab and England score increased post (pre 31.76±11.85, post 81.76±10.14)
Montel & Bungener (2008) <sup>[32]</sup>	Cross-sectional study	135 PD patients: 45 preoperative patients, 45 postoperative patients, 45 non-stimulated patients	58.7±9.3	—	—	UPDRS; Hoehn & Yahr, MINI; MADRS; CHIP; WCC;	Patients awaiting surgery used more scale strategies than patients not undergoing subthalamic nucleus DBS ones. Patients not enduring neurosurgery used more emotional coping strategies than the others. The mean Hoeh and Yahr stage was 1.5±0.7 in on stage and 2.3±0.9 in off stage. UPDRS scores were different for each group in on stage (awaiting surgery 10.6±4.7; stimulated ones 6.7±5.7; not considered for surgery 18.2±10.3). Higher depression was measured in the medicated patients with MADRS (9.2±4.4) compared to stimulated patients (5.7±4.4) or pre-stimulated ones (5.6±3.6)
Montel and Bungener (2009) <sup>[23]</sup>	Cross-sectional study	40 neuro-stimulated patients (subthalamic nucleus DBS) and 40 PD disease patients under drug treatment	56±9.2 for the stimulated group and 55.8±9.3 for the drug-treatment group	11.9±5 for the stimulated group and 11±4.4 for the drug-treatment group	12 months post	MINI; MADRS; EHD; HAMA; FAB; WCC; CHIP; PDQ-39	Patients under drug therapy seemed to use more instrumental strategies than stimulated patients. The PDQ-39 showed that the subscale “communication” was altered greater in stimulated patients than in drug treated patients. There was no correlation between QOL and coping strategies in the stimulated group. In the drug-treated group, there was a correlation between emotion-focused strategies (CHIP, WCC) and emotional well-being (PDQ-39). What’s more, depression and anxiety measured by semi structured interview (MINI) or specific scales (MADRS, EHD, HAMA) were similar between two groups
Montel <i>et al</i> (2010) <sup>[30]</sup>	Cross-sectional study	135 not demented PD patients	65.3±9.2 for the frontal type executive impairment group (FAB < 15) ; 59.3±10.5 for the group without frontal type executive impairment (FAB > 15)	12.1±6.2 for the frontal type executive impairment group; 9.8±5.5 for the group without frontal type executive impairment	—	DSM-IV-TR criteria for dementia ; FAB; MADRS; WCC; CHIP	Patients presenting a frontal type executive impairment used surprisingly more coping strategies than did patients without executive dysfunction, except for instrumental strategies. 31% of patients presented executive impairment without dementia at the FAB, they tended to be more depressed on the MADRS measure and to use more different coping strategies than patients without executive dysfunction

Table 1 Continued

Study	Design	Subjects	Age (year)	Duration of disease (year)	Follow-up (month)	Measures	Results
Schüpbach <i>et al</i> (2005) <sup>[26]</sup>	Pro-spective study	37 PD patients undergoing bilateral subthalamic nucleus DBS	54.9± 9.1	15.2 ±5.3	Pre and 1, 6, 24 and 60 months post	UPDRS; MADRS	Many adverse effects of neurosurgery should have an impact on quality of life, mostly on familial and socio-occupational dimensions
Soulas <i>et al</i> (2011) <sup>[31]</sup>	Pro-spective study	41 patients with advanced PD undergoing bilateral subthalamic nucleus DBS	62.0±8.0	14.5 ±5.7	Pre and 6 and 12 months post	UPDRS; WCC-R; BDI; STAI; PDQ-39; SF-36	Postoperatively, motor aspects (UPDRS) and physical components of quality of life tended to improve (PDQ-39; SF-36): associated factors for these improvements were a younger age, shorter duration of disease, higher preoperative anxiety and depression, changes in problem-focused coping. Mental factors of quality of life tended to impair (SF-36), whereas depression and anxiety were stable over time. But it seems that improvements in these mental aspects of quality of life were linked to a less frequent use of a coping strategy based on seeking social support

