Introduction

Movement disorders encompasses a wide range of neurologic diseases and syndromes that can be characterized by whether or not the motor manifestations are primarily hypokinetic or hyperkinetic. The hypokinetic disorders include such common syndromes as parkinsonism including Parkinson disease, multiple system atrophy (MSA), progressive supranuclear palsy (PSP), and various other syndromes that clinically manifest bradykinesia, muscle rigidity, and gait impairment. The hyperkinetic disorders characterize a wide range of syndromes and diseases including Huntington disease, dystonia, Tourette syndrome, essential tremor, myoclonus, and tardive dyskinesia. Each of the hyperkinetic syndromes clinically manifests either as tremor, chorea, tics, myoclonus, or dystonia. Clinical descriptions of these disorders can be found in a wide variety of references [1, 2]. This chapter will focus on the advantages and disadvantages of radiosurgery versus medical treatment of movement disorders. Radiosurgery has been used most extensively to treat Parkinson disease and essential tremor. The chapter will define the clinical syndromes of Parkinson disease and essential tremor, discuss the medical therapy that is available, and finally discuss the advantages and disadvantages of radiosurgery in these two disorders.

Parkinson Disease

Parkinson disease is the most common identifiable syndrome that can be diagnosed in the context of parkinsonism. The most important clues to the diagnosis of Parkinson disease include, of course, elements of parkinsonism (usually two of three of the cardinal features: bradykinesia, resting tremor, cogwheel rigidity). These begin in an insidious, asymmetric fashion. To fit the Parkinson disease diagnosis, the symptomatology has to be progressive. Many movement disorders specialists also require a history of sustained levodopa responsiveness. The presence of all these features will help ensure an accurate clinical diagnosis in most patients who present with parkinsonism [3].

On the other hand, none of these features, including unilateral onset and levodopa responsiveness, can definitely exclude other parkinsonian syndromes. Quite the contrary: unilateral presentations are present in Parkinson disease in only about 70% of patients, and levodopa responsiveness can be seen in a wide variety of parkinsonian syndromes. Nonetheless, these clues to the diagnosis of Parkinson disease can be quite valuable clinically [4].

The insidious nature of the onset of Parkinson disease was first recognized by James Parkinson in 1817. In An Essay on the Shaking Palsy [5], he wrote, “So slight and nearly imperceptible are the first inroads of this malady, and so extremely slow is its progress, that it rarely happens, that the patient can form any recollection of the precise period of its commencement.”

In the early evolution of the signs and symptoms of Parkinson disease, there is often very little functional impairment, and patients often choose to not take any symptomatic therapy until the evolving motor disorder begins to impinge on some aspect of their lives. Early treatment of Parkinson disease with either levodopa/carbidopa or one of the dopamine receptor agonists is very effective in alleviating motor symptomatology. This is referred to as “the honeymoon” period during which time the patient’s symptomatic medication works extremely well and there is very little in the way of adverse events. There are a wide range of therapeutic choices that are extremely effective in early Parkinson disease, and it would be highly unlikely that surgical intervention would ever be required in these patients. As Parkinson disease advances, the wide range of pharmacologic agents that are available to treat this disorder begin to become less effective. The most common problems that occur when patients have had the disorder for greater than 5 years are motor fluctuations and dyskinesias. Motor fluctuations consist of an erratic effect of drugs such as levodopa on the motor symptomatology. Patients begin to notice that 20 to 30 minutes after a dose of levodopa is taken, they feel stronger, their tremor lessens, and they walk better. They also begin to notice that 3½ hours after the ingestion of the last dose, the medication begins to wear off. Patients notice that their tremor begins to reemerge; they become slower and stiffer and have more difficulty carrying out the activities of daily living. Neurologists often refer to the period of time when the medication is producing its best effect as “on” and the time when the medication is working less effectively as “off” time. Patients began to experience more and more off time in the course of their day as the disease evolves. The other major complication that can be limiting in terms of therapeutic choices...
is the emergence of dyskinesias. Dyskinesia describes a wide range of involuntary movements (usually choreo-dystonic) other than tremor that begin to appear in patients with long-standing Parkinson disease who have been treated with dopaminergic agents. Dyskinesias are choreodystonic movements that occur in the limbs, axial regions, and can also cause lingual facial buccal movements or mouthing and chewing movements. Dyskinesias are precipitated by the total dopaminergic dose of medication the patient is receiving. Levodopa/carbidopa and the dopamine receptor agonists are the most potent drugs that induce dyskinesias. However, the MAO and COMT inhibitors can also induce dyskinesias. The therapeutic problem is that a patient’s increasing “off” time is an indication for the need for increased dopaminergic medication, but the appearance of increasingly severe dyskinesia is a sign that the dopaminergic medication needs to be decreased. It is in these patients that surgical options are often discussed.

