A Novel Database Lookup Method for Deep Brain Stimulation Network Mapping

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1. INTRODUCTION

Clinical outcomes following deep brain stimulation (DBS) to the subthalamic nucleus (STN) in Parkinson’s disease (PD) can be predicted based on functional connectivity (FC) seeding from stimulation sites [1].

Previously, to do so, optimal connectivity was condensed to a single map, which was then compared with connectivity profiles of patients in other cohorts.

Aim:
We developed a revised strategy, which stores each patient’s FC profile and clinical improvements in a look up database and quantifies pairwise similarities to predict unseen patients. Novel patient’s FC is compared to each entry in the database. Based on similarities, a weighted average of improvements in database patients is formed.

2. METHODS

Patients: 51 PD-STN patients that underwent surgery at Charite Berlin.
Clinical improvement: Unified Parkinson’s disease rating scale III (UPDRS-III).
Connectome: Normative resting-state connectome calculated from 1,087 scans included in the Human Connectome Project [2].

Methodological workflow:
1. DBS electrode placement and stimulation volumes (E-fields) were reconstructed using Lead DBS software. FC fingerprints were estimated by seeding from E-fields using the normative connectome.
2. Lookup Database method was used to predict clinical improvement in unseen patients (multiple cross-validation designs).

2.1 Methological workflow:

Database with brain functional connectivities can be used to predict DBS related clinical improvement.

3. RESULTS

Correlations between estimated and empirical UPDRS-III improvements for different types of cross-validations were:

- K7: Pearson’s R = 0.36, p = 0.009
- K7: Leave-one-out: Pearson’s R = 0.35, p = 0.015

4. CONCLUSIONS

We introduce a novel method for DBS network mapping using a look up database. Potential advantages include:

- Model retains more information from the original data.
- Direct prediction of clinical response variable.
- Certainty variable added to account for the ceiling effect.