PDQ-39: 39-Item Parkinson's disease Questionnaire; SF-36: 36-Item Short Form Health Survey; BDI: Beck Depression Inventory; STAI: State-Trait Anxiety Inventory; SCIDI: Semi-structured Clinical Interview for DSM-III-R Axis II disorders; UPDRS: Unified Parkinson's Disease Rating Scale; NHP: Nottingham Health Profile; HAD: Hospital Anxiety and Depression Scale; MINI: Mini International Neuropsychiatric Interview; MADRS: Montgomery and Asberg Depression Rating Scale; CHIP: Coping with Health Injury Problems; QOL: quality of life; WCC: Ways of Coping Checklist; EHD: Echelle d'humeur depressive-Depressive mood scale; HAMA: Hamilton Anxiety Scale; FAB: Frontal Assessment Battery; DSM-IV-TR: Diagnostic and Statistical Manual of Mental Disorders; WCC-R: Ways of Coping Checklist-revised; Pre: preoperative(ly); post: postoperative(ly).

Improvements in health-related quality of life appear to be the result of a combination of factors, including enhanced motor function, and consequently decreased dependence, reduced antiparkinsonian treatments, and improved neuropsychiatric status<sup>[19]</sup>.

Although it is well accepted that neurosurgery in Parkinson's disease improves health-related quality of life, not all aspects of health-related quality of life appear to be significantly enhanced. In particular, the overall improvements in health-related quality of life observed postoperatively can be mostly explained by improved "physical" dimension of health-related quality of life<sup>[21-22]</sup>. However, "mental" health-related quality of life, on the other hand, is not appreciably improved postoperatively. One proposed explanation is that after many years of evolution of the disease, often inducing social isolation, patients frequently have social problems, in terms of difficulties in initiating social contacts or reintegrating social networks.

In terms of the PDQ-39, there is a variation throughout the improved health-related quality of life dimension after neurosurgery, especially with regard to the physical and mental aspects of the disease.

Thus, while "emotional well-being" can be improved

postoperatively, "communication" remain impaired, probably through a reduction in verbal fluency induced by subthalamic nucleus deep brain stimulation<sup>[16, 23]</sup>. However, previous studies have found this factor to be stable over time. Motor complications are the main determinant of improved postoperative health-related quality of life in some patients<sup>[18]</sup>, while in others, postoperative side effects of neurosurgery are related to impairment of health-related quality of life<sup>[3]</sup>. Moreover, the psychosocial profile of suitable candidates for subthalamic nucleus deep brain stimulation appears to remain relatively stable after neurosurgery<sup>[16, 24]</sup>. Nonetheless, an improvement in depression may be observed in the first year after subthalamic nucleus deep brain stimulation<sup>[1]</sup>, which contributes to an improvement in health-related quality of life<sup>[19]</sup>. Moreover, since current depression can modulate health-related quality of life<sup>[5, 19, 23, 25]</sup>, it is necessary to offer specific pre- and postoperative care to these patients. This is mostly important for Parkinson's disease patients in whom the impact of the motor features of the disease and the neuropsychiatric disturbances affect both health-related quality of life and well-being.

The postoperative persistence of mood disorders and apathy, as well as the side effects of the neurosurgery (e.g. hypomania, disinhibition, dysarthria or decreased verbal fluency, weight gain, and eye apraxia) may con-

tribute to the impairment of postoperative health-related quality of life, mostly in the familial and socio-professional dimensions<sup>[26]</sup>.

When comparing stimulated and non-stimulated Parkinson's disease patients, Montel and Bungener<sup>[23]</sup> found no difference in perceived health-related quality of life. The authors underlined the impact of the subjective nature of such health-related quality of life self-evaluation together with a permanent dissatisfaction with perceived personal situation. In the case of motor improvement, this dissatisfaction needs to be tempered with the subjective character of health-related quality of life scales in regard to their use and interpretation, since self-evaluation is affected by possible memory distortions and/or postoperative changes in mood, behaviour or personality<sup>[17]</sup>. As for postoperative non-improvement of health-related quality of life, Gronchi-Perrin *et al*<sup>[17]</sup> highlighted the impact of unrealistic expectations regarding neurosurgery conflicting with the final result of the surgery, inducing disappointment. Obviously, neurosurgery in Parkinson's disease leads to marked changes in a patient's life, in particular a gain in autonomy through a dramatic improvement of motor functions. It is also understandable that these patients, disabled for many years, hope for a return to their pre-morbid state, and therefore may need time to adapt to their new postoperative state and lifestyles. For clinicians, these results are clearly in keeping with their experience with Parkinson's disease patients undergoing subthalamic nucleus deep brain stimulation, and thus there is a need to develop more qualitatively-based studies to gain a better assessment of the expectations or representations regarding neurosurgery.

