Hypothalamic amnesia and frontal lobe function disorders after Langerhans cell histiocytosis

Langerhans cell histiocytosis (LCH), a rare disease previously known as histiocytosis X, is characterised by abnormal cell proliferation. If the CNS is invaded, the hypothalamus is the typical site location. There are virtually no neuropsychological data on hypothalamic LCH sequelae. Memory disorders in the context of posterior but also anterior hypothalamic lesions, regardless of the aetiology, have in most cases been attributed to the involvement of the mammillary bodies (MB). However, Ptak et al. reinterpreted a case, acknowledging that “Damage of the anterior hypothalamic, rather than the mammillary bodies, may [ . . .] have been responsible for the observed confabulatory amnesia” (pape1600). An interesting question is whether neuropsychological deficits are secondary to hypothalamic damage in itself or to a disconnection syndrome. The latter is based on the bilateral hypothalamic nucleus—widespread brain complex connections. Two subsystems are of particular interest in the present case: the hippocampus-fornix—hypothalamus-MB circuit, and the amygdalastria terminalis plus caudate nucleus-hypothalamus circuit.

We report the case of a patient who presented with hypothalamic LCH and underwent thorough neuropsychological, radiological, and metabolic assessments.

Case report
A right handed woman (date of birth 1931), was admitted (March 2000) to the Hôpitaux Universitaires’ Neurology Unit (Strasbourg, France) complaining of memory deficits. In 1992, she was diagnosed as having hepatic and hypothalamic LCH, the first being confirmed by biopsy, the second suggested by diabetes insipidus. Endocrinological assessment showed signs of anterior pituitary dysfunction. Standard biological and physical examinations were normal. MRI showed a bilobulated hypothalamic tumour, extending from the optic chiasm to the posterior part of the third ventricle floor and towards the pituitary stalk. It displaced the left thalamus very slightly and compressed both MB, which became non-identifiable. There was no abnormal signal in the thalami and the mesial temporal regions were morphologically normal. Cortical atrophy was normal for her age. MRI follow up (1998, 2000, 2001), showed stable lesions (20×18×14 mm; fig 1). An 18F fluorodeoxyglucose restig positron emission tomography (PET) scan (December 2000) revealed small hypometabolic regions in the ventromedial prefrontal cortices, left superior frontal gyrus, parietal lobe, caudate nucleus and upper brain stem, plus a pronounced hypothalamic hypermetabolism (fig 2).

Neuropsychological investigation (July 2000)
Written informed consent was obtained. The patient was disoriented for time only. Verbal IQ (90) and Performance IQ (96), language, constructional praxis, visuoperceptual, and spatial abilities were normal. Performance on anterograde and retrograde episodic and semantic memory tests was severely impaired. Likewise, scores on six tests sensitive to frontal lobe dysfunction were uniformly defective. Moreover, she had recently become “hostile and irritable”. Consequently, her husband completed a personality change scale (J Barrash, et al. 25th INS meeting, Orlando, Florida, February 1997). The considerable difference between her past (63) and present (110) behavioural characteristics was compatible with a frontal lobe disorder.

Comment
Secondary to hypothalamic LCH, our patient developed amnesia, dysexecutive syndrome, and personality alteration, in an otherwise normal context. Ptak et al described a similar case (amnesia and frontal lobe dysfunction) in the context of circumscribed hypothalamic lesions.1 The postmortem diagnosis of sarcoidosis did not exclude the possibility of LCH. As the patient’s lesion involved mostly the medial hypothalamic nucleus, the authors accounted for the symptoms in terms of the strong reciprocal connections with the anterior limbic structures. Further studies have demonstrated connections from the medial prefrontal cortex to the anterior and ventromedial hypothalamus and those from the orbital region to the lateral hypothalamus.2

