DBS Targeting in a Neuromodulation Monitoring Unit
First 30 cases

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Abstract

Summary: We evaluate targets for Deep Brain Stimulation (DBS) based on stimulation and chronic recording from temporary depth electrodes placed in a **Neuromodulation Monitoring Unit** (NMU).

Rationale: The optimal target for deep brain stimulation (DBS) in children is often not known, and it is likely that the best target may vary depending on the etiology and anatomic distribution of injury in each child.

Methods

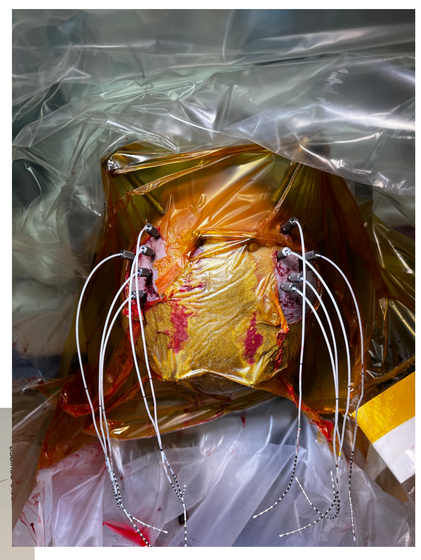
10-12 Adtech depth electrodes record simultaneously from 160-192 channels in basal ganglia and thalamus in awake children 24 hours per day for up to 1 week. We perform test stimulations to predict the effect of permanent DBS electrode implantation.

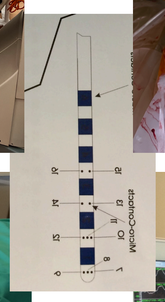
Results

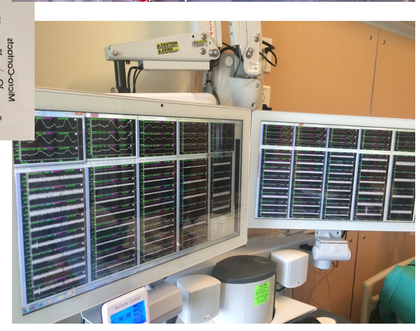
- Optimal stimulation target varies between children.
- **Improvement more than 5 points on BFMDRS scale in 27/28 children with dystonia.**
- 4 permanent electrodes
- No persistent adverse events.

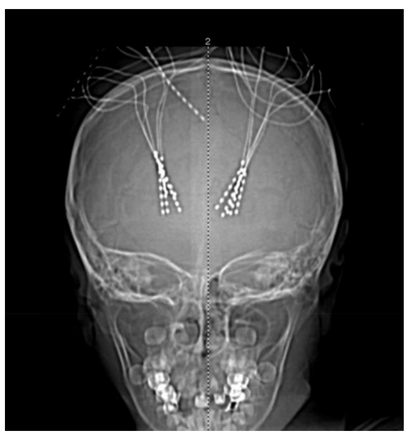
Conclusion

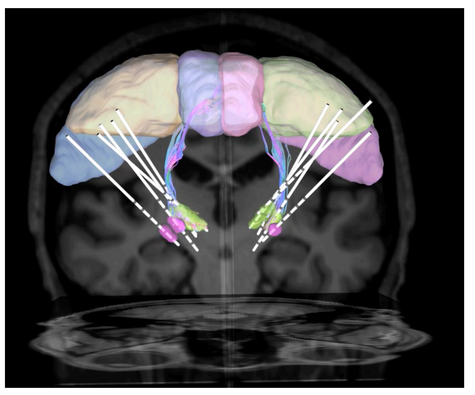
The new method of DBS targeting identified different targets that varied between children. This method may increase effectiveness and allow DBS to be applied to a broader range of children including those with diagnoses not previously known to respond to stimulation.

