

## BACKGROUND

- Variables determining outcomes in deep brain stimulation (DBS) for Parkinson's disease (PD) include patient selection, electrode placement, and device programming (Bronstein 2011)
- Methods for optimizing electrode placement
  - Microelectrode recording (MER)
  - Macrostimulation
  - Anatomic lead placement with magnetic resonance imaging (MRI) or other image guidance
- No Class I evidence exists to support that use of MER improves patient outcomes compared to other approaches
- Potential risks of MER
  - Major vascular injury: 1.7-3.4% (Hariz 2002, Gorgulho 2005, Sansur 2007, Zrinzo et al 2012)
  - 1.6% of these hemorrhages are symptomatic (Kenney 2007, Baizabal Carvallo 2012)
  - Likely due to the use of multiple parallel trajectories to map the target nucleus
  - Requires an awake and prolonged procedure for the patient
- Although neurophysiological mapping is lacking with MRI-guided approach, this technique has been shown to be effective and safe with accurate electrode placement (Liu 2001, Starr 2010, Foltynie 2011)
- Potential benefits of image guidance
  - Single planned surgical trajectory
  - May be performed under general anesthesia
  - Ability to account for brain shift through intra-operative imaging
  - Early detection of intraoperative hemorrhage
- The relative safety and efficacy of image guided electrode placement compared to traditional MER-guidance has not been studied.

**OBJECTIVE:** To obtain pilot data comparing the safety and efficacy of DBS electrode implantation using MRI guidance to MER guidance in patients with Parkinson's disease (PD).

## METHODS

- Patients with PD considered by consensus opinion to be candidates for DBS placement in the subthalamic nucleus (STN) or pallidum (GPI) were randomized to MER- vs MRI-guided procedures.
- Inclusion Criteria:**
  - Age 30-79
  - Diagnosis of idiopathic PD
  - Determined to be candidates for STN or GPI DBS by consensus recommendation of a multidisciplinary team as evidenced by:
    - Ability to provide informed consent as determined by preoperative neuropsychological assessment
    - Optimized medically by a movement disorders neurologist.
    - Persistent motor symptoms which are not effectively controlled with optimal medical management. These symptoms may include levodopa-induced dyskinesias, tremor, or fluctuations in the effectiveness of levodopa throughout the day.
- Exclusion Criteria:**
  - Dementia as determined by pre-operative neuropsychological assessment
  - Previous intracranial surgery
  - Intracranial tumor
  - Lack of ability to provide informed consent as determined by preoperative neuropsychological assessment
  - Medical co-morbidities that would make the patient a poor surgical candidate
- Pre-operative motor score off medications was compared to post-operative on DBS/off medication score at >6months.
- Pre- and post-operative neuropsychological assessments, number of MER tracts or stylet passes, incidence of radiologically-apparent hemorrhage, and surgical complications were also compared.
- Radial error of electrode placement based on post-op high-res CT
- Post-operative neurology and neuropsychology raters were blinded to treatment assignment.

