QUANTITATIVE IMAGING BIOMARKERS IN NEUROLOGIC DISEASE: POPULATION STUDY PERSPECTIVE

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ABSTRACT

The capacity of recognizing the first signs of disease has enormous socio-economic benefits. Population studies have the potential to see disease develop before your eyes, and when including advanced imaging techniques in these studies, literally so. Population imaging studies, especially when complemented with other biomedical and genetic data, provide unique databases that can be exploited with advanced analysis and search techniques for discovering methods for early detection and prediction of disease. This new way of medical research will have considerable impact in the practice of medicine at large.

In this presentation we will focus on the development of quantitative imaging biomarkers in neurology using imaging data acquired in a population setting. Currently, effective treatment strategies are lacking in e.g. dementia and stroke. In order to develop such strategies, improved understanding of the early, preclinical stages, of disease, is essential.

Quantitative imaging biomarkers for neurologic disease are developed within the context of the Rotterdam Study, a prospective population based study of the causes and determinants of chronic diseases in the elderly that was initiated in 1995. MR brain imaging was performed during this study in random subsets in 1995 and 1999, and since 2005, MR brain imaging is part of the core protocol of the Rotterdam Study. The large scale acquisition of MR brain imaging within the Rotterdam Study allows us to study whether morphologic brain pathology is already present years before clinical onset of neurologic disease, and whether MRI based measurements may be used for prognosis. More information on the Rotterdam Scan Study can be found in [1].

Within the context of the Rotterdam Scan Study, a standardized and validated image analysis workflow is being developed to enable the objective, accurate, and reproducible extraction of relevant parameters describing brain anatomy, possible brain pathologies, and brain connectivity from multispectral MRI data. Image processing in the Rotterdam Scan Study has four main goals: First, owing to the sheer size and complexity of the imaging database being generated, automation of the tedious task of manual analysis is required. Second, qualitative image assessment should be replaced by objective quantitative analyses as much as possible. Third, we aim to limit or avoid altogether inter- and intraobserver variability. Fourth, image processing allows the extraction of relevant image-derived parameters that would not be feasible manually or cannot be assessed visually.

This presentation will provide an overview of different quantitative imaging biomarkers that have been developed, or are currently developed as part of the Rotterdam Scan studies. These include brain tissue quantification (grey matter, white matter, also quantified per lobe), quantification of cerebrospinal fluid, volume and shape of neurostructures such as the hippocampus, ventricles and cerebellum, brain connectivity based on diffusion tensor MRI, and vascular brain pathologies such as white matter lesions and microbleeds.

Index Terms— Population studies, MRI, automated image analysis, stroke, dementia

[1] Ikram MA, van der Lugt A, Niessen WJ, Krestin GP, Koudstaal PJ, Hofman A, Breteler MMB, Vernooij MW. The Rotterdam Scan Study: design and update up to 2012. Eur J Epidemiol 26(10):811-24, 2011.