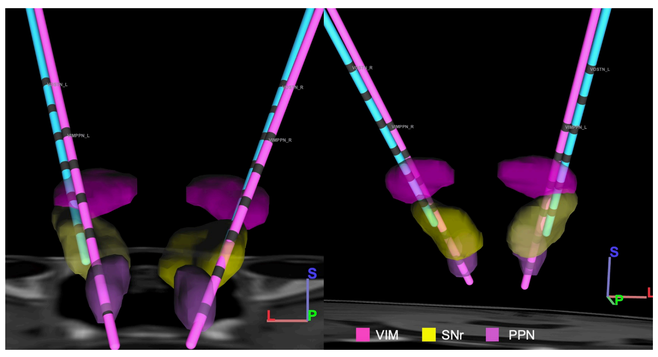




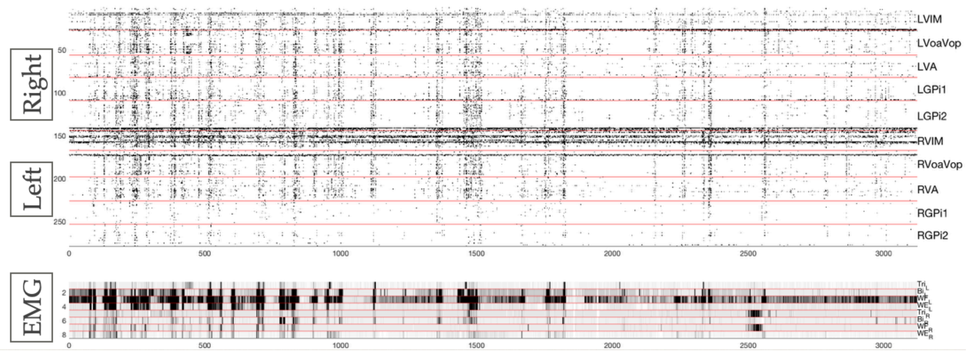




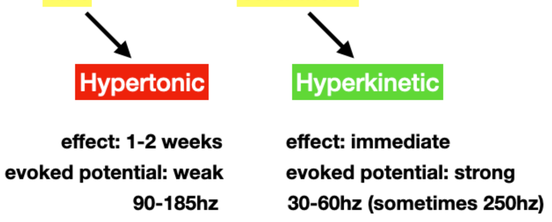




Recording



Stimulation

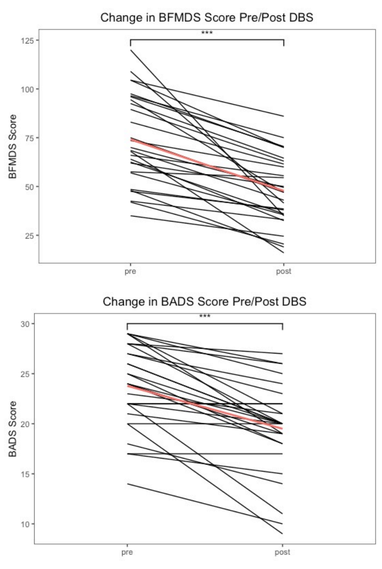


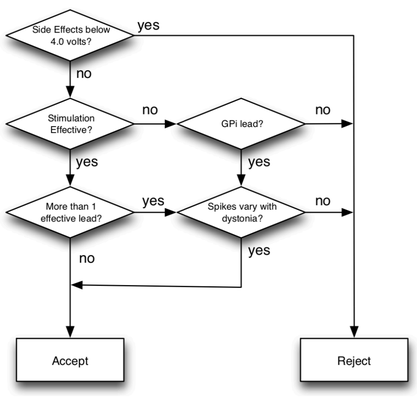
Near-complete resolution of hyperkinetic component.

Details

We present 30 cases of a technique for determining optimal neuro-anatomical targets. Up to 12 Adtech ™ MM16C depth electrodes are implanted in each child in multiple brain regions, including subthalamic nucleus (STN), internal globus pallidus (GPi), ventrolateral nucleus of the thalamus (VL), ventral intermediate nucleus of the thalamus (Vim), and ventroposterolateral nucleus of the thalamus (VPL). Each electrode has up to 10 high-impedance “micro” contacts capable of identifying local spikes, and 6 “macro” contacts capable of identifying standard local field potentials and through which test stimulation can be performed. Children are monitored for up to 1 week in the neuromodulation monitoring unit (NMU) with continuous and simultaneous recording from up to 192 contacts (Tucker-Davis Technologies recording system), and bipolar stimulation at macro contacts during attempts at movement.

Changes in BADS and BFMDRS scores were examined using mixed-effects models, which were coded in the R environment (version 4.1.2) using the ‘lme4’ package [1]. Time (pre and post) was included as a fixed effect, while subject level variability was modeled as a random effect. The p-values from these models were obtained in R [2]. There was a statistically significant difference in both the BADS and BFMDRS scores. The mean change in BADS was 4.3 (95% CI: 3.1, 5.5, $p < 0.001$). The mean change in BFMDRS was 26.4 (95% CI: 19.5, 33.2, $p < 0.001$).





