

Evaluation Of Neonatal Brain White Matter Development By Using Diffusion Basis Spectrum Imaging

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Introduction

Preterm infants are a major pediatric public health problem in decades [1]. The evaluation of preterm brain white matter is much needed.



Diffusion tensor imaging (DTI): map and characterize cerebral microarchitecture by detecting signal attenuation caused by water molecular movement

Problem: only shows the overall effects of voxels[2], neglects details in voxel

Try to solve it: using advanced model, DBSI

Advantages: show fractions of fiber bundles, intracellular components, extracellular components as well as water components in voxel[3].

Objectives

General goal: characterize main white matter micro-architecture development in preterm using DBSI.

- Apply DBSI on preterm neonatal brains
- Detect DBSI differences between term and preterm (term-equivalent) infant brains

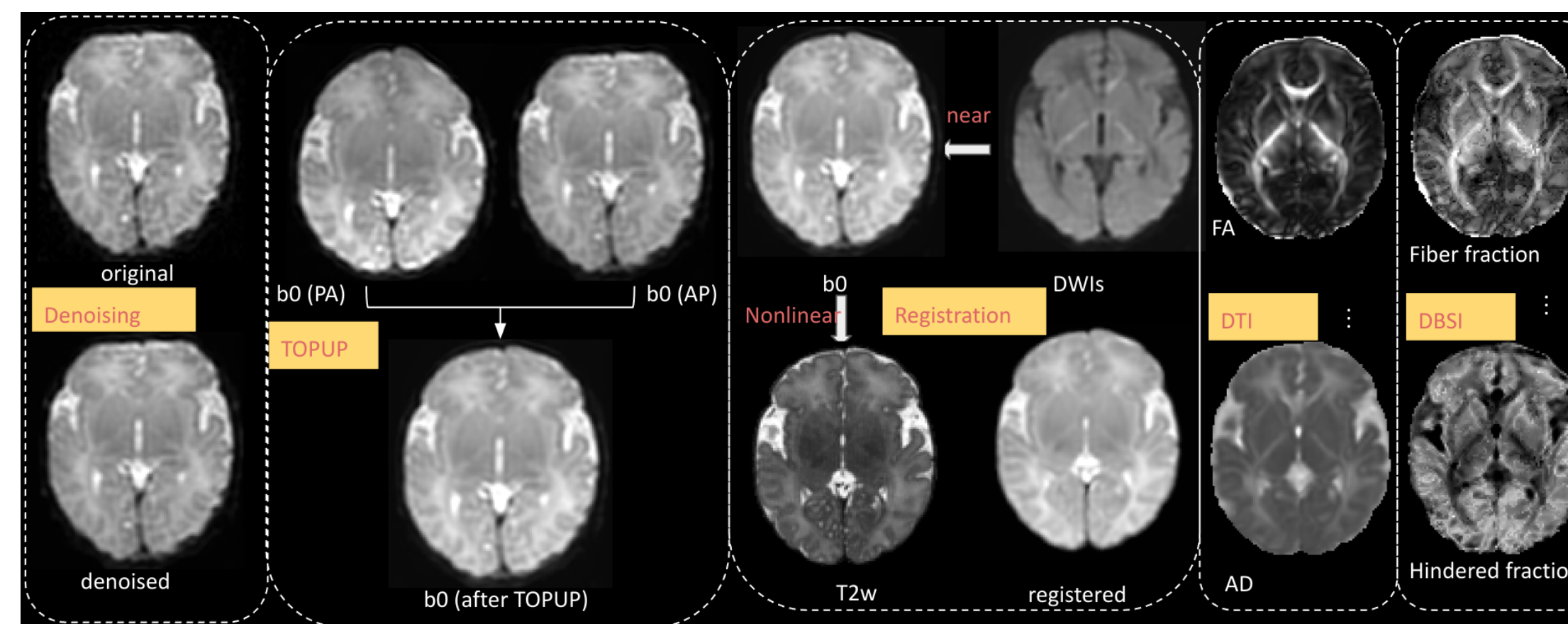
Methods

Three groups of infants were scanned by using GE Discovery™ MR750 scanner.

	Group 1 Preterm Scan 1	Group 2 Preterm Scan 2	Group3 Term control
Age at born (weeks)	32.00 ± 1.49	32.30 ± 1.40	39.11 ± 1.09
Ages at scan (weeks)	34.14 ± 1.19	40.18 ± 0.90	39.51 ± 1.38
Number	15	12	5

dmRI data: $2 \times 2 \times 2mm^3$, TR/TE: 8s/120ms, 2 b_0 and 25 different b ($0 < b \leq 800s/mm^2$)

