PhD Thesis Title: Intelligent feature analysis of FDG PET-CT images for more accurate diagnosis in large vessel vasculitis

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ABSTRACT:

Aortitis refers to inflammatory conditions affecting the aortic wall that cannot be explained by atherosclerosis alone. Large Vessel Vasculitis (LVV) is the main type of non-infectious aortitis and can affect any of the large arteries. Aortitis and LVV are difficult to diagnose and treat due to a variety of reasons such as non-specific symptoms and diagnostic tests, a large number of potential causes, and risks involved in providing incorrect or delayed treatment. [18F]-Fluorodeoxyglucose Positron Emission Tomography-Computed Tomography (FDG PET-CT) imaging plays a key role in diagnosis of LVV due to its ability to detect inflammation early and non-invasively, but is mostly assessed qualitatively making its interpretation vulnerable to bias and inter-observer variation. Therefore, there is a need for more reliable imaging biomarkers which can be achieved with radiomic analysis.

The aim of this thesis is to explore the diagnostic ability of radiomic features in FDG PET-CT imaging of aortitis. First, the feasibility is determined and a methodological pipeline established. Next, the findings are validated with data from multiple centres and the overall method automated. The first step of the method is the aortic segmentation using an artificial intelligence which produces similar radiomic features as the manual segmentation. When used as input in the diagnostic models, several individual radiomic features and groups of radiomic features demonstrated high diagnostic performance across the training, test and validation cohorts. In particular, features based on heterogeneity performed well. The method displayed good generalizability and transferability, which are important prerequisites for clinical use. These findings could be used to build an automated clinical decision tool which would facilitate objective and standardized assessment regardless of observer experience.

References to author publications that relate specifically to the dissertation:

1. **Duff LM**, Scarsbrook AF, Ravikumar N, Frood R, Praagh GD van, Mackie SL, Bailey MA, Tarkin JM, Mason JC, Geest KS van der, et al. An Automated Method for Artificial Intelligence Assisted Diagnosis of Active Aortitis Using Radiomic Analysis of FDG PET-CT Images. Biomolecules 2023 Feb 9;13(2):343. doi: 10.3390/biom13020343.
2. **Duff L**, Scarsbrook AF, Mackie SL, Frood R, Bailey M, Morgan AW, and Tsoumpas C. A methodological framework for AI-assisted diagnosis of active aortitis using Radiomic analysis of FDG PET–CT Images: Initial analysis. Journal of Nuclear Cardiology 2022 Dec;29(6):3315-3331. doi: 10.1007/s12350-022-02927-4. Epub 2022 Mar 23.
3. **Duff L** and Tsoumpas C. Automated diagnosis and prediction in cardiovascular diseases using tomographic imaging. In Book: Big Data in Multimodal Medical Imaging (2019), pp. 71-102. Taylor and Francis Group.