In conclusion, we suggest that our patient’s neuropsychological impairments, with their catastrophic consequences for daily life, require abnormality beyond the MB and might reflect the “superadditive” effect of damage at different, strategically important connections. In view of the above, we suggest that our patient is not an infiltrating but an encapsulated form of the disease, the small cortical zones of hypometabolism are not thought to be directly caused by the histiocytosis condition. They could be accounted for in terms of disconnections resulting from the hypothalamic lesion. The deficit in the memory consolidation process could reflect a dysfunction of the hippocampus-fornix-MB circuit. Failure of retrieval processes could reflect the prefrontal-hypothalamic connections. Moreover, the patient’s false recognitions and confabulations showed the frontal involvement suggested by Ptak et al. However, for the time being, we are unable to account for the parietal and upper brain stem hypometabolism.

The hypothalamic hypermetabolism is interpreted in terms of an index of the active ongoing disease process. In conclusion, we suggest that our patient’s neuropsychological impairments, with their catastrophic consequences for daily life, require abnormality beyond the MB and might reflect the “superadditive” effect of damage at different, strategically important connections. In view of the above, we suggest that our patient is not an infiltrating but an encapsulated form of the disease, the small cortical zones of hypometabolism are not thought to be directly caused by the histiocytosis condition. They could be accounted for in terms of disconnections resulting from the hypothalamic lesion. The deficit in the memory consolidation process could reflect a dysfunction of the hippocampus-fornix-MB circuit. Failure of retrieval processes could reflect the prefrontal-hypothalamic connections. Moreover, the patient’s false recognitions and confabulations showed the frontal involvement suggested by Ptak et al. However, for the time being, we are unable to account for the parietal and upper brain stem hypometabolism.

The hypothalamic hypermetabolism is interpreted in terms of an index of the active ongoing disease process.

References
2 Ongur D, Price JL. The organisation of networks within the orbital and medial prefrontal cortex of rats, monkeys and humans. Cerebral Cortex 2000;10:206–19

Meningioma of the optic nerve sheath: treatment with hydroyuxurea

The best treatment of optic nerve sheath meningiomas remains controversial. Recent reports have emphasised the efficacy of fractionated stereotactic or conformal radiotherapy, and some clinicians favour this approach instead of surgery or observation.2 On the other hand, a beneficial effect of hydroyuxurea on unresectable, residual, and recurrent meningiomas has been reported in

Figure 1 T1 weighted coronal MR image showing a circumscribed hypothalamic tumour.

Figure 2 PET scan. Frontal, parietal, caudate nucleus, and upper brain stem hypometabolism, and hypothalamic hypermetabolism. Conditions were contrasted with 12 normal subjects (p<0.001).
A 46 year old woman presented with painless and progressive right sided visual failure for two years. On admittance, visual acuity of the right eye was 0.05. In addition, there was an afferent pupillary defect, and swelling of the right eye was increased to > 200 ms, and computed perimetric examination showed a significant decrease in tumour size (volume 0.15 cm³) originating from the upper part of the right optic nerve sheath and compressing the nerve. The tumour showed an isointense signal to grey matter on T1 weighted and 3 mm slice thickness, and was diagnosed as a meningioma (fig 1A). Latency of the P100 wave of visual evoked potentials of the right eye was increased to > 200 ms, and computed perimetric examination showed a severe restriction of the peripheral visual field of the right eye (fig 2A). There were no clinical or radiological features of neurofibromatosis type 1 or 2. The patient was not on regular medication.

Treatment was initiated with hydroxyurea, 20 mg/kg body weight/day orally. Four months after initiation of treatment the patient reported a considerable improvement of vision. No adverse events were noted apart from mild hair loss. Visual acuity improved to 0.5. After seven months of continuous treatment, visual acuity was 0.7, and after 10 months, 0.8. At this time, P100 latency of visual evoked potentials was normal and computed perimetric examination showed a significant recovery of visual field (fig 2B). However, cranial MRI showed no detectable change in tumour size (volume 0.15 cm³; fig 1B). At the time of writing the disease had remained stable for a further 18 months now.

