Study: **Assessment of renal function by multiparametric MRI**
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Study Title	Assessment of renal function by multiparametric MRI/ BASEC 2023-00913
Short Title / Study ID	Renal function and multiparametric MRI
Study Category and Rationale	Study category B. The study includes mostly approved MRI sequences, except for an ASL sequence that is a work in progress (WIP)-sequence but has undergone manufacturer's quality assurance and has been used in other studies without issues.
Background and Rationale	The kidneys play a central role in maintaining systemic homeostasis through regulation of electrolyte balance, fluid distribution, and removal of metabolic waste. Despite their functional reserve, renal physiology undergoes gradual decline with advancing age, even in the absence of overt kidney disease. These structural changes are accompanied by progressive nephron loss, reduced renal perfusion, and impaired oxygenation, ultimately contributing to diminished filtration capacity. Traditional clinical markers of kidney function, such as serum creatinine and estimated glomerular filtration rate (eGFR), do not fully capture these early microstructural and physiological changes. Both are indirect measures influenced by multiple confounding factors and often remain within normal limits until significant nephron loss has occurred. This diagnostic delay presents a major challenge in distinguishing between normal renal aging and early pathological decline. In recent years, multiparametric magnetic resonance imaging (mpMRI) has emerged as a promising non-invasive approach to characterize renal physiology at a tissue level. By integrating different imaging techniques – T1, T2 and T2*-mapping, arterial spin labeling (ASL) and intravoxel incoherent motion mpMRI enables a more comprehensive evaluation of renal function than conventional methods. Standardization efforts have further improved its reproducibility, but the specific impact of physiological aging on renal MRI parameters remains insufficiently explored. The purpose of this study is to investigate age-related changes in renal tissue characteristics using multiparametric MRI in a cohort of healthy individuals and to assess the potential of these imaging biomarkers for differentiating physiological aging from early functional deterioration.
Risk / Benefit Assessment	Magnetic resonance imaging (MRI) is a safe imaging technique without any evidence of detrimental secondary effects. However, it carries a risk for individuals with metal or electronic implants and may cause discomfort, particularly for claustrophobic individuals. This study design does not offer any direct benefits to the participants but may benefit future participants by facilitating earlier detection of renal function impairment and a more customized therapy regimen.
Objective(s)	This study is a prospective, exploratory, single-center trial aiming on the exploration of the value of mpMRI in the assessment of renal function. The primary null hypothesis proposes no correlation between serum creatinine/eGFR values and MRI parameters, while the alternative hypothesis suggests a significant correlation. o The first sub-aim is to assess kidney function with mpMRI across age groups, o The second sub-aim is to compare mpMRI parameters between healthy participants and their age-matched metabolic syndrome group, and o The third sub-aim is to assess intra- and inter-reader variability.
Endpoint(s)	Primary endpoint: • 1st aim: Exploration of the value of mpMRI in the assessment of renal function with serum creatinine and eGFR as the gold standard for comparison. Secondary endpoints: • 1st sub-aim: Comparison across the defined age groups. • 2nd sub-aim: Assessment of intra- and inter-reader variability of MRI parameters.
Study Design	Open label, non-randomised study
Statistical Considerations	The study aims to enroll 60 healthy participants, with 20 participants per age group (20-40a, 40-60a and > 65a). Multiple MRI parameters will be used to describe the kidney's functional aspects, and statistical comparisons will be performed using t-tests, ANOVA as well as correlation coefficients and a multivariable ANOVA test. The data will be presented using histograms and box plots. Measures of intra- and inter-reader agreement will be used to assess differences between different readers. All primary analyses will be performed with the full analysis set.

Inclusion- / Exclusion Criteria	To be eligible for participation, subjects must meet the following **inclusion criteria**: - Informed consent as documented by the signature (Informed Consent Form) - participants ≥18 years of age - participants must refrain from consuming food or beverages for three hours before the MRI The presence of any of the following **exclusion** criteria will lead to exclusion of the participants: o Women who are pregnant or breast feeding o Intention to become pregnant during the course of the study and lack of safe contraception o inability to follow the procedures of the study, e.g., due to language problems, psychological disorders, dementia, etc. of the participant. o enrolment of the investigator, his/her family members, and other dependent persons o participants with non-MRI compatible metallic or electronic implants, devices, or metallic foreign bodies (cardiac pacemaker, shrapnel, cochlea implants, neurostimulator, or other non-MRI compatible implants). o history of hypertension o history of renal disease as indicated by a normal Quick-Serum-Creatinine level of less than 105 µmol/l
Number of Participants with Rationale	We plan to recruit 60 participants (20 participants of each age group) to allow for a sufficient cohort size for statistical analysis.
Study Intervention	• Capillary blood draw • MRI without contrast agent 20-30 minutes
Control Intervention	/
Study procedures	The participants will fast (no food or drinks for 3 hours) and undergo a multiparametric MRI examination prior to a capillary blood draw (if no recent (<1 week) blood sample is available in their medical record). MRI parameters will then be examined by two readers and statistical analysis will be conducted.
Study Center(s)	University of Zurich Hospital
Data privacy	The project data will be handled with utmost discretion and access will only be given to authorized personnel. Participants will be identified by a unique participant number, and MRI scans will be saved using a pseudonymized identifier. The study data will be stored on password-secured computers and servers for a minimum of 10 years after study termination, and periodic sampling and quality control will be performed. The study-related clinical data will be stored on a password-protected share, accessible only to dedicated users within the University Hospital Zurich network, and the key to translating the pseudonymized participant identifier to the real participant's name will be kept at the local study center.
Ethical consideration	This study aims to investigate the efficacy of different MRI techniques for assessing renal function in healthy individuals. The results may provide valuable insights into the diagnosis and treatment of age-related kidney diseases. Participants will be fully informed about the trial's purpose, procedures, potential risks and benefits, and any other relevant details that may affect their decision to participate. Incidental findings will be reported unless participants opt out beforehand.
GCP Statement	This study will be conducted in compliance with the protocol, the current version of the Declaration of Helsinki, the ICH-GCP, the HRA as well as other locally relevant legal and regulatory requirements.