Surgical treatment options in patients with Parkinson disease are currently discussed when the major medical treatment parameters have been exhausted. This includes the proper dosing and use of levodopa/carbidopa in combination with dopamine receptor agonists, MAO and COMT inhibitors, and amantadine.

Deep-brain stimulation (DBS) is the surgical modality that has become the treatment of choice for patients who have intractable medical problems related to their Parkinson disease. Deep-brain stimulation has been demonstrated to be an effective therapy for properly selected patients with Parkinson disease [6].

The timing of surgery and the selection of patients for surgery has become an intensely researched topic [7].

The timing of surgical procedures in Parkinson disease has traditionally been relegated to those patients who have essentially failed conventional medical therapy. There is growing interest in the concept that surgical treatment should be considered at an earlier stage in Parkinson disease before the patient’s disability and functional impairment becomes too advanced. This approach would still not include early patients who are doing extremely well on their medication.

At the present time, patients with Parkinson disease who are suitable candidates for a surgical procedure include those patients who retain a good response to levodopa even for a short period of time, have no medical contraindications for surgery, have no significant cognitive impairment, have no comorbid, serious psychiatric diagnoses, and have realistic expectations about the effects of surgery on their chronic progressive neurodegenerative disease [7, 8]. It is important for patients to understand that the surgical approach to Parkinson disease is palliative and will not result in a “cure.” In addition, patients must understand that the best response to surgery will result in more “on” time, but they will not be any better than their current best response to levodopa. This is a very important point, and patients must understand that their current best levodopa response in terms of the quality of their “on” time is the limit of what surgery can achieve. The purpose of the surgery with regard to motor fluctuations is to allow the patient to have more good “on” time. However, the quality of the “on” time in terms of motor performance will be no better than the best levodopa-induced “on” time.

When the target is the subthalamic nucleus (STN), DBS often results in a reduction of the total amount of dopaminergic medication that is required to maintain a good motor response. It is probably this reduction in dopaminergic medication that results in the striking amelioration of dyskinesias in many patients with Parkinson disease who previously had moderate to severe dyskinetic movements. When the target is the globus pallidus interna in DBS surgery, dyskinesias are often not improved.

DBS procedures have been performed with increasing frequency, and the literature and reports concerning the effects and complications related to DBS are far more documented and scrutinized than the results of radiosurgery in the same disorders [9–11].

Ablative surgery in Parkinson disease has a very long history [12–18]. Unfortunately, the role of lesion making and alleviation of the motor symptomatology of Parkinson disease has a very mixed history of enthusiasm for new lesion techniques followed by unrealistic expectations and the ultimate determination that the complication rate and benefit from most of the previous lesion techniques was unwarranted. The enthusiasm for the surgical approach of DBS initially was related to its apparent effectiveness without the need to make an actual lesion in the central nervous system. The mechanism through which DBS alleviates motor symptoms in Parkinson disease is not understood. However, what has become apparent is that proper location of stimulating electrodes within a target whether it is the STN or the globus pallidus interna is extremely important. It has been repeatedly demonstrated that movement or misplacement of the electrodes by as little as 1 to 2 mm can make a tremendous difference in terms of the therapeutic benefit the patient achieves. This is obviously very important because one of the problems with radiosurgery in terms of treatment of movement disorders is that the size and location of the lesion cannot be as exquisitely controlled.

Patients with Parkinson disease should be treated with pharmacologic agents when significant functional impairment begins. There is a wide variety of medical treatments available that provide many years of excellent symptomatic relief of the motor symptomatology of Parkinson disease. When the patient begins to develop motor fluctuations and/or dyskinesias, surgical options can be considered. The most widely used surgical option at this time is DBS of the STN, which has been extensively studied. Radiosurgery lesioning in the treatment of parkinsonism must not only be compared with medical therapy but also with DBS. Radiosurgery lesioning in Parkinson disease was reviewed in the previous chapter, and because of the limited number of patients that have had this procedure, the nature of the studies, and serious adverse events that have been published, the difficulty with control of lesion size and location and the delay between treatment and therapeutic outcome currently indicate that if a surgical option is to be employed, DBS or a conventional ablative procedure is the better choice. Radiosurgery lesioning in Parkinson disease should be considered in patients who are too frail to undergo DBS procedures or who have severe complicating medical problems that would interfere with the placement of the electrodes.