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## **COPING STRATEGIES AND SUBTHALAMIC NUCLEUS DEEP BRAIN STIMULATION**

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As in other chronic diseases, patients display coping strategies to maintain their psychological balance. Coping strategies are defined as "the overall cognitive and behavioural efforts to master, reduce or tolerate inside or outside demands which threaten or surpass personal resources"<sup>[27]</sup>. Usually in Parkinson's disease, the most widely used scale to investigate coping strategies is the Way of Coping Checklist (WCC)<sup>[28]</sup>, a generic scale. To date, no specific scale has been developed for neurological diseases in general and for Parkinson's disease in particular. However, the Coping with Health Injuries and Problems (CHIP)<sup>[29]</sup>, developed in the context of chronic diseases, has been adapted and

validated for neurological diseases within a population of Parkinson's disease and multiple sclerosis<sup>[30]</sup>. A recent study<sup>[31]</sup> found that coping strategies in stimulated patients were stable over time but also comparable with those used in the general population, raising the question as to whether there is a relationship between coping strategies and executive dysfunction. The hypothesis of an impact of a probable executive dysfunction on the deployment of maladaptive coping strategies was thus proposed<sup>[31]</sup>. Indeed, in a prior study, Montel and Bungener<sup>[32]</sup> noticed that in non-stimulated Parkinson's disease, patients with executive impairment appeared to use more flexible coping strategies than patients without executive dysfunction. However, these same authors<sup>[23, 33]</sup> observed that stimulated and non-stimulated patients do not manifest the same coping strategies.

One of the proposed explanations is that their situations are very different not only in terms of motor disability, but also in terms of hope for a better condition in the future. Non-stimulated patients seem to focus on instrumental strategies, *i.e.*, they are constantly seeking information on how to improve their state (such as new medication, alternative therapies and surgical therapies). By contrast, stimulated patients, having benefited from the most advanced neurosurgical treatment, do not focus on such instrumental strategies<sup>[23, 33]</sup> and do not appear to use specific coping strategies. Hence, these patients need time to adapt to this new state but also to their coping strategies in a manner contingent on this new state. For instance, stimulated patients using a coping strategy based on seeking social support tended to improve their mental health-related quality of life, whereas other active strategies (problem solving, planning, emotional control) failed to have any positive effect on health-related quality of life. These results are surprisingly given that the impact of seeking social support is highly dependent on the characteristics of social networks.

To date, to the best of our knowledge, there are only a few available articles<sup>[23, 31, 33]</sup> on this topic, therefore there is a need to gain further insight into coping strategies in the neurosurgical context of Parkinson's disease and the relationship between coping, health-related quality of life and psychosocial dimensions.

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## **SOCIAL ADAPTATION AND SUBTHALAMIC NUCLEUS DEEP BRAIN STIMULATION**

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Parkinson's disease has a negative impact on social

adaptation<sup>[34-35]</sup>. Social adaptation<sup>[36]</sup> can be defined as “the interplay between the individual and the environment”, *i.e.* the individual’s behaviour in terms of socially-accepted roles. “Social adjustment is a reflection of the patient’s interactions with others, satisfactions and performances in roles, which are more likely modified by previous personality, cultural and family expectations”. Weissman<sup>[36]</sup> added that the individual’s assumed roles are dependent on age and potentially on psychopathology. The notion of social adjustment contrasts with quality of life, which refers more generally to the consequences of Parkinson’s disease on activities of daily living.