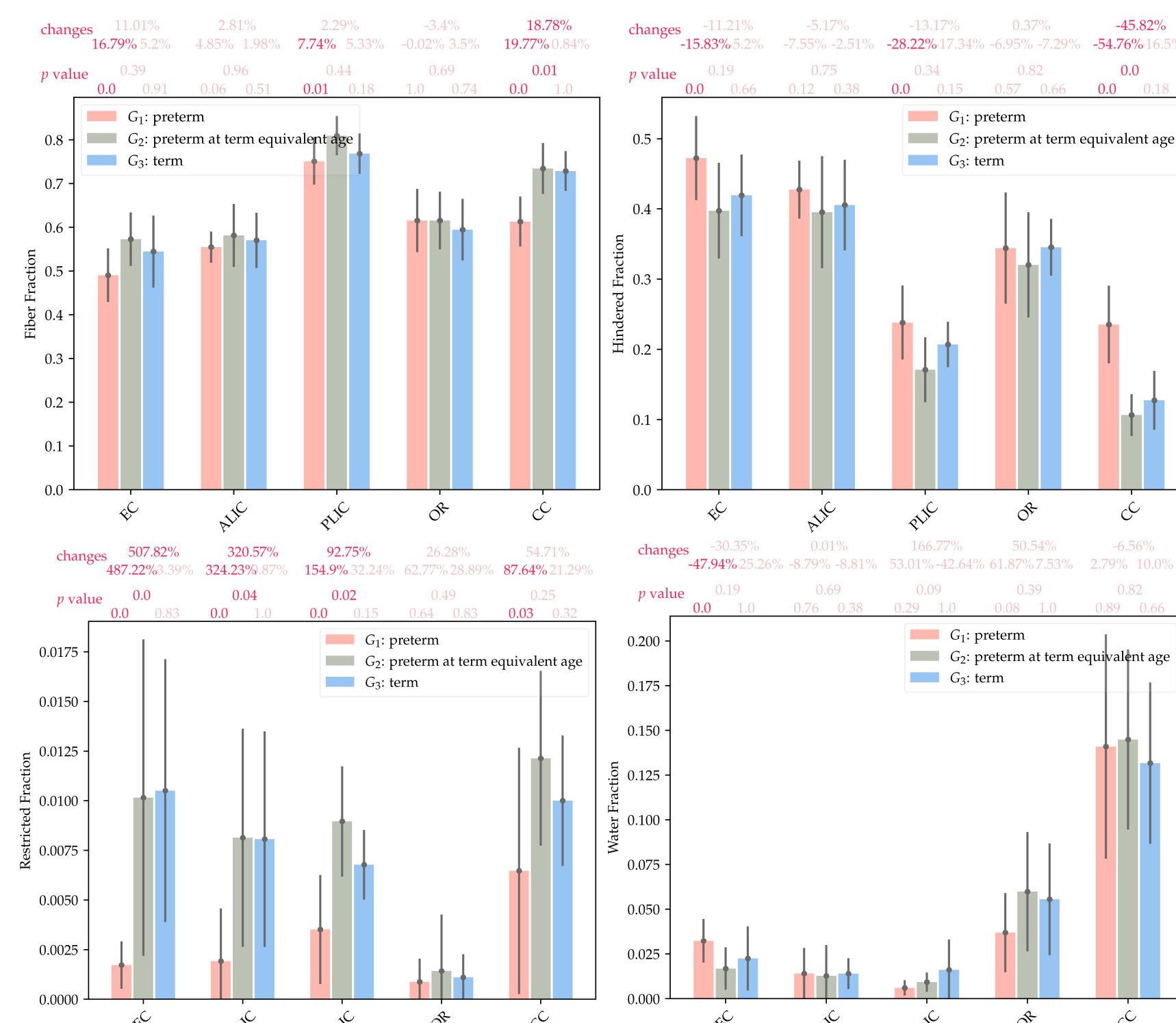
Preprocess:



ROIs (manual): Optic radiation (OR), posterior limb of the internal capsule (PLIC), corpus callosum (CC), external capsule (EC) and anterior limb of the internal capsule (ALIC)

Statistics: comparisons (G_1 vs G_2 , G_2 vs G_3); Mann-whitney test ($p < 0.05$)

Results



Group 2 vs Group 3: no DTI and DBSI significant changes in all ROIs (EC, ALIC, PLIC, OR, CC)

Group 1 vs Group 2:

- In EC, PLIC, and CC, DBSI results showed drastic changes: significant fiber fraction increase (16.79%, 7.74% and 19.77%), significant extra-cellular (hindered) diffusion fraction decrease (-15.83%, -28.22% and -54.76%) and significant intra-cellular (restricted) diffusion fraction increase (487.22%, 154.90% and 87.64%).
- In ALIC, significant changes were found in DBSI results (324.23% increased intra-cullular diffusion fraction), as well as in dti metrics (9.44% decreased AD, 10.69% decreased RD, 10.17% decreased MD).
- Optic radiation (OR) show early maturation already at Group 1 infants, with no major changes in either DTI metrics and DBSI results.

Conclusion

Infants, from 34 weeks to 40 week age, experienced significant brain development (fiber mature, cell component increase, extra-cellular space decrease) in external capsule, posterior limb of the internal capsule and corpus callosum as well as early maturation in optic radiation.

32 weeks preterm infants managed to reach the same level of maturation in major white matter bundles compared to term control infants.

DBSI metrics, especially hindered fraction and restricted fraction, have the potential to show the development of neonatal brains.

Future Work

It is an ongoing project (part of a CIHR grant); We continue the recruitment of younger preterm infants, and we expect more changes at term.

References

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