G46 Heart Study in Magnetic Resonance: Birth of a Protocol

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After attending this presentation, attendees will understand the specific approach to create a protocol for ex-situ cardiac MRI (Magnetic Resonance Images) based on the clinical experience

This presentation will impact the forensic science community by showing which elements (physics, materials) must be considered to create an easy applicable and reproducible protocol for examining a heart ex-situ by MRI.

In recent years, MDCT (Multi-detector Computed Tomography) and MRI (Magnetic Resonance Imaging) are becoming increasingly important tools for investigations in forensic medicine. Both modalities can be used on the same case. In the Institute of Legal Medicine, Lausanne-Geneva, multi-phase postmortem CT-angiography (MPMCTA) using the oily contrast agent mixed with paraffin oil is executed regularly. Because of this technique, the complete vascular system can be examined in detail, which is especially important in order to investigate the coronary arteries in cases of ischemic heart disease. However, MDCT is not appropriated to investigate cardiac tissue. Cardiac MRI could solve this problem. Additionally, no adequate scanning protocol and no guidelines for interpreting postmortem cardiac MRI are available at this time. The purpose of this study is: (1) to create a protocol for an ex-situ study permitting the systematic examination of cardiac tissue of patient suspected of heart attack; and, (2) to investigate the performance of the oily contrast agent used for MPMCTA for its application on MRI.

This study was performed on a MRI unit using a 32 channels-head coil. Different scanning protocols were tested using six porcine hearts and one human heart. The protocols included: a) the preparation of the organ including contrast-agent injection and the positioning of the heart inside the coil, b) the scanning parameters used for the MRI acquisition. The following detailed the protocols:

a) In order to define a reproducible position of the heart inside the coil, different samples were tested made of plastic and glass containing paper, sand, or flour to avoid vibration artifacts due to the low weight of the examined heart. To unfold the left ventricular wall, different materials were inserted through the aortic valve such as a balloon catheter, polystyrene balls, or modeling clay. Different positions of the heart have been tested and a material for marking anatomical landmarks had been searched. During contrast agent injection into the coronary arteries, different types of catheters were inserted, the influence of vascular ligature, and the concentration of the oily contrast agent were tested.

b) As we performed the MRI sequences with a 32 channels-head coil, we had opportunities to use a small slice thickness (0,6 mm to 3 mm), a relative small field of view (180-250 mm) with a good signal-to-noise ratio. The choice of the different T1-or T2-weighting sequences depended on the original software equipment of the MRI unit and of the suspected pathology.

This study shows that the oily contrast agent had a good signal in T1-weighed sequences, which makes this contrast agent adequate for the MRI examination. This can be explained by the fact, that it is an oily liquid. The filling of the coronary arteries with the oily contrast agent depended on the morphology of the vessels and on their size. In some cases, the result was disappointing; however, this problem could be solved by the use of an angiographic catheter and the dilution of the contrast agent with a solvent in order to decrease its viscosity.

To find consequential edema of cardiac infarct, T2- weighted sequences were performed in the small axe of the left ventricle, in analogy to clinical examinations and the cardiac dissection technique used in our center. In some sequences we observed a bad image quality due to the movement of the heart produced by radiofrequency waves and the gradients. This problem could be overcome by the filling of the recipient with heavy materials. A glass recipient filled with flour turned out to be optimal because it didn't interact with the magnetic field and therefore no artifacts were observed.

For an easy orientation on the resulting images of the heart, a tablet of vitamin E was used (oily contrast in MRI) as landmark that was introduced in a cork stopper which was inserted into the aorta.

This study demonstrates: (1) that an optimal scanning protocol for cardiac ex-situ MRI contains the performance of T1-weighted sequences to evaluate the coronary arteries and of T2-weighted sequences for the imaging of the cardiac tissue, and that the preparation of the organ is essential for the quality of the exam; and, (2) the application of an oily contrast agent is providing an excellent contrast for coronary arteries on MRI.

Postmortem MRI, Cardiac MRI, Forensic Imaging

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