The most often used scale to evaluate social adaptation, in the context of Parkinson’s disease, is the Social Adjustment Scale (SAS)<sup>[36]</sup> or its self rating version, the Social Adjustment Scale-Self Report (SAS-SR)<sup>[37]</sup>. Social adjustment can be evaluated through a “global adjustment” score or through dimension scores (work, social life and leisure, family life, interaction with children, marital relations and material situation). Subthalamic nucleus deep brain stimulation markedly improves Parkinson’s disease symptoms, which are linked to the psychosocial consequences of the disease described earlier. What therefore is the impact of subthalamic nucleus deep brain stimulation on social adaptation? Houeto *et al*<sup>[6]</sup> retrospectively investigated social adaptation after subthalamic nucleus deep brain stimulation for Parkinson’s disease. They observed that social maladaptation persisted after subthalamic nucleus deep brain stimulation in some patients. In their sample, social adjustment was good in 9 patients, moderate in 14 and severely impaired in 1 patient. These scholars<sup>[6]</sup> also highlighted that postoperative maladjustment was more manifest in late-onset Parkinson’s disease patients. The persistence of motor complications related to dopamine treatments may explain the postoperative overall social maladjustment associated with impaired adaptation in social life and leisure.

Other scholars<sup>[4-5, 7, 38]</sup> pointed to a postoperative social maladjustment, evaluated by the SAS or by semi-structured interviews. Reported global SAS scores were found to be relatively stable preoperatively and 2 years postoperatively<sup>[38]</sup>. Neither global scores nor subscores improved postoperatively<sup>[4]</sup>, although social adjustment varied individually, *i.e.*, some were found improved or stable while others impaired.

Only a small percentage of Parkinson’s disease patients experienced social maladjustment<sup>[4, 7]</sup>. Agid *et al*<sup>[4]</sup> re-

ported that the two most severely impaired dimensions were occupational aspects and marital relationship. More than a half of their Parkinson’s disease patients who were working before surgery wanted to stop working postoperatively (64%) while 65% of married couples experienced marital difficulties postoperatively. Whereas working and marital relationship seemed to be progressively impaired, dimensions such as social life, relations with children, family life and financial aspects, on the other hand, improved postoperatively<sup>[38]</sup>. According to Schüpbach *et al*<sup>[38]</sup>, predicting the postoperative evolution of social adaptation in each patient is practically impossible although the preoperative global SAS score does appear to be correlated with the postoperative evolution of each individual. Prediction of postoperative social adjustment, from the standpoint of practical experience of clinicians, is difficult, depending on expectations or representations for neurosurgery, but also on the postoperative evolution of the motor state and potential side effects of neurosurgery. However, without specific consideration and intervention on cognitive representations for the result of subthalamic nucleus deep brain stimulation, patients presenting advanced preoperative social maladjustment show less progress in the global SAS score than those presenting mild preoperative social maladjustment. However, they do show better competence in reintegrating socio-familial and possibly professional activities, specifically when they are free of neurological complications.

Since the possibility of postoperative social maladjustment has been highlighted in the context of spectacular motor improvement, medical teams involved in subthalamic nucleus deep brain stimulation are trying to find explanations for this effect.

Jabre, Schüpbach and their colleagues<sup>[39-40]</sup> agree that it is currently difficult to state any specific reason for this social maladjustment. Because cases of social maladjustment can be observed without specific psychiatric or intellectual causes, surgical, motor, intellectual or psychiatric hypotheses can be ruled out<sup>[38-39]</sup>. Other factors have been discussed, such as the consequence of socio-familial and occupational reintegration problems<sup>[4]</sup>.

Houeto *et al*<sup>[6]</sup> highlighted three factors as potentially contributory to social maladjustment. Firstly, marital conflicts may be linked to a modification of the roles in the couple, and a long dependency will induce difficulties in reintegrating a new social and familial environment. Secondly, the presence of anxiety, and thirdly older age at surgery could be pejorative factors.



Table 2 Social adjustment after bilateral subthalamic deep brain stimulation in Parkinson's disease patients