Comment

This case shows the clinical value of hydroxyurea in the management of optic nerve sheath meningiomas, although there was no detectable decrease in tumour size. There is increasing evidence for the benefit of radiotherapy in optic nerve sheath meningiomas. Andrews et al reported an improvement in vision in 10 of 24 cases (42%) after treatment with fractionated stereotactic radiotherapy alone. A comparison of long term visual outcome by Turbin et al showed better results for patients treated by conventional multilong treatment of optic nerve sheath meningiomas carries a high risk of irreversible damage to the optic nerve, the diagnosis was made purely by radiological means. This approach is in accordance with current standard of diagnostic measures of optic nerve sheath meningiomas based on clinical details and high quality neuroimaging without pathological confirmation.4

References

1 Andrews DW, Faroozan R, Yang BP, et al. Fractionated stereotactic radiotherapy for the treatment of optic nerve sheath meningiomas: preliminary observations of 33 optic nerves in...
Recurrent anti-GQ1b IgG antibody syndrome showing different phenotypes in different periods

Anti-GQ1b IgG antibody is often found in the sera of patients with Miller Fisher syndrome. Bickerstaff’s brain stem encephalitis, Guillain–Barré syndrome with ophthalmoplegia, acute ophthalmoparesis without ataxia, and occasionally, in isolated internal ophthalmoplegia and chronic ophthalmoplegia. These syndromes may be designated as anti-GQ1b IgG antibody syndrome.1 We report a patient who showed three different phenotypes of the anti-GQ1b IgG antibody syndrome at different periods.

Case report

The patient was a 19-year-old woman. At age 10, she visited a neurologist because of diplopia and an unsteady gait two weeks after a respiratory tract infection. Neurological examination showed ophthalmoplegia, dilated pupils with sluggish pupillary responses, areflexia, and cerebellar ataxia. Laboratory tests including nerve conduction studies were normal except for a slight increase in CSF protein (40 mg/dl) without pleocytosis. Within three months, her condition gradually improved and she was discharged without a neurological deficit except for persistent areflexia.

At age 17, she noticed mild diplopia, which gradually got worse. She visited our hospital with the complaint of slowly progressive diplopia. Although oculomotor movements were not restricted, her pupils were dilated bilaterally with reaction to light. She showed areflexia and slight ataxia without pathological reflexes, Babinski sign, and brainstem auditory evoked potentials. Brain MRI was normal. Nerve conduction studies were normal except for absence of the F wave.

At age 19, a week after developing fever of unknown origin, the diplopia suddenly progressed. The next morning, her gait became unsteady and she was admitted to hospital. On admission (day 1), she had complete ophthalmoplegia without oculocephalic reflexes. The pupils were markedly dilated without reaction to light. Her speech was slurred. Her extremities were slightly weak. She could not sit on the bed by herself because of severe unsteadiness. Her deep tendon reflexes were absent, with no pathological reflexes. The CSF was normal, including the protein level. Nerve conduction studies were within the normal range except for absence of the F wave. An enzyme linked immunosorbent assay showed that serum IgG reacted strongly with GQ1b (titre, 1:5200) and GT1a (titre, 1:3200), but not with other gangliosides.

She was given intravenous immunoglobulin (IVIg) on days 2–6. On day 5, she developed disturbed consciousness, Cheyne–Stokes respiration, and extensor plantar responses. Intratrachal intubation was required for ventilatory failure. Electroencephalography (EEG) showed diffuse theta activity. Brain MRI was normal.

From day 11, her illness gradually improved. Serum anti-GQ1b IgG and anti-GT1a antibody titres decreased below the cut off level by day 55. The F wave on nerve conduction studies became normal by day 78. Fifteen weeks after the onset, she had almost recovered except for areflexia and slight restriction of ocular abduction of the both eyes.

