MR-Safety and Compatibility of Intrauterine Devices at 3T and 7T

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Introduction

Intrauterine devices (IUD) are the world's most widely used method of reversible contraception [1]. Depending on the type, a single IUD may be used for 5 to 10 years. Two basic types of intrauterine devices can be distinguished: the metal-containing and the metal-free intrauterine device (IUD). When patients with an implanted contraceptive device undergo Magnetic Resonance Imaging (MRI), it must be ensured that the examination involves no risk to the patient (MR safety) and that the diagnosis is not affected by artifacts or the function of the device is not compromised (MR compatibility). Currently, all IUDs, including metal-containing devices, are MRI compatible up to a magnetic field strength of 1.5 Tesla [2-5]. With the advent of high-field and ultra high-field MR imaging, and their growing indications, it is necessary to assess MR safety of these devices in higher fields. The aim of this study at 3T and 7T was (1.) to evaluate the displacement of the IUDs (2.) to measure RF induced temperature increases of metal-containing IUDs and the surrounding uterine tissue, and (3.) to assess image artifacts.

Material and Methods

In this study, four different IUDs have been studied, the only two approved in the United States (ParaGard®, Mirena®), and two of many approved metal containing devices on the European market (Safe-T® and Nova-T®). Bovine reproductive tracts of four healthy slaughtered cows were obtained. The ovaries, uterus, and cervix were separated from the vagina. A vertical incision was made in the mid-sagital line of the anterior portion of the distal cervix exposing the endometrium (Figure 1). Each intrauterine device was then bound to a fiberoptic temperature probe (Luxtron 790 Fluoroptic Thermometer, Luxtron Corp., Santa Clara, CA), and a vitamin E position marker. The intrauterine device, temperature probe, and the position marker were then sewn into the endometrium along the posterior wall of the uterus (Figure 1). The anterior uterine incisional defect was closed using 6.0 sutures. Next, the uteri with IUD, temperature probes, and position makers were placed in a T/R head coil of a 3T and 7T whole body MR scanner (Achieva, Philips Medical Systems, Cleveland, OH, USA). MR Imaging was then performed using a variety of standard MR sequences (T_1-3D-FFE, T_2-TSE-IR, DTI-SSh, T_2-TSE, 3D-PCA, T_2-3D-TFE, T_2^*-3D-FFE). The temperatures of the IUDs were recorded every 20 seconds during each MR sequence.

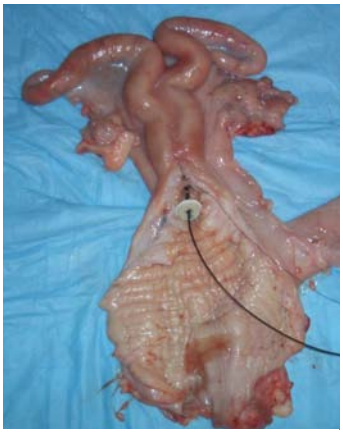

Figure 1 Placement of IUD, temperature probe and fiducial marker in a cow uterus.

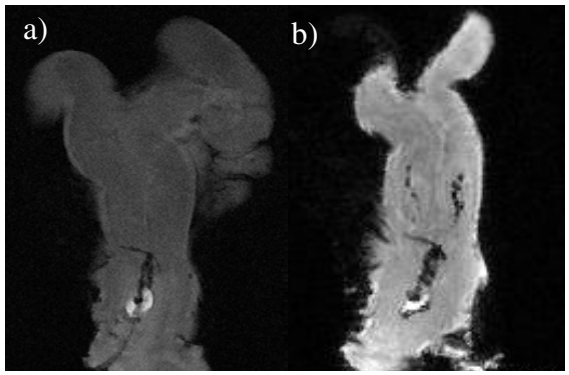

Figure 2a) 3T T_{1w}-3D-TFE MR image and **b)** 7T-T_{1w}-3D-TFE MR image of a cow uterus shows the Cu-containing IUD (ParaGard®), the temperature device and a fiducial marker in the uterine cavity as well as an anterior wall defect. Metal containing IUD causes no significant artifacts.

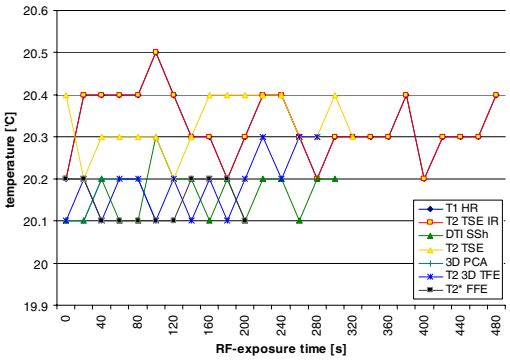

Figure 3 Exemplary temperature sequences using different MR sequences on the Cu containing NovaT® IUD in a cow uterus at 7T.

Results

Evaluation of the MR images by a board-certified radiologist showed no significant decrease in image quality at 3T and 7T. Figure 2 shows an example of a Spin Echo MR image with the ParaGuard IUD at 3T (Figure 2a) and 7T (Figure 2b). No displacement of the IUD was observed during exposure to the magnetic fields. No statistically significant temperature change was measured during RF-exposure with any of the tested MR sequences (Figure 3). The maximum temperature increase of 0.3°C was measured with a T_2-TSE-IR sequence at 7T.

Discussion

The maximum measured temperature increases in the uterine cavities are within the allowed temperature-rise guidelines of The Food and Drug Administraion (FDA) [6]. Based on these results, all IUDs tested are both safe and compatible with MRI at 3T and 7T in the animal model. We believe, therefore, that these IUDs would also be safe in humans. This could be proved with human in-vivo studies in the future.

Literature

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