Introduction

- With early unilateral brain injuries, significant reorganization of motor pathways is possible due to ongoing neural development.
- In typical development, there are direct ipsilateral corticospinal projections that are normally withdrawn while contralateral projections are strengthened.
- Following an early unilateral lesion, it is hypothesized that the ipsilateral projections from the contralateral hemisphere are maintained due to an increased reliance on these non-lesioned pathways.
- The timing of the injury (prenatal vs. perinatal) can determine the type of lesion, what structures are damaged, and availability of remaining structures for neuroplasticity.
- Understanding how injury timing impacts motor pathways will lead to more individualized treatments for children with pediatric hemiplegia.

Purpose: Determine if there are differences in the descending motor pathways between prenatal and perinatal unilateral brain injuries

Methods

Subjects:
- Pediatric hemiplegia: n=12 with unilateral brain injuries (age 12.8 ± 8.7 yrs)
- Prenatal injuries: n=6
- Perinatal injuries: n=6
- Pediatric control: n=10 typically-developing children (age 12.3 ± 3.9 yrs)

Imaging:
- All subjects underwent diffusion tensor imaging on 3 T
- 60 diffusion directions with \( b=1000 \text{s/mm}^2 \) and 8 scans with \( b=0 \)

Image Analysis:
- Images were processed using FMRIB Software Library (FSL)
- A diffusion tensor model was fit at every voxel and a color map indicating primary diffusion direction was generated
- Masks were hand-drawn on the transverse slice of the posterior limb of the internal capsule and the cerebral peduncles, guided by the color map
- Probabilistic tractography was completed from the cerebral peduncles to the posterior limb of the internal capsule, requiring fibers to pass through both masks. Pathways were thresholded at 10% to remove unlikely projections.
- Analysis was completed on the section from the internal capsule to cerebral peduncles to improve accuracy of results
- Average fractional anisotropy (FA), mean diffusivity (MD), axial (AD), and radial diffusivities (RD) were computed as well as volume.

Results

Figure 1. Representative Anatomical MRIs. Peri-ventricular lesions are common in prenatal injuries, while MCA lesions can be seen perinatally.

Figure 2. DTI metrics for lesioned corticospinal tracts.

Figure 3. DTI metrics for nonlesioned corticospinal tracts.

Conclusion

- Both prenatal and perinatal unilateral injuries result in decreased white matter integrity on both the lesioned and nonlesioned corticospinal tracts.
- Perinatal injuries present with greater damage compared to prenatal injuries.
- Perinatal injuries have greater compensatory increases in volume on the nonlesioned side.
- Differences in corticospinal tract changes between prenatal and perinatal injuries may be due to the nature of the lesion, with MCA lesions in the perinatal period being more damaging.
- An improved understanding of how the pathways are impacted differently depending on injury timing can help to explain differences in motor deficits and lead to more tailored interventions.

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