Metachronous Deep Brain Stimulation
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1. Introduction

Patients with movement disorders present with a variety of symptomatology. In many cases, the symptomatology includes the triad of bradykinesia, rigidity, and tremor. The tremor is often not symmetrical. In some patients, tremor is the major disabling symptom of their movement disorder. Previously published works demonstrate the utility of a unilateral deep brain stimulator or unilateral thalamotomy in the reduction of tremor. [1-3]. However, unilateral thalamotomy oftentimes does not address the ipsilateral rigidity and tremor, nor some of the contralateral rigidity. We identified a group of patients in whom the symptomatology consisted of a mixture of tremor as the presenting symptom coupled with akinesia and bradykinesia located largely on the contralateral side. There were some patients with tremor on the contralateral side as well. The difference in the grade of each of the aforementioned symptoms from the presenting tremor side and the contralateral side were at least one or two grades, utilizing the United Parkinson’s Disease scale (UPRDS).

2. Materials and Methods

Seven patients were identified with asymmetry of tremor. In five of these seven patients, a tremor was present only on the dominant side. In two patients, tremor was present bilaterally, but clearly more disabling on the dominant side. These patients also had symptomatology of rigidity and bradykinesia on the contralateral side. Three of the patients had rigidity on the same side as the tremor, especially in the lower extremity, while the upper extremity demonstrated largely tremor and no rigidity. Exclusionary criteria included dementia, stroke or infarct in the area of lesioning and/or deep brain stimulation, and a bleeding diathesis. Patients were evaluated with standard neurological evaluation and history and physical. They also had testing involving the UPRDS scale, tremor ratings and Oswestry Disability Scale and SF36 forms. The patients underwent preoperative imaging and studies with MRI. They were videotaped for gait and postural analysis. The video was analyzed both for comparison purposes both pre- and postoperatively, as well as initially with a motor program to evaluate angle of gait, angle of trunk and steppage issues (Peak Performance Technologies, Colorado Springs, CO). The patients were candidates for the unilateral treatment for tremor on the basis of the presenting symptom. This was always treated first. In five of seven patients, the tremor side underwent implantation of a deep brain stimulator with standard CT-guided targeting [4]. The deep brain electrode was implanted, stimulated and tested in the operating room (Activa System, Medtronic, Inc., Minneapolis, MN). It was connected to the implant power device, all as part of the same procedure after final determination of the best site by stimulation.

The patients began stimulation 2 days postoperatively. Within 2 months of the original surgery, patients underwent deep brain stimulation and implant on the contralateral side for the additional symptoms of their movement disorder (rigidity, akinesia, bradykinesia or tremor). In this case, they had a contralateral subthalamic stimulator placed. This was placed utilizing CT guided targeting, Schaltenbrand and Bailey Atlas and macro-stimulation. Stimulation parameters varied in the postoperative groups according to their symptomatology. Programming was done by the operating surgeon. Rates of stimulation range between 160-180 Hz. MAs averaged 2 to 4.5 over the length of the study. Other parameters were individualized to the patients. No ramp was used. The patients were evaluated at 1 month, 3 months and 6 months following surgery with a SF36 form, UPRDS, video imaging and neurologic interview. All patients had their 3-month follow up with a neurologist independent of a neurosurgeon.
3. Results

Implantation at the site of tremor improved tremor in 86 percent of the patients. The tremor was either completely reduced in 61 percent, or markedly reduced in the remaining patients. With implantation in the thalamus, an initial reduction in the bradykinesia contralaterally was seen in the first 3 to 4 weeks, but was not sustained. Following contralateral implantation, half of the patients reported bilateral reduction in the rigidity. The akinesia improved on the implanted side when the subthalamic nucleus was targeted, and was most marked in patients who had been treated only with dopamine agent drugs. In the patients with dopamine agents in use, they had a lessened reduction in tremor on the secondary side. Testing of tremor reduction in the drug-on or drug-off state was not different. Motor improvement (bradykinesia, akinesia) was most improved in both groups during stimulation. Motor improvement of bradykinesia was seen to be better in the drug-off than in the drug on group, whereas akinesia was not seen to be different in its degree of improvement relative to the drug status [5-6], especially contralateral to the subthalamic nucleus implants. There was one infection at the implant site. This electrode was externalized and the generator was able to be replaced after 1 month of antibiotics. Two patients went on to develop dementia, but remained well controlled vis a vis their akinesia, rigidity and tremor.

4. Conclusion

Patients with metachronous staged implantation of the thalamus on one side and subthalamic nucleus on the other side present a subgroup of patients with movement disorders who may benefit from the non-balanced regimen. Metachronous implants in the thalamus and subthalamic nucleus may allow for more precise treatment of asymmetric tremor and a more balanced treatment of akinesia and rigidity. We have not seen any neurologic complications in this small group at 1-year follow up.

References