Study	Design	Subjects	Age (year)	Disease duration of (year)	Follow-up (month)	Measures	Results
Agid <i>et al</i> (2006) <sup>[4]</sup>	Prospective study	29 neuro-stimulated PD patients	52.4	10.8	Pre and 24 months post	SAS; MINI 500; PDQ-39; MADRS; BAS; UPDRS	Postoperatively, improvements in motor abilities, mental state and quality of life are observed. Whereas, neither the global social adaptation nor specific dimensions of social adaptation are improved. They highlight three contributive factors to explain this non improvement of social adaptation: impact of neurosurgery on "the self", on "the other", on the "others"
Houeto <i>et al</i> (2002) <sup>[6]</sup>	Retrospective study	24 neuro-stimulated PD patients	At onset of disease 43±6.5	16±4.5	Retrospective evaluation: 19 ±11 months post	SAS; MINI 500; ISPC; UPDRS; MDRS; Frontal score	Slight to severe maladjustment in 15 out of 24 patients. Improvements in motor abilities contributed to regain of autonomy for patients, and marital difficulties were possibly exacerbated by anxiety disorders. Older patients seem to be more vulnerable. The authors highlight the importance of a specific preoperative and postoperative follow-up in these patients, in order to evaluate the socio-familial context and to select patients that can adapt to postoperative changes in a short time period
Houeto <i>et al</i> (2006) <sup>[5]</sup>	Prospective study	20 neuro-stimulated PD patients	54.9±10.3	13.7±6.1	1 month pre, 6 and 24 months post	UPDRS; MDRS; Frontal score; MINI, a non-standardized psychiatric interview; MADRS; BAS; PDQ-39; SAS	Even after a strict selection for patient candidates for subthalamic nucleus deep brain stimulation, neurosurgery induced a postoperative improvements in motor function and mood, anxiety and quality of life. However, personal, familial, professional and social adaptation did not improve postoperatively (24 months). The reasons for these non-improvements are not clear, and cognitive, psychiatric or personality change factors are not satisfactory. The authors suggest the impact of patient's preoperative psychological and sociological status on the non-improvement in social maladjustment
Jabre & Bejjani (2007) <sup>[39]</sup>	Retrospective study, correspondence to the editor	74 neuro-stimulated PD patients	—	—	—	—	The team never encountered professional, marital or social problems in their sample of patients. Agid <i>et al</i> proposed four possible answers to this difference in social adaptation. They underlined the favourable access to psychological support in Leban, the need to search for social maladjustment thanks to in-depth interviews, the impact of the social security system on the need to return to work, and the structure of the society
Kalteis <i>et al</i> (2006) <sup>[7]</sup>	Prospective study	33 neuro-stimulated PD patients	60.2±7.9	13.5±4.8	3 pre evaluations (8 to 6 weeks, 4 weeks, 2 weeks) and 5 post evaluations (3 and 9 weeks, 3, 6 and 12 months)	BRMES; HAMA; GAS; GCI; POMS; BDI; VAS; STAI-X1/X2; SCL-90-R	Improvements in the global psychosocial functioning at 9 weeks and stabilization: 3 preoperative employed patients return to work postoperatively. The distress and burden of the disease decreased after surgery. But, in some patients, a decline of psychosocial functioning and psychiatric symptoms could be observed

Table 2 Continued

Study	Design	Subjects	Duration of		Follow-up (month)	Measures	Results
			Age (year)	disease (year)			
Schüpbach <i>et al</i> (2006) <sup>[38]</sup>	Prospective study	29 neuro-stimulated PD patients	52.4±9	10.8±4.8	Pre and 18 and 24 months post	UPDRS; MDRS; Frontal score; MINI; MADRS; BAS; PDQ-39; SAS; semi directive interview exploring social adaptation (work, social life, family life, marital life, relation with children), open and non-structured interview exploring impact of neurosurgery on personal, marital and socio-professional life	The global SAS score was similar pre and 24 months post, contrasting with the improvement of motor abilities and quality of life. The global SAS improved in 28% of the patients, 34% remained stable and 38% worsened. The dimensions for marital life and professional activity worsened more than improve. Moreover, interviews permitted to identify three postoperative problems in social adaptation: impact of neurosurgery on body image and self-perception, impact of subthalamic nucleus deep brain stimulation on the couple and on the professional life. So, the authors concluded on the importance of a preoperative multidisciplinary psychosocial preparation and a specific postoperative follow-up of PD patient candidates for neurosurgery

SAS: Social Adjustment Scale; MINI 500: Mini International Neuropsychiatric Inventory; PDQ-39: 39-Item Parkinson's disease Questionnaire; MADRS: Montgomery and Asberg Depression Rating Scale; BAS: Brief Scale for Anxiety; UPDRS: Unified Parkinson's Disease Rating Scale; ISPC: Iowa Scale for Personality Change; MDRS: Mattis Dementia Rating Scale; BRMES: Bech-Rafaelsen Melancholia Scale; HAMA: Hamilton Anxiety Rating Scale; GAS: Global Assessment Scale; GCI: Global Clinical Inventory; BDI: Beck Depression Inventory; VAS: Visual Analogical Scale; STAI-X1/X2: State-Trait Anxiety Inventory-X1/X2; SCL-90-R: Self-report symptoms inventory 90 items-revised Pre: preoperative(ly); post: postoperative(ly); PD: Parkinson's disease.