Comment

Our patient showed three different conditions of the illness at three different periods between the ages 10 and 19: first, acute onset of ophthalmoplegia, ataxia, and areflexia at age 10, which is a typical presentation of the Miller Fisher syndrome; second, chronic progressive diplopia associated with internal ophthalmoplegia from age 17; and third, acute onset of complete ophthalmoplegia, ataxia, marked drowsiness, and respiratory paralysis with extensor plantar responses and EEG abnormalities at age 19.

We diagnosed the third episode as Bickerstaff’s brain stem encephalitis, because she showed transient central nervous system involvement (drowsiness, respiratory disturbance, positive plantar responses, and EEG abnormalities) in addition to the triad of the Miller Fisher syndrome. High anti-GQ1b and anti-GT1a IgG antibody titres at the time of the most recent illness and their decrease following recovery supported this diagnosis.

There are clinical similarities between Miller Fisher syndrome and Bickerstaff’s brain stem encephalitis. Conditions such as these have been considered as consecutive spectra of the same disease. Miller Fisher syndrome is usually a monophasic illness, but, on rare occasions, it has been reported to occur after a long asymptomatic interval.1

It has been reported that clinical features of recurrent Miller Fisher syndrome are constant from episode to episode.2 This is in contrast with recurrent Guillain–Barré syndrome, which shows considerable variety in the distribution and severity of weakness between each episode.3 This is the first report of Bickerstaff’s brain stem encephalitis as a recurrent episode of the Miller Fisher syndrome.

In the second phase of chronic progressive diplopia, our patient showed abnormalities of the pupils with slight ataxia and absence of the F wave in nerve conduction studies. As external oculomotor movement was not restricted, progressive diplopia might reflect pupillary abnormalities; diplopia has been discussed in isolated internal ophthalmoplegia without external ophthalmoplegia associated with anti-GQ1b IgG antibody.4 In addition, chronic external ophthalmoplegia has been found with raised serum anti-GQ1b IgG antibody.5 These findings suggest that chronic internal ophthalmoplegia may be associated with anti-GQ1b IgG antibody, although we could not examine this antibody during that period.

It is unique in our patient that three different phenotypes of the anti-GQ1b IgG antibody syndrome are presented at different times. There has up to now been no report in which different anti-GQ1b IgG antibody syndromes have recurred at different times in a single patient. Our case indicates that Miller Fisher syndrome, Bickerstaff’s brain stem encephalitis, and chronic internal ophthalmoplegia may form part of the spectrum of the anti-GQ1b IgG syndrome, although the mechanism of the variability in clinical phenotypes of the anti-GQ1b IgG syndrome remains unknown.

In conclusion, our case indicates that different phenotypes of the anti-GQ1b IgG antibody syndrome can occur at different times in the same patient, showing that this syndrome may be a distinct entity with a wide clinical spectrum on a unique immunological background.

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References

decided to investigate the incidence of this complication in a cohort of patients with the condition, as well as in a group of subjects with Tourette's syndrome. The latter is an interesting choice for a control group as Tourette's syndrome and Sydenham's chorea share common clinical features—for example, childhood onset, the constellation of motor and behavioural disturbances, and the response to neuroleptic agents.

**Methods**

In the first part of the study we undertook a retrospective review of the case records of patients with Sydenham's chorea and Tourette's syndrome followed up at the MDC-UFGM from July 1993 to October 2002, looking for drug induced parkinsonism. We then compared the chlorpromazine equivalent dose used in patients with Tourette's syndrome, Sydenham's chorea, and drug induced parkinsonism. For each patient with Sydenham's chorea we randomly selected two age matched subjects with Tourette's syndrome. Sydenham's chorea was diagnosed according to a modified Jones criteria, and the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) criteria were used to identify patients with Tourette's syndrome. Drug induced parkinsonism was diagnosed when patients exposed to neuroleptics were found to have bradykinesia and at least one of the following: rigidity, tremor, postural instability. All patients were seen by one of us (FC). Differences were considered statistically significant at a probability (p) value of < 0.05.

