Measuring structural connectivity in migraine: the impact of correcting for region volumes

Ana Matoso[1], Ana R Fouto[1], A. Ruiz-Tagle[1], I. Esteves[1], Gina Caetano[1], Nuno A. Silva[2], Pedro Vilela[3], Raquel Gil-Gouveia[4,5], Patricia Figueiredo[1], and Rita G Nunes[1]

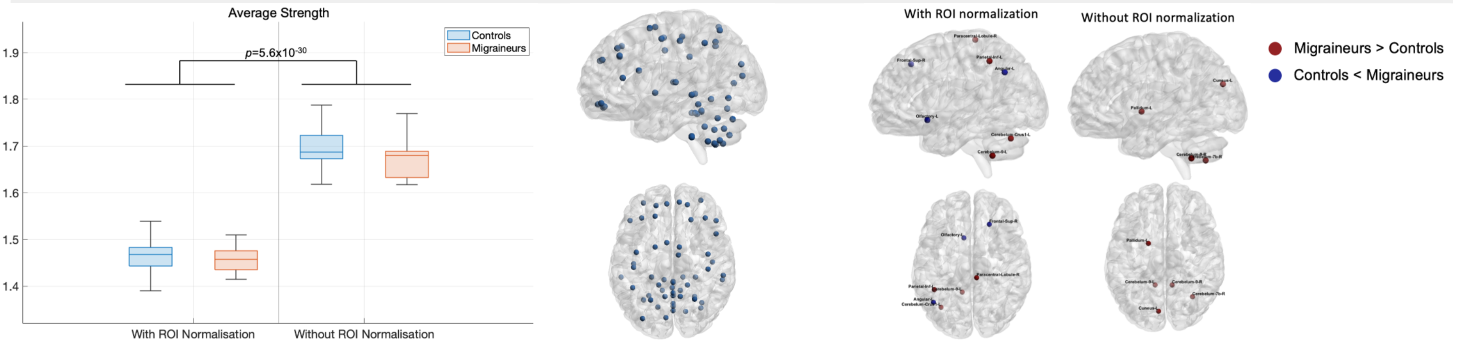
1 Institute for Systems and Robotics- Lisboa and Department of Bioengineering, Instituto Superior Técnico, Universidade de Lisboa, Lisbon, Portugal
2 Learning Health, Hospital da Luz, Lisbon, Portugal
3 Imaging Department, Hospital da Luz, Lisbon, Portugal
4 Neurology Department, Hospital da Luz, Lisbon, Portugal
5 Center for Interdisciplinary Research in Health, Universidade Católica Portuguesa, Lisbon, Portugal

Abstract

INTRODUCTION: Migraine is one of the most prevalent neurological disorders in the world, affecting about 17% of the population worldwide [1]. Recent studies have focused on understanding the neural causes of migraines, investigating changes in the brain's microstructure in migraine sufferers. Brain function relies on a complex wiring architecture with efficient local processing (segregation) and rapid information exchange (integration); in a neurological disease such as migraine, the balance between integration and segregation can be disrupted. To explore these changes, researchers have used diffusion MRI (DWI) and graph theory to analyze brain connectivity [2,3]. However, there is currently no consensus on whether normalizing the connectivity by the regions of interest (ROI) volumes is necessary to avoid potential biases. This study assesses the impact of such normalization in the context of migraine.

METHODS: DWI images were acquired in 14 episodic menstrual migraine patients and in a control group of 15 healthy women. Data preprocessing was done following the DESIGNER pipeline [4]. Tractography based on spherical deconvolution was performed using MRTrix [5] to determine the structural connectome using the AAL116 atlas. Then, global (characteristic path length, global efficiency, average strength, and clustering coefficient) and nodal (strength and clustering coefficient) connectivity metrics were calculated using the BCT toolbox [6] in MATLAB. The metrics were compared between normalizations using a t-test and between controls and migraineurs using a Mann-Whitney U test.

RESULTS & DISCUSSION: All global metrics were significantly different ($p<0.05$ corrected with Bonferroni correction) between normalizations as well as the nodal metrics in several nodes (Figure 1a and 1b). Moreover, when comparing groups, the normalization does not seem to affect the analysis of results when using the global metrics. However, the same cannot be said of the nodal metrics where there appear to be different results depending on the normalization applied (Figure 1c). This shows that, especially when comparing nodal metrics, the normalization chosen is of great importance since it will yield very different results when comparing groups. To conclude, this work demonstrates that applying a normalization by the regions' volume significantly impacts the values of the extracted connectivity metrics which then may influence the results for the comparisons of nodal metrics across groups.



(a) (b) (c)

Figure 1: a) Average strength per group and per normalization. There is a significant difference between the value of the average strength of both normalizations ($p<0.05$ corrected). b) Nodes in which the strength is significantly different between normalizations ($p<0.05$ corrected). c) Nodes in which the strength is significantly different between controls and migraineurs in each of the normalizations ($p<0.05$ uncorrected).

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