Two MSc graduate projects:
The baby brain pipeline: MRI analysis in craniosynostosis

Background

Syndromic craniosynostosis is a congenital disorder in which several skull sutures close prematurely, causing skull and facial anomalies. For example in trigonocephaly, a specific type of craniosynostosis, there is no growth between the two frontal bones, resulting in a keel-shaped, very narrow forehead, oval shaped orbits, and eyes that are closely set together (Fig. 1). The prevalence is rising and is currently 0.9 in 10000 live births for The Netherlands. Given the complex care for these children and the low prevalence, care is concentrated in centers of expertise. For the Netherlands, this is the Dutch Craniofacial Center at the Erasmus MC, which is leading world-wide in scientific research. Over the years, research made it clear that syndromic craniosynostosis is accompanied by an increased risk on behavioural and neurocognitive problems. Currently, treatment is directed at restoring the shape of the forehead by surgery within the first year of life.

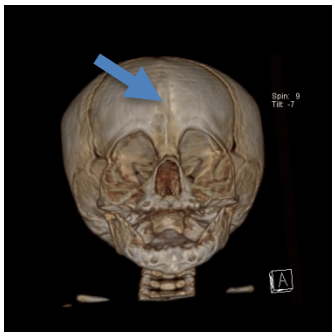
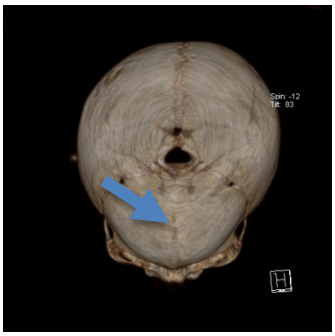


Figure 1. 3D-CT scan of a child with trigonocephaly. As a result of the premature closure of a cranial suture (arrow), the forehead is narrow and the orbits have an abnormal oval shape.



Aim

The Dutch Craniofacial Center aims to get a better understanding of the disease process and its consequences, particularly relating to visual, behavioural and neurocognitive functioning. It is yet unclear whether surgery of these children is beneficial. We hypothesize that in some patients refraining from surgery might result in similar outcome, but this cannot yet be proven.

In a current study, we aim to use advanced MRI techniques to study the impact of craniosynostosis on the structure and function of the brain, i.e. high resolution structural MRI, arterial spin labelling (ASL) MRI to quantify the perfusion of the brain and diffusion tensor imaging (DTI) MRI to get insight into the brain's microstructure. For the analysis of these brain scans, in small children with brain deformations, no automated approaches exist. The two proposed projects aim at development of dedicated image analysis tools for children with craniosynostosis.

Project 1: Baby brain tissue – tissue segmentation in young infants.

Accurate segmentation of the brain white and gray matter is essential for the analysis of brain volume, ASL and DTI data. For adult MRI data, many well-validated tools available, but for infants specific pipelines need to be developed given the fact that white and gray matter is less distinctive at very young ages. This project therefore aims to develop a dedicated infant brain tissue segmentation tool using machine learning methods. The tool will be evaluated on brain MRI scans of healthy children and children with craniosynostosis.

Project 2: Baby brain atlas – image registration in craniosynostosis.

Regional analysis of brain volume, ASL and DTI data requires atlas tools for identifying brain regions. However, the brain and skull deformations in children with craniosynostosis hamper the use of standard tools. Registration – the process of spatial alignment of two images – is much more difficult in this case. This project therefore aims to develop a robust registration technique for atlas-based analysis of brain regions in infants with craniosynostosis. Both conventional and learning-based registration method will be considered.

Work environment

The MSc projects will be conducted in collaboration between two departments: the Department of Radiology & Nuclear Medicine and the Department of Plastic and Reconstructive Surgery and Hand Surgery. You will be working in a multi-disciplinary team including image analysis experts, neuroradiologists, clinicians and biomedical scientists.

Requirements

If you are an MSc student with an affinity for developing and validating advanced techniques for the analysis of medical image data sets, machine learning, plus some experience in software development and scripting languages (e.g. some understanding of Linux, Python), we are looking for you! Furthermore, good communication and writing skills are a pre-requisite.

Information and application

Supervisors:

- Dr. Esther E. Bron, Radiology & Nuclear Medicine, Erasmus MC
- Dr. Henri Vrooman, Radiology & Nuclear Medicine, Erasmus MC
- Prof.dr. Irene Mathijssen, Plastic and Reconstructive Surgery and Hand Surgery, Erasmus MC
- Nine de Planque, Plastic and Reconstructive Surgery and Hand Surgery, Erasmus MC
- Prof.dr. Wiro Niessen, Radiology & Nuclear Medicine, Erasmus MC

To apply, please e-mail your CV along with a motivation letter to e.bron@erasmusm.nl