**Results**

Sydenham's chorea was diagnosed in 91 patients and Tourette's syndrome in 97 during the study period. Five patients (5.5%) with Sydenham's chorea (mean (SD) age, 13.4 (2.1) years), of whom four were female, developed drug induced parkinsonism, whereas this complication was not identified in the Tourette's syndrome group (p = 0.03, Fisher's exact test). Parkinsonism was characterised by the presence of bradykinesia and rigidity. Of the subjects, tenor was identified in three, and postural instability was not observed. The mean cumulative chlorpromazine equivalent dose used in the patients with Sydenham's chorea when they developed parkinsonism was 16.518 (6254) mg. The onset of drug induced parkinsonism occurred after a mean exposure of 88.2 (65.8) days.

The cumulative chlorpromazine equivalent dose in the 10 Tourette's syndrome patients (two female; mean age 13.5 (1.1) years (p = 0.26 vs Sydenham's chorea)) during a three month period was 19.575 (6529) mg (p = 0.76 vs Sydenham's chorea). At the time of the onset of drug induced parkinsonism the mean chlorpromazine equivalent dose in the Sydenham's chorea patients was 176.6 (95.5) mg; in the Tourette's syndrome group the figure was 217.5 (220.0) mg (p = 0.05, paired t test).

**Comment**

We showed that 5.5% of our patients with Sydenham's chorea developed drug induced parkinsonism during treatment with neuroleptics, while this complication was not observed in a cohort of Tourette's syndrome patients of the same body weight. There are several possible explanations for this. First, the patients with Sydenham's chorea might have received a higher dose of neuroleptics. This hypothesis is ruled out by the finding that 10 randomly selected, age matched Tourette's syndrome patients and the five Sydenham's chorea patients with drug induced parkinsonism were treated with a similar cumulative chlorpromazine equivalent dose during the three month period when the latterdeveloped parkinsonism. One may argue that although both groups received a similar cumulative dose of neuroleptics in the time between the start of treatment and the onset of drug induced parkinsonism, the patients with Sydenham's chorea could have been exposed to a higher dose of dopamine receptor blocking drugs at the time when they developed parkinsonism. However, this was not the case because if anything the mean dose of neuroleptic in the Sydenham's chorea syndrome subjects at the onset of drug induced parkinsonism was lower than in the Tourette's syndrome patients, though the difference failed to reach statistical significance.

A second explanation for our findings is the concomitant use of valproic acid in three of our Sydenham's chorea group. Although this drug has been implicated in the development of drug induced parkinsonism, this complication has only been described in adults treated for a period of 12 months or more. A third and also unlikely hypothesis is the overrepresentation of female patients in the Sydenham's chorea group; however, recent studies have consistently failed to identify sex as a risk factor for drug induced parkinsonism. 

Our results thus support the conclusion that in comparison with Tourette's syndrome, patients with Sydenham's chorea are at greater risk of developing drug induced parkinsonism.

**Comparison of the tendon and plantar strike methods of eliciting the ankle reflex**

Little work has evaluated the various ways of eliciting the ankle reflex. A previous study of elderly patients with normal/absent reflexes found greater intraobserver and interobserver agreement with the plantar compared with the tendon strike method. Other studies showed that the reflex was best elicited in the knee position but moving comatose patients can be impossible or lengthy. We compared the reliability of the plantar and tendon strike methods of eliciting the ankle reflex in a different disease state, subjects by examiners with different skill levels. Four patients with pathologically brisk reflexes, five with reduced/absent reflexes, and nine subjects with normal reflexes as judged by an experienced neurologist, were recruited. All subjects had symmetrical signs and gave written informed consent. Subjects were screened from examiners so that only their legs were visible. None had identifying scars, wasting, or pes cavus. Subjects were examined by 15 third year medical students and five experienced neurologists. Initial training in both methods was given in the tendon strike method. The Achilles tendon of the supine patient was struck with the leg flexed at the knee and externally rotated at the hip, in the plantar technique the examiner's hand was struck while placed on the plantar aspect of a supine patient's foot. Reinforcement was permitted at examiners discretion. Each examiner saw half of the subjects (that is, nine patients and controls) on four occasions. On each occasion they examined both ankles. Examiners evaluated the reflexes four times using each technique twice. The order of bed, subject, and method allocation to examiners was according to a randomised partially balanced incomplete block design. Examiners rated the reflexes as normal, pathologically brisk, or reduced/absent and stated whether or not they were confident in their result. The study had local ethical approval.

