MRI evaluation of metal acupuncture needles

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Introduction

MRI safety of acupuncture needles is an important issue for functional MRI of acupuncture. Traditional acupuncture needles are made of ferromagnetic material and therefore are not MR compatible, because they can generate large artifacts during MRI scanning and experience a force in the magnetic field that may be pulled out or hurt the subjects [1,2]. In addition, metal needles may produce heat due to MR radio frequency (RF) transmission along the metal needles [3]. In this study, we evaluated three types of metal acupuncture needles on MR imaging artifact and RF-induced heating effect, and finally applied the MR compatible needles for MRI of acupuncture.

Materials and experiments

Three types of metal needles, including (a) a traditional stainless steel needle, (b) a gold needle with a purity of 75%, and (c) an Austenitic stainless steel needle, were used for MRI of acupuncture. The length and diameter of the standard stainless steel needle and the gold needle are 4 cm and 0.3 cm, respectively. The Austenitic stainless steel needle is 5 cm in length and 0.32 cm in diameter, slightly longer and thicker than other two needles. The evaluations included MRI artifacts and temperature increases of these needles during MRI scanning, which were performed on a whole body 3T Magnetom TRIO Scanner (Siemens, Erlangen, Germany) equipped with a body coil for RF transmission and a 12-channel phased array receive-only head coil. First, the needles were scanned in agarose gel phantoms to evaluate MR artifacts using the T1-weighted gradient-echo Fast Low Angle Shot (FLASH) pulse sequence with 100ms TR, 2.86ms TE, 150mm×117mm FOV, 70° flip angle, 256×320 matrix, and 5mm slice thickness. Then, the needles were bound to an MR compatible fiber optic thermometer and placed in gel phantoms, respectively, to evaluate the temperature increases during MRI using a FLASH with 8ms TR, 2.86ms TE, 150×117mm FOV, 70° flip angle, 256×320 matrix size, 3mm slice thickness, and 700 measurements (the total scanning time was 23 minutes and 32 seconds). The temperature was recorded every five seconds during MR imaging. Finally, two acupuncture needles with small artifacts and temperature changes, the gold needle and the Austenitic stainless steel needle, were used for MRI of acupuncture at the Sanyinjiao (SP6) acupoint, which was performed by using a fast spin echo (FSE) sequence with 700ms TR, 27ms TE, 300mm×201mm FOV, 120° flip angle, 512×435 matrix size, and 2mm slice thickness.

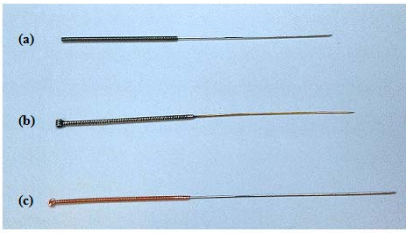

Figure 1. Three types of acupuncture needles, (a) a standard stainless steel needle, (b) a gold needle, and (c) an Austenitic stainless steel needle.

Results and Discussion

The MRI artifacts of the three acupuncture needles were shown in Figure 2. The gold needle generated little artifact, and the Austenitic stainless steel needle produced moderate artifacts in the gel phantom (Figure 2-b&c). However, the traditional stainless steel needle produced a huge artifact. In addition, it can be attracted by MR magnet, and dangerous to the subjects. Therefore, the traditional stainless needle is not safe for MRI of acupuncture.

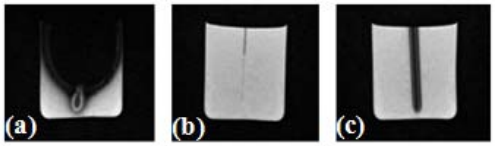

Figure 2. MRI artifacts of the three needles in a phantom. (a) The huge artifact produced by the traditional stainless steel needle, (b) The small artifact of the gold needle, and (c) The moderate artifact generated by an Austenitic stainless steel needle.

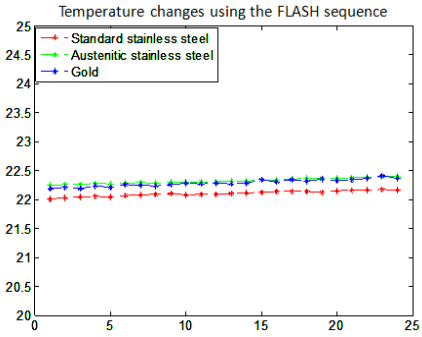

Figure 3. Temperature increases of of the three needles during MRI scanning. Red line: The standard stainless steel Green line: The Austenitic needle, and Blue line: The gold needle.

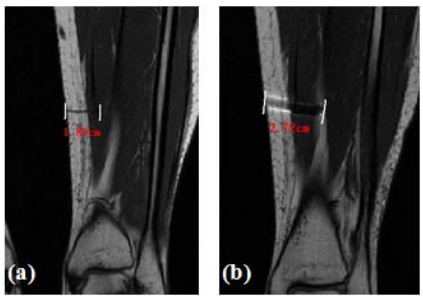

Figure 4. In-vivo scanning with three needles. (a) The gold needled inserted into SP6. (b) The Austenitic stainless steel needle inserted into SP6.

The temperature of the needles in the phantom have no significant change during a long time MR scanning (Figure 3), which indicated that this length of acupuncture needles would not be subject to an RF heating problem. Therefore, the gold and Austenitic stainless steel needles showed a good MR compatibility, which were further validated by MRI of acupuncture at Sanyinjiao (SP6) acupoint in human body (Figure 4).

Conclusion

In conclusion, gold and Austenitic stainless steel acupuncture needles are MR compatible, which can be used for systemic research on the ancient acupuncture using a modern and powerful MR imaging modality.

Reference

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