Schüpbach *et al*<sup>[38]</sup> also concluded the impact of neurosurgery on body image. These aspects were conceptualized<sup>[4, 40]</sup> with (1) a "SELF" level based on the personal experience of Parkinson's disease and neurosurgery, (2) the "OTHER" level concerning the disruption of the marital situation during Parkinson's disease, and (3) the "OTHERS" level concerning socio-occupational life.

This social maladjustment after subthalamic nucleus deep brain stimulation could be perceived as "the burden of normality", and thus it is very important to prepare Parkinson's disease patients and their families for the changes induced by neurosurgery<sup>[40]</sup>. Several authors suggest that careful preoperative selection for deep brain stimulation in Parkinson's disease needs to be amplified and that follow-up should integrate investigation of the patient's social status, particularly in the socio-familial and socio-occupational sphere<sup>[4, 6]</sup>. Particular attention should be focused on young patients, for whom socio-occupational and familial reinsertion are of great importance<sup>[34-35]</sup>. However, it remains of primary importance to actively search for social maladjustment, using specific tools such as adjustment scales or in-depth interviews, allowing for the fact that maladjustment depends on the structure and values of the society<sup>[6]</sup>. Finally, it is clear that psychosocial maladjustment after subthalamic

nucleus deep brain stimulation in Parkinson's disease may be more common than at first glance. Medical teams need to place greater and more systematic focus on this issue and develop interventions in an attempt to improve this adjustment.

## DISCUSSION

Subthalamic nucleus deep brain stimulation has become a remarkable treatment for advanced forms of Parkinson's disease<sup>[1-3]</sup>. Indeed, subthalamic nucleus deep brain stimulation provides a dramatic improvement of motor features of Parkinson's disease in strictly selected patients. However, some aspects of the psychosocial profile of these patients still remain unclear, mostly with regard to social adjustment, coping strategies and mental health-related quality of life. It is thus exceedingly important to develop studies relative to these issues, as they represent a genuine and severe challenge in public health.

In a first instance, over the past ten years, many authors have reported that while global health-related quality of life is deemed to improve, this is not the case for every dimension of health-related quality of life in Parkinson's

disease, since the mental aspects of health-related quality of life are considered not to improve postoperatively<sup>[21]</sup>. This tendency has been reported in all articles regarding health-related quality of life, whether measured by generic or specific instruments<sup>[9-14]</sup>. Furthermore, the improvement in physical health-related quality of life and the non improvement in mental health-related quality of life are both considered to be stable<sup>[15-22]</sup>.

Some studies combine the assessment of health-related quality of life with that of coping strategies. However, while some have stated that stimulated patients do act differently from non-stimulated Parkinson's disease patients<sup>[23, 33]</sup> in terms of coping strategies, the link between health-related quality of life and coping strategies in the context of neurosurgery is not clear. One particular difficulty is that very few studies ( $n = 3$ ) have tackled this fundamental issue<sup>[23, 31, 33]</sup>, hence raising a secondary problem regarding the type of scale used to measure coping strategies. Indeed, while there are a number of existing scales<sup>[28-29]</sup>, each does not investigate the same dimensions, therefore underlining a problem of reliability for these few studies, and more importantly raising the question as to what is measured exactly and how to go about such measurement. Moreover, the most widely used measurement scales have been generic in nature, whereas the specificity of neurological diseases such as Parkinson's disease requires a more specific approach. As initially attempted by Montel & Bungener<sup>[30]</sup> by validating the CHIP scale for the assessment of coping in a neurological context, it may prove interesting to elaborate a Parkinson's disease-specific coping scale which is not only better adapted to the characteristics of this neurological pathology but also to the specificity of subthalamic nucleus deep brain stimulation. Thus, it is currently difficult and certainly premature to generalize the few data concerning coping strategies and neurosurgery, and more importantly to postulate any link between coping and health-related quality of life in the context of subthalamic nucleus deep brain stimulation. Further studies on this topic are clearly necessary and should prove valuable in clarifying current knowledge.