**References**


and intraobserver agreement. Patients with normal or reduced reflexes of clinicians had similar results with both techniques. Light of other physical signs. Experienced clinicians preferred the plantar strike but no clinician to examiners. The low sensitivities show that subtle lower motor neurone signs giving clues to examiners. The low sensitivities show that the ankle reflex should be interpreted in the light of other physical signs. Experienced clinicians had similar results with both techniques. This conflicts with previous findings in elderly patients with normal or reduced reflexes of better interobserver and intraobserver agreement with the plantar method. The disparity may reflect this study including patients with brisk reflexes or that the clinicians were neurologists, or both. Medical students did better with the plantar method for brisk reflex patients. They have insufficient experience to differentiate normal from brisk with the tendon method. This suggests that students should be taught the plantar method in preference to the tendon strike method.

### References


### Table 1

<table>
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<tr>
<th>Table 1 (A) Sensitivity of tendon and plantar strike methods including κ coefficient of interobserver agreement.</th>
<th>Table 1 (B) Intraobserver agreement between two tests of each method shown as the percentage (95% CI) of times that identical results were obtained. The κ coefficient (standard error) shows response agreement for the two test sessions for each method</th>
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<tbody>
<tr>
<td>A</td>
<td>B</td>
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<tr>
<td><strong>Subjects</strong></td>
<td><strong>Correct reduced/absent (95% CI)</strong></td>
</tr>
<tr>
<td>Students</td>
<td>Tendon strike</td>
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<td></td>
<td>Plantar strike</td>
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<td>Clinicians</td>
<td>Tendon strike</td>
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Competing interests: none declared.

<table>
<thead>
<tr>
<th><strong>Subjects</strong></th>
<th><strong>Correct reduced/absent</strong></th>
<th><strong>Correct normal</strong></th>
<th><strong>Correct brisk</strong></th>
<th><strong>κ (SE)</strong></th>
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</thead>
<tbody>
<tr>
<td>Students</td>
<td>Tendon strike</td>
<td>86.5 (71.2 to 95.5)</td>
<td>67.6 (55.4 to 78.2)</td>
<td>66.7 (46.0 to 83.5)</td>
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<td></td>
<td>Plantar strike</td>
<td>81.1 (64.8 to 92.0)</td>
<td>64.8 (52.5 to 75.8)</td>
<td>59.3 (38.8 to 77.6)</td>
</tr>
<tr>
<td>Clinicians</td>
<td>Tendon strike</td>
<td>92.3 (64.0 to 99.8)</td>
<td>68.4 (43.4 to 87.4)</td>
<td>61.5 (31.6 to 86.1)</td>
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<tr>
<td></td>
<td>Plantar strike</td>
<td>92.3 (64.0 to 99.8)</td>
<td>57.9 (33.5 to 79.7)</td>
<td>92.3 (64.0 to 99.8)</td>
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**Mirror movements of the non-affected hand in hemiparkinsonian patients: a reflection of ipsilateral motor overactivity?**

Mirror movements may result from a primary motor efferent system dysfunction with secondary motor reorganisation. A profound dysfunction of the motor pathways has been reported in Parkinson’s disease (PD) during execution of motor tasks. Recent PET studies have demonstrated overactivation of ipsilateral motor areas in hemiparkinsonian patients. However, the clinical expression of ipsilateral cortical activation was not specifically investigated in previous reports. In this study, we explored the presence of mirror movements (MM) during standardised unilateral hand tasks in a series of 21 hemiparkinsonian patients.

