**Deep brain stimulation of anteromedial globus pallidus internus for severe Tourette syndrome**

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**ABSTRACT**

Tourette syndrome (TS) is a complex disorder characterized by tics and is associated with behavioral problems. Although its intensity decreases in adolescence and adult life, in some cases it continues to remain severe and refractory to medical treatment. Deep brain stimulation has been offered as a treatment option in such cases. We report two cases of TS treated with anteromedial globus pallidus internus. Both the cases had good postoperative control of tics and associated obsessive–compulsive behavior.

**Key words:** Anteromedial globus pallidus internus deep brain stimulation for Tourette Syndrome, Deep brain stimulation, Deep brain stimulation for Tourette Syndrome

**INTRODUCTION**

Tourette syndrome (TS) is a complex neuropsychiatric disorder with various combinations of motor and vocal tics. The DSM-V diagnostic criteria require the presence of tics for more than a year, onset before 18 years of age, and occurrence of both multiple motor and at least one phonic tic for a definitive diagnosis of TS. A subset of TS patients remains refractory to medical management and behavioral therapies. Deep brain stimulation (DBS) has been offered to them since 1999. The two most common targets for DBS have been centromedian nucleus-parafascicular complex (Cm-pfc) and parts of globus pallidus internus (GPi). Most of the published work is in the form of case reports of one or two cases and short follow-ups, with only few having larger numbers. We report two cases of TS treated with anteromedial GPi (amGPi) DBS using Vercise® device, with 18 months’ follow-up. This is the first case report of TS being treated with the Vercise® device.

**CASE REPORTS**

We report two cases of severe TS who met the inclusion criteria recommended by TSA and underwent amGPi DBS at our institute. The study was approved by the Scientific and Ethics Committee of the Jaslok Hospital and research center.

**Case 1**

A 27-year-old male presented with complaints of uncontrolled tics from the age of 5 years. The complex motor tics involved, repetitive and jerky movements of the head, throwing the head back, hitting on the chest with hand, and flinging movements of his arms. Initially, they were of less severity and frequency; however, they continued to increase through the years. Despite all odds, he developed a career as an animation expert. However, due to severe tic movements, he had to leave his job, and this led him...
to depression and anxiety. He visited several doctors, psychiatrists, and received various treatment and medicines without improvement. He also failed to respond to cognitive and behavioral therapy. Along with the motor tics, he also had vocal tics in the form of making sounds through the throat. He had marked anxiety and obsessive–compulsive behavior (OCB). His Yales Global Tic Severity Score (YGTSS) was 80/100, and Yale–Brown Obsessive Compulsive Scale (YBOCS) score was 22/40. Premontory Urge for Tics Scale (PUTS) was 24 indicating medium intensity. There was no structural lesion on magnetic resonance imaging of the brain. He had adequate self-motivation and family support. He underwent bilateral amGpi DBS with Vercise® device. Center of the anterior one-third of the GPi as selected as the target. At the time of discharge, he had 75%–80% subjective relief from his symptoms. At 18 months’ follow-up, his YGTSS was 22/100, his YBOCS was 2/40, and the PUTS score was only 6. After surgery, he resumed back his profession as an animation designer.

Case 2
A 31-year-old male presented with vocal and motor tics from the age of 6 years. Initially, the motor tics were in the form of repetitive and jerky movements of the head, throwing the head back, flinging movements of his arms, touching the shoulder with his chin, jerking and shrugging of shoulders and broadening of the nostrils as if smelling something. Similarly, his initial vocal tics included sniffing and throat clearing which appeared at the age of 23 years. This was associated with coprolalia.

The TS was associated with OCB, such as smelling his armpit, rubbing of feet, and scratching private parts. The patient also reported of having an urge to hurt other people, fear of traveling, driving, unwanted sexual thoughts with strangers, and family members. Due to severe tics movements, he had to leave his job, and this led him to have depression and anxiety. The symptoms were refractory to all medical treatments, including behavioral therapy. His preoperative YGTSS was 78/100, and YBOCS score was 19/40. He underwent bilateral amGpi DBS with Vercise® device. At 18-month follow-up, his YGTSS was 34/100, and the YBOCS score was 2/40. He has resumed back his job and enjoying his hobbies, one of them being able to play football.

DISCUSSION

Tourette’s syndrome (TS) is a complex neuropsychiatric disorder characterized by tics (both motor and vocal) and associated comorbid psychiatric condition.[8] It has estimated the worldwide prevalence of 4–5/10,000.[5] It is associated with a wide range of comorbid behavioral abnormalities including attention-deficit hyperactivity disorder in 21%–90%, OCB in 50%, and other anxiety and mood disorders.[8] However, the incidence of OCB and other mood disorders increases in severe TS.[3] In the operative series published by Sachdev et al.,[7] 9 out of 11 patients had OCB. Both our patients had moderate OCB. In 1999, Vandewalle et al. reported the first DBS for medically refractory TS.[1] Since then, around 162 patients have undergone DBS for TS at eight different brain targets, the two most common being Cm-pfc (78 patients) and amGpi (44 patients).[2] There was a median improvement of 52.68% in the global YGTSS and 48% reduction in severity of tic scores in this meta-analysis.

The amGpi contains the associative and limbic connections of Gpi. One proposed neurobiological model of TS hypothesizes the existence of aberrant foci of striatal neurons that become inappropriately active.[8] These foci of striatal overactivity lead to altered output to the Gpi and substantia nigra, which in turn causes an imbalance of the normal promotion of voluntary movements and suppression of involuntary movements. Thus, neuromodulation of the Gpi can serve to counteract the overactive striatal output.[9] The limbic connections of the Gpi through nucleus accumbens also aid in improving the behavioral and mood comorbidities associated with severe TS.[7] In a double-blind randomized crossover study of three patients, Welter et al. found that amGpi stimulation improved the tic severity scores significantly greater than the Cm-pfc stimulation in two of the three patients.[10] Van der Linden et al. implanted leads in amGpi and Cm-pfc in one patient and performed trial (external) stimulation to select the lead. H found amGpi stimulation improved the scores better than Cm-pfc stimulation and went on to permanently implant the amGpi lead.[11] Sachdev et al. reported on a series of eleven patients undergoing amGpi DBS. Ten of the 11 patients improved after surgery with six patients having more than 50% improvement in YGTSS. The mean reduction in YGTSS was 49%. The YBOCS scores improved from a mean of 15.82–6.55. There were no severe intraoperative adverse events.[7] In another series, Kefalopoulou et al. reported that there was 12.4 points improvement in patients undergoing amGpi stimulation, between their off stimulation and on stimulation condition in a double-blind randomized crossover study.[13] In our patients, we had a mean improvement of 42 points of YGTSS scores, equivalent to 58% of improvement. The YBOCS scores also improved from a mean of 20.5 points to 2 points. There were no associated intraoperative adverse events.

CONCLUSION

DBS for TS is now being increasingly practiced worldwide.[3] The jury is still out as to which is the most appropriate target, as most of the information is based on case reports. However, based on the published literature and relative safety of the targeted site, we performed amGpi DBS with results comparable to those published...
earlier. We conclude that amGpi DBS offers significant improvement in severe TS patients.

Declaration of patient consent
The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

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