Another important consideration is that some authors have identified social maladjustment in a few neurostimulated patients<sup>[4-7, 38, 40]</sup>. However, the majority of these studies regarding social maladjustment in Parkinson's disease following subthalamic nucleus deep brain stimulation have been published by the same French group. Indeed, this team appears to have used the same patient cohort and data to publish their findings. For example, Agid *et al*<sup>[4]</sup> and Schüpbach *et al*<sup>[38]</sup> reported the same data for disease duration, mean age, time of evaluation

and scales.

This raises an important question, proposed by Jabre and Bejjani<sup>[39]</sup>, as to the impact of socio-cultural dimensions, in that social maladaptation observed in some French patients has yet to be confirmed by other studies. In other words, is social maladjustment in stimulated Parkinson's disease patients a French-specific problem? It would appear that postoperative social maladjustment may be influenced by the particular organization of the French society, its values and its health system. However, one could question as to what would happen if French caregivers did not ask about social maladjustment after neurosurgery. For instance, there may be a link between social maladjustment and some cases of suicide<sup>[41-44]</sup> observed after subthalamic nucleus deep brain stimulation. Even though the societal structure surrounding these patients obliges them to reintegrate their preoperative environment, all the more reason for medical teams to search for social maladjustment in order to help these subjects.

The aforementioned also underscores an important point as to how must we evaluate social adjustment in Parkinson's disease. Schüpbach & Agid<sup>[40]</sup> recommended in-depth interviews with patients and caregivers. These authors mostly used the SAS in their studies<sup>[36]</sup>. This particular scale, which is one of the oldest adaptation scales known, was developed in the context of psychiatric diseases in order to evaluate social adjustment, including instrumental and affective role assessments. The use of this type of scale provides the caregiver the possibility of making a clear semi-structured interview with Parkinson's disease patients. However, since we know that Parkinson's disease is a specific neurological disease, would it not be of greater interest to develop a more specific instrument for the evaluation of social adjustment before and after subthalamic nucleus deep brain stimulation? Based on previous data<sup>[4-7, 38, 40]</sup>, such a tailored scale would enable to approach the issue of social maladjustment more precisely in the specific context of neurosurgery.

Moreover, in the realm of neurodegenerative diseases such as Parkinson's disease, it is still difficult to determine whether the postoperative non-motor deficits, *i.e.* non-improvement of health-related quality of life or social maladjustment, are due to the evolution of Parkinson's disease itself or to the neurostimulation procedure. As clearly highlighted in this review, we can confirm that many aspects including social maladjustment, the non improvement of health-related quality of life, the apparent variability in adaptive coping strategies and the

processes underlying such strategies are still unclear in the specific context of subthalamic nucleus deep brain stimulation, hence there is a need for better assessment tools. Further prospective and controlled studies are necessary, together with more significant sampling and control groups in order to specify these dimensions and secondarily to clarify their link with coping strategies. Hence, the development of specific instruments measuring coping strategies, targeted care for maladapted patients and the experimentation of therapies to improve or maintain social adjustment are of great importance.

Finally, with regard to postoperative social maladjustment observed in a few patients, most authors propose to carefully consider the preoperative expectations of Parkinson's disease patients and to search for effective strategies in order to reduce postoperative disappointments from the patients and their relatives. As stated by Castelli *et al* <sup>[24]</sup>, "it is important to temper the patient's expectations towards the benefit of the intervention; many patients [...] frequently developed unrealistic expectations of becoming completely healthy."

To the best of our knowledge, one French team is currently working on such a topic<sup>[42]</sup>. In the framework of preparing potential Parkinson's disease candidates who undergo subthalamic nucleus deep brain stimulation, this team's approach proposes a preoperative preparation consisting of one semi-structured interview investigating perceived life before Parkinson's disease, with Parkinson's disease and hopes for the postoperative period. Thereafter, a cognitive restructuring is proposed for "unrealistic expectations" thought to induce postoperative disappointment and thereby contributing to social maladjustment. We are presently waiting for the result of this study in the hope that it will help us gain a better understanding of the mechanism of social maladjustment, the non-improvement of health-related quality of life and their respective links with coping strategies.

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(Reviewed by Zhang B, Eriksen J, Dushanova J)  
(Edited by Li CH, Song LP, Liu WJ, Zhao M)