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Anatomo-Clinical Atlases in SubThalamic Deep Brain Stimulation: correlating clinical data and electrode contacts coordinates

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Introduction

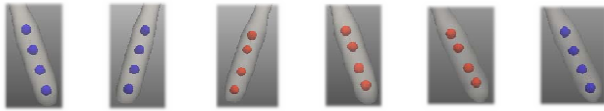
- Constructing **digital atlases** gathering location of electrode contacts and clinical scores for a population of PD patients
- Finding the **optimal therapeutic site** for SubThalamic Deep Brain Stimulation (STN DBS) of Parkinson Disease (PD)
- Studying motor improvement and neuro-psychological side-effects

Data

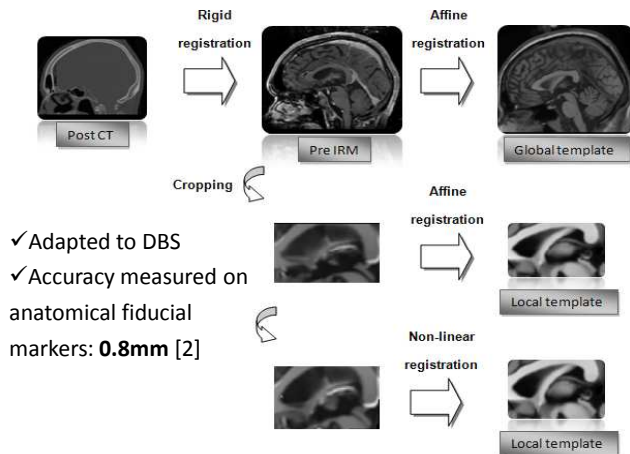
- 30 patients with bilateral STN DBS:
- 15 women and 15 men, mean age: 56 +/- 8 years
 - Pre-operative 3T T1 MRI, pre- and post-operative CT
 - Clinical scores: Pre-op Vs post-op under stimulation
 - Motor scores: UPDRS III, Schwab & England, Hoehn & Yahr
 - Neuropsychological scores: Categorical verbal fluency, phonemic verbal fluency, Trail Making Test (TMT), MATTIS, STROOP

Image Processing

1) Automatic contacts localization on post-op CT [1]



2) Registration on a same anatomical space



Non Supervised Classification

Hierarchical Ascendant Classification (HAC) used on clinical scores merged with coordinates → search homogeneous groups of patients
Vector data: $X = (x, y, z, S)$ with coordinates and clinical score
Ward criterion:

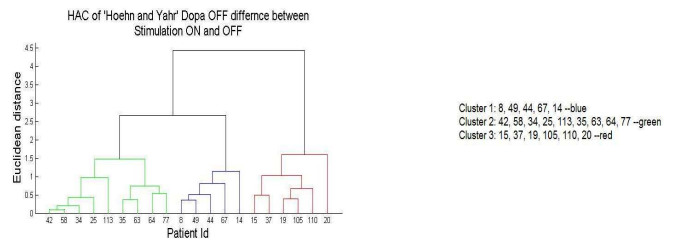
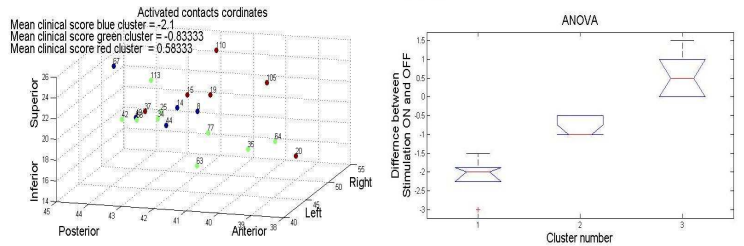
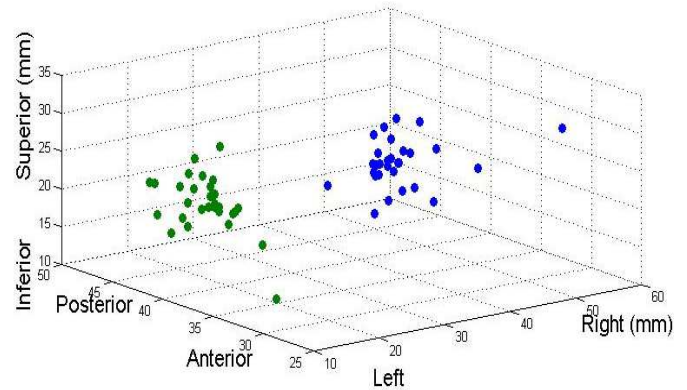
$$d^2(a, b) = \frac{\sum_{k=1}^4 w_k (\bar{x}_{ak} - \bar{x}_{bk})^2}{n_a + n_b}$$

where \bar{x}_a (resp. \bar{x}_b) = $\frac{1}{n_a}$ $\sum_{i=1}^{n_a} x_{ai}$ is the centroid of cluster a (resp. b)

and w_k are the weights, specified by $w_1 = w_2 = w_3 = \frac{1}{6}$ and $w_4 = \frac{1}{2}$.

Results

All electrode activated contacts of the 30 patients:
(1 activated contact * 2 electrodes * 30 patients)
Left electrode activated contacts --green
Right electrode activated contacts --blue



UPDRS III: Better improvement in the postero-superior region

Stroop test: Improvement in the postero-superior region and deterioration in the antero-inferior region

Categorical fluency test: Deterioration in the posterior region, improvement in the antero-superior region

Conclusion

Anatomo-clinical atlases are helpful for:

- Better comprehension of phenomenon
- Pre-operative targeting

Future works will integrate other clinical scores (Quality of life, cognitive criteria)

[1] Lalys et al. "Post-operative assessment in Deep Brain Stimulation based on multimodal images: registration workflow and validation", SPIE Medical Imaging, February 2009

[2] Lalys et al. "Construction and assessment of a 3T MRI brain template", NeuroImage, 49(1):345-354, 2009