## RESULTS

Figure 1: Subject characteristics and follow-up

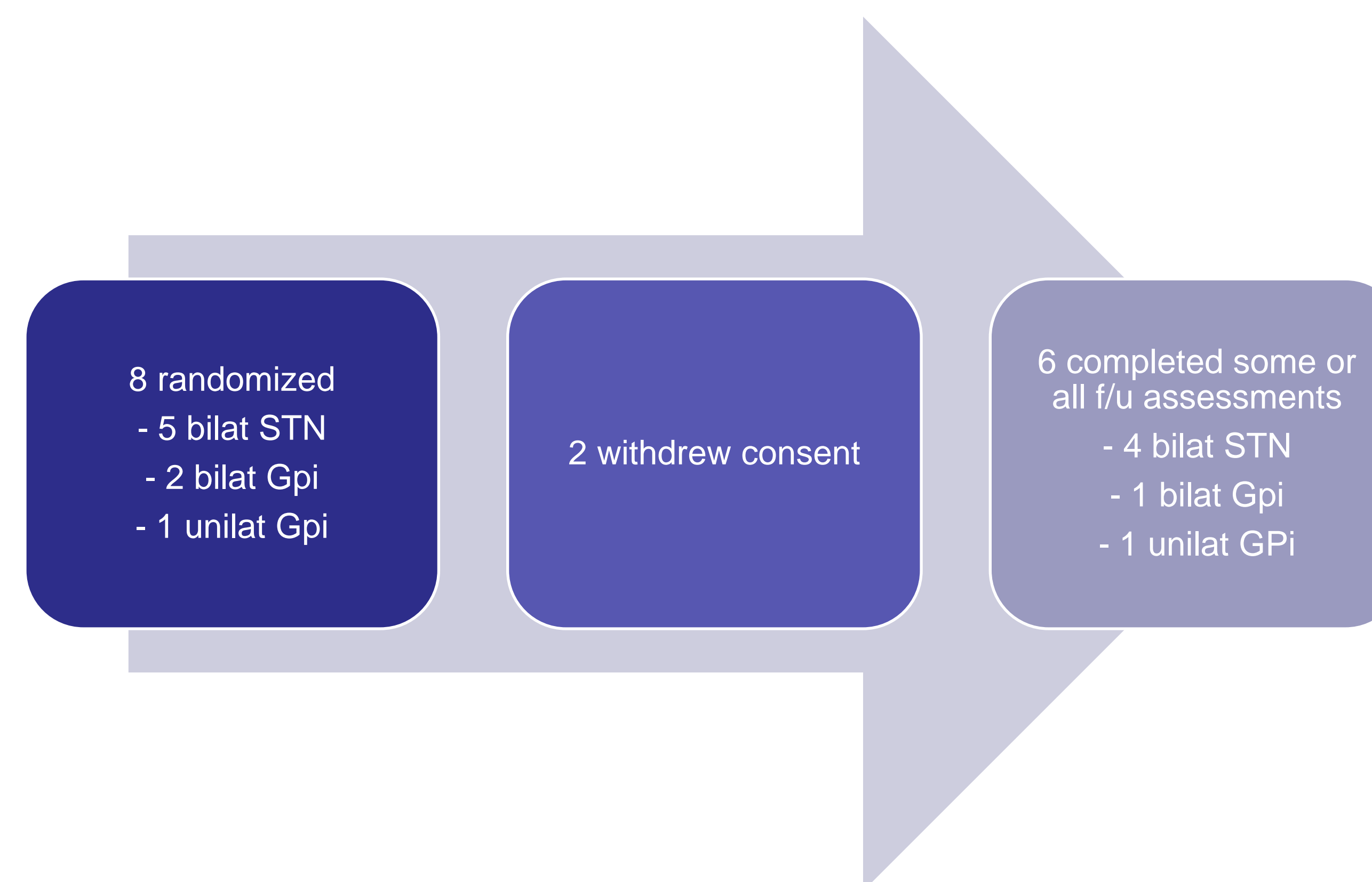


Table 1: Surgical outcomes

	MRI	MER
<b>N</b>	3	5
<b>Electrodes</b>	5	10
<b>Mean# stylet passes or MER tract per electrode</b>	1	2.3 (range 2-4)
<b>Microlesion effect</b>	1 (33%)	4 (80%)
<b>Mean radial error</b>	0.6mm +/- 0.3mm	1.1 +/- 0.3mm
<b>Adverse events</b>		
<b>Hemorrhage</b>	0	0
<b>Surgical</b>	0	0
<b>Post-operative</b>	0.33 per patient* (1 in 3 pts)	1.4 per patient† (7 in 5 pts)

\* hardware discomfort; † headaches, tremors worse, confusion, falls leg cramps, hardware discomfort

Table 2: Neurologic Outcomes

	MRI	MER
<b>Mean baseline UPDRS</b>	39.0±14.0	38.3±13.3
<b>% improvement UPDRS*</b>	43.7±32.3% (n=2)	33.7±0.49% (n=2)
<b>% Δ LEDD</b>	69.7±27.4	23.2±43.7
<b>Mean time (d) after surgery</b>	229±67	191±10

\* on stim/off meds compared to off meds baseline  
UPDRS = Unified Parkinson's Disease Rating Scale  
LEDD = levodopa equivalent daily dosing

## RESULTS – CONT.

Table 3: Neuropsychological Outcomes

Pre-operative	Post-operative
Premorbid intellectual functioning was not significantly different between the groups.	
MMSE scores were intact and not significantly different between the groups (MRI: 29 vs MER: 26).	MMSE remained intact for both groups.
Total DRS total scores were significantly different between the groups, but both are considered intact (MRI: 143 vs MER: 140).	<ul style="list-style-type: none"> <li>DRS Total scores were not significantly different between the groups and did not significantly change following surgery.</li> <li>A trend for slower processing speed for the MER group after surgery (Trail Making Part A, Symbol Digit written).</li> <li>Significant difference between the groups on a problem solving/reasoning task (WCST categories and total errors) with an improvement noted in the MRI group.</li> </ul>
No significant differences in depression or anxiety scores.	Depression scores were significantly higher for the MER group versus the MRI group (MRI: 4 and MER: 10), but both are considered minimal levels.
No other significant differences between the groups.	

## CONCLUSIONS

- MER allows for electrophysiological mapping of the brain target in DBS procedures (either STN or GPI), but is not the only effective methodology for accurate electrode placement.
- This pilot study suggests that, compared to MER guidance for DBS electrode placement, MRI-guided procedures in patients with PD may be associated with:
  - Fewer electrode passes
  - Fewer post-operative side effects
  - Less chance of microlesion effect
  - Less radial error in electrode placement
- UPDRS and LEDD should be interpreted with caution due to variance in follow-up interval
- Neuropsychological measures should be interpreted with caution due to small sample size
- Further study is warranted to verify these findings in a larger cohort of patients.

## REFERENCES

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