Patients were divided into two groups: de novo patients (n=11), age 53.2 (7.5) years (mean (SD)), duration of evolution 1.8 years (range: 1–5 years), UPDRS III motor score 12 (7.5), affected side: left n=5, right n=6, and treated patients (n=10), age 59.8 (7.6) years, duration of evolution 3.7 (1.8) years (range: 2–7 years), UPDRS III motor score 14 (7.5), affected side: left n=4, right n=6, mean daily dose of levodopa: 450 mg (range: 300–900 mg), improvement of motor disability >40% (range: 40–80%), Evaluation was performed as follows: for de novo patients, before treatment; for the treated patients, in the “off” condition after at least 12 hours withdrawal of antiparkinsonian treatment (levodopa). Patien
ts were not tested in the “on” condition, to avoid confusion between dyskinesia and MM. They were compared with 21 age matched normal subjects, age 56.4 (10.8) years.

### Activation tasks

Subjects were told to hold their hands in the air with the elbows flexed and to perform a voluntary movement with one hand while the other hand was relaxed. Each hand was tested separately in the following four tasks performed 10 times as rapidly as possible with the widest amplitude: (1) Comprehension movements, (2) opening and closing of the hand, (3) finger tapping (thumb and index finger), (4) flexion-extension movements of the wrist. Tasks 1 to 3 correspond to items 23 to 25 of the UPDRS III, respectively.

Each task was scored as follows: 0= no MM, 1=MM (that is, the presence of repetitive unintentional contralateral movements that mimic totally or partially the intended movement. The “MM score” was the combined score for the task, for each side (maximum 4). Statistical analysis was performed using the non-parametric Spearman test, for a correlation analysis between the “MM score” and the UPDRS motor score.

In 80% of the de novo patients and 90% of the already treated and more severely affected patients, tested in the “off” condition, MM were observed in the relaxed hand while voluntary movements were being performed with the other hand. The most remarkable finding was that MM were never observed when voluntary movements were performed with the non-affected hand, whereas they were almost constant when voluntary movements were performed with the affected hand. They were observed both in the de novo group and the treated group. There were more often observed for alternate movements or repetitive flexion/extension movements of the wrist than for finger tapping. None of the control subjects displayed MM.

In the de novo patients, there was a significant correlation (r=0.60; p=0.0475) between the severity of motor impairment, as defined by the UPDRS III motor score, and the occurrence of MM as indicated by the “MM score”. No such correlation existed in the treated group.

Mirror movements could reflect the higher than normal level of cerebral activation in response to complex movements reported both in normal subjects and in PD patients. However, none of the controls displayed MM and the four tasks were not complex as patients performed them without difficulty, albeit more slowly.
Alternatively, extended recruitment of cortical motor areas could reflect an overflow of commands into the contralateral hemisphere in unilaterally affected patients. In line with recent experimental results in a unilateral rodent model of Parkinson’s disease, we suggest that MM observed in the non-involved hand during movements of the akinetic hand reflect ipsilateral activation of the primary motor cortex. In the absence of sensorimotor activation controlateral to the affected akinetic (right) hand, the ipsilateral diffusion of activation may be considered as a compensatory mechanism. This ipsilateral activation could be explained in two different ways. Firstly, a corticocortical spread as the two hemispheres are connected via the corpus callosum and corticocortical pathways. Secondly, bilateral basal ganglia projections as several anatomical observations have shown that the basal ganglia are reciprocally and directly connected to the contralateral cortex. Thus, the activation of the ipsilateral motor cortex could result from the activation of one or both of these pathways. The precise role of the ipsilateral activation of the primary cortex in the pathophysiology of Parkinson’s disease is still unknown but it could be suggested that this phenomenon is a compensatory mechanism.

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