Subject	Etiology	Genetic/other factors	Type or characteristics	hyperkinetic vs hypertonic	Age at Implant	BAD Pre	BAD Post	Change in BAD	BFMDS Pre	BFMDS Post	Change in BFMDS
1	primary generalized dystonia	compound heterozygous mutation in PcdhA7 gene	dystonia	hypertonic	6	29.0	19.0	-10.0	120.0	35.0	**-85.0**
2	Kernicterus	G6PD Deficiency	dystonia	hyperkinetic	15	28.0	26.0	-2.0	109.0	41.5	**-67.5**
3	DYT1 primary dystonia		dystonia	hyperkinetic	16	22.0	11.0	-11.0	68.0	16.0	**-52.0**
4	H-ABC syndrome	TUBB4A mutation	dystonia, ataxia	hypertonic	13	26.0	20.0	-6.0	94.5	47.0	**-47.5**
5	Cerebral Palsy (FT and neonatal depression)		dystonia	hyperkinetic	18	29.0	25.0	-4.0	104.5	70.0	**-34.5**
6	dyskinetic cerebral palsy	variants of unknown significance in KMT2B and CACNA1A	hyperkinetic dystonia	hyperkinetic	12	25.0	20.0	-5.0	64.0	32.5	**-31.5**
7	Cerebral Palsy	lymphangioma and respiratory arrest at 4mo	dystonia	hypertonic	20	17.0	15.0	-2.0	48.0	19.0	**-29.0**
8	Cerebral Folate Deficiency	Antibody-mediated	dystonia	hyperkinetic	7	28.0	20.0	-8.0	92.5	64.5	**-28.0**
9	Lesch Nyhan		dystonia	hypertonic	14	27.0	24.0	-3.0	75.0	47.0	**-28.0**
10	primary (ADCY5)	ADCY5	dystonia	hypertonic	10	28.0	27.0	-1.0	97.5	70.0	**-27.5**
11	Post-pump chorea	Williams Syndrome	chorea	hyperkinetic	5	27.0	23.0	-4.0	89.5	63.0	**-26.5**
12	Right midbrain and inferior stroke	astrocytoma resection	Cervical and hemi-dystonia	hypertonic	18	24.0	20.0	-4.0	62.5	36.0	**-26.5**
13	Kernicterus		dystonia	hypertonic	19	25.0	18.0	-7.0	68.5	43.0	**-25.5**
14	Kernicterus	G6PD Deficiency	dystonia	hyperkinetic	9	29.0	21.0	-8.0	96.0	70.5	**-25.5**
15	Unknown (possible vasculitic)	possible immune deficiency/autoimmune disorder	left hemidystonia	hypertonic	14	20.0	9.0	-11.0	42.0	20.5	**-21.5**
16	Unknown (dx CP)	Multiple chromosome abnormalities and homozygosity	dystonia	hyperkinetic	14	24.0	18.0	-6.0	57.0	35.5	**-21.5**
17	Unknown (dx CP)	microcephaly and right microopthalmia	dystonia	hypertonic	19	26.0	20.0	-6.0	96.5	75.0	**-21.5**
18	Cerebral Palsy	schizencephaly	dystonia	hypertonic	16	24.0	19.0	-5.0	83.0	61.5	**-21.5**
19	Huntington's Disease	86 CAG repeats	dystonia s/t Huntingtons	hypertonic	12	23.0	21.0	-2.0	70.0	49.5	**-20.5**
20	Cerebral Palsy	fever/meningitis at 3 days old	dystonia	hypertonic	20	29.0	26.0	-3.0	104.5	86.0	**-18.5**
21	Cerebral palsy	Perinatal HIE	dystonia	hyperkinetic	12	22.0	22.0	0.0	73.5	60.0	**-13.5**
22	Stroke	Hemolytic Uremic Syndrome	dystonia	hypertonic	6	22.0	22.0	0.0	62.0	50.0	**-12.0**
23	unknown (dx CP)	presumed primary	dystonia	hyperkinetic	12	14.0	10.0	-4.0	35.0	24.5	**-10.5**
24	Cerebral Palsy	Perinatal HIE	dystonia	hypertonic	14	21.0	19.0	-2.0	48.5	38.0	**-10.5**
25	Cerebral Palsy	XXX syndrome	dystonia	hypertonic	10	22.0	20.0	-2.0	66.0	55.5	**-10.5**
26	Cerebral Palsy (HIE)		dystonia	hypertonic	8	17.0	17.0	0.0	42.5	33.0	**-9.5**
27	Cerebral Palsy	Perinatal HIE	dystonia	hypertonic	18	18.0	14.0	-4.0	47.5	38.5	**-9.0**
28	Cerebral Palsy	prematurity	dystonia	hypertonic	15	20.0	20.0	0.0	57.5	54.5	**-3.0**
29	Tourette Syndrome		Motor and vocal tics		15						
30	Kernicterus	G6PD Deficiency, cochlear implant	dystonia; not implanted	hypertonic	17						