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Improved Intraoperative Therapeutic Window with Directional DBS Compared to Omnidirectional DBS Using a Novel Lead Design

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Introduction: Deep brain stimulation (DBS) is currently carried in all directions around the stimulation lead. Computational models show that directional leads may improve focalization of current flow in the brain but their clinical application has not yet been investigated. We report four cases of an on-going intraoperative study using directional DBS.

Methods: Three males with Parkinson's Disease underwent STN DBS and one male with Essential Tremor underwent Vim DBS, including intraoperative microrecording and macrostimulation. At the target determined for the permanent electrode, directional stimulation was assessed using a novel lead (directSTIM™, Aleva Neurotherapeutics, Switzerland). It features two rings of three independent electrodes of 1mm² (figure). The angular position of the electrodes allows stimulation at 0°, 120° and 240° directions. The parameters of stimulation were monopolar, 90µs, and 130Hz. The therapeutic window (TW) is defined as the electrical current threshold at which side effects occur minus the current threshold at which a significant therapeutic effect on motor symptoms is observed (low boundary=TWLB). The TW was measured in each direction (TWdir) and the best TWdir was compared to omnidirectional stimulation (TWomni).

Results: 2/4 patients showed a ratio TWdir/TWomni ≤ 0.25. 1/4 did not show a ratio <1. The ratio could not be measured on 1/4 patient. The best directional TWLB was 0.63mA(0.3-0.9mA) and was lower than the omnidirectional TWLB 1.13mA(0.6-1.95mA). No added benefit was observed using two electrodes either one above the other or one next to the other.

Conclusions: These first observations suggest that directional TW is increased compared to omnidirectional TW. Moreover, TWLB for therapeutic effect is significantly lower (<1mA) in the best direction compared to omnidirectional stimulation.. Therefore, directional stimulation may increase effectiveness of DBS. Further intraoperative and chronic studies are needed to confirm these results.

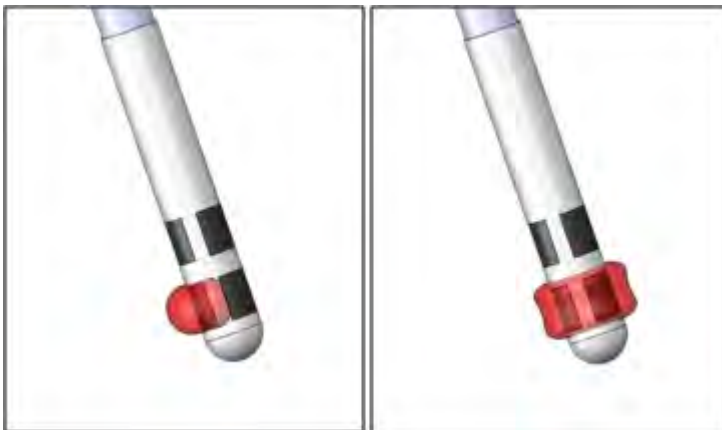


Figure: computed volume of tissue activated with one contact stimulated(left) compared to 3 contacts(right).