Evaluation of MRI issues for an access port with a Radiofrequency Identification (RFID) tag

Blake Titterington a, Frank G. Shellock b,∗

a Biochemistry Department, Frank R. Seaver College of Science and Engineering, Loyola Marymount University, Los Angeles, CA 90045, USA
b Keck School of Medicine, University of Southern California and Institute for Magnetic Resonance Safety, Education, and Research, Los Angeles, CA 90045, USA

Article history:
Received 17 February 2013
Revised 7 April 2013
Accepted 8 April 2013

Abstract

Objective: A medical implant that contains metal, such as an RFID tag, must undergo proper MRI testing to ensure patient safety and to determine that the function of the RFID tag is not compromised by exposure to MRI conditions. Therefore, the objective of this investigation was to assess MRI issues for a new access port that incorporates an RFID tag.

Materials and Methods: Samples of the access port with an RFID tag (Medcomp Power Injectable Port with CertainID; Medcomp, Harleysville, PA) were evaluated using standard protocols to assess magnetic field interactions (translational attraction and torque; 3-T), MRI-related heating (3-T), artifacts (3-T), and functional changes associated with different MRI conditions (nine samples, exposed to different MRI conditions at 1.5-T and 3-T).

Results: Magnetic field interactions were not substantial and will pose no hazards to patients. MRI-related heating was minimal (highest temperature change, 1.7 °C; background temperature rise, 1.6 °C). Artifacts were moderate in size in relation to the device. Exposures to MRI conditions at 1.5-T and 3-T did not alter or damage the functional aspects of the RFID tag.

Conclusions: Based on the findings of the test, this new access port with an RFID tag is acceptable (or, MR conditionable, using current MRI labeling terminology) for patients undergoing MRI examinations at 1.5-T/64-MHz and 3-T/128-MHz.

© 2013 Elsevier Inc. All rights reserved.

1. Introduction

An access port is an implant that is utilized to provide long-term vascular administration of chemotherapeutic agents, antibiotics, analgesics, or other medications. This device is typically implanted in a subcutaneous pocket, in the subclavicular area with a catheter inserted in the jugular, subclavian, or cephalic vein. Specially designed access ports may also be used for “power-injection” of contrast media to facilitate a diagnostic radiologic procedure, such as using IV contrast agents for a CT or magnetic resonance imaging (MRI) examination.

At the present time, access ports require the use of ionizing radiation (fluoroscopy, CT, or x-ray) to properly identify a radiopaque marker or other visible lettering (e.g., the marking of “CT” on the implant is often used) that indicates that the port is acceptable for a power injection (e.g., up to 5-cc/sec at 300 psi). Failure to use an access port specifically developed for power injections can result in serious patient injuries. Therefore, it is vital to confirm that the access port is, in fact, indicated for power injection and, thus, able to withstand high-pressure conditions.

Recently, a new access port was developed that incorporates a radiofrequency identification (RFID) device or “tag”. An RFID tag is a microchip attached to an antenna that allows a wireless, non-contact mechanism utilizing radio-frequency electromagnetic fields to transfer electronically-stored data from the tag (which is attached to or embedded in an object, such as an implant), to a scanner or “reader”, providing automatic identification of that item [1]. Importantly, an access port that incorporates RFID technology permits the use of a reader to positively identify the port as a power injection device, eliminating the requirement to strictly use ionizing radiation to determine the type of port that is implanted in the patient.
A medical implant, such as an access port with an RFID tag, must undergo proper MRI testing that involves characterization of magnetic field interactions, MRI-related heating, and artifacts to ensure patient safety [1–6]. Notably, because the electromagnetic fields associated with MRI may compromise the reliability of the data or damage the functional aspects of the RFID tag used with the access port [2], it is important to specifically evaluate this component of the new implant. Therefore, the objective of this investigation was to assess these aforementioned MRI issues for a new access port that incorporates an RFID tag.

2. Materials and methods

2.1. Access port with an RFID tag

Samples of a new access port that incorporates a radio-frequency identification (RFID) device or “tag” (Medcomp Power Injectable Port with CertainID; Medcomp, Harleysville, PA) underwent evaluation in this investigation (Fig. 1). The materials used for this port include titanium (including a small connector component, length, 7-mm), polysulfone, silicone, tungsten, and ferrite. The RFID tag, when activated, transmits a bit stream encoding a 16-character code and may be read by means of an activation field that is provided by a handheld scanner or “reader” (Veracity Reader, Medcomp, Harleysville, PA), which supplies the power for its operation (Note: the reader was not evaluated for MRI issues and, therefore, it is not permitted to be in the MR system room.) The handheld reader displays information viewable by the medical practitioner, conveying that the implanted port is an RFID Port. The frequencies used by the RFID tag include the following ranges: 129.0 to 133.2 kHz and 135.2 to 139.4 kHz.

3. Evaluation of magnetic field interactions

The access port with an RFID tag was assessed for magnetic field interactions (i.e., translational attraction and torque) at 3-T (Excite, Software G3.0-052B, General Electric Healthcare, Milwaukee, WI) using standard testing techniques [2–7]. A static magnetic field strength of 3-T was selected for this investigation because it is the highest magnetic field currently in widespread use [8]. Therefore, the results for magnetic field interactions will apply to MR systems operating at 3-T or less [8].

3.1. Translational attraction

Translational attraction was determined using the deflection angle test [2–7]. A test fixture (protractor with 1°-graduated markings attached to a holding device) was used to measure the deflection angle for the access port with an RFID tag in the 3-T MR system. This device was attached to the protractor at the 0° indicator using a 20-cm-long string (less than 1% of the implant’s weight) [2–7]. The deflection angle apparatus was placed at the highest “patient accessible” spatial gradient magnetic field for the 3-T MR scanner, which is 720 G/cm and occurs at an off-axis position, 74-cm from isocenter of the MR system [2–7,9]. Gauss line plots, gauss meter readings (Extech 480823 Electromagnetic Field and Extremely Low Frequency Meter; Extech, Nashua, NH, USA), and visual investigation were used to determine the point of the highest, patient accessible, spatial gradient magnetic field [2–7,9]. The access port with an RFID tag was held vertically from the test fixture and then released. The deflection angle to the nearest 1° was measured three times and a mean value was calculated.

3.2. Evaluation of torque

The access port with an RFID tag was next evaluated for magnetic field-induced torque at 3-T using a previously described technique [2–7]. The test fixture (a flat plastic material, 15-cm × 15-cm, with a millimeter grid) with the test sample was placed at the center of the 3-T MR system, where the effect of torque imposed on a metallic object is known to be the greatest [2–7]. The implant was then moved 45° relative to its previous position and observed for alignment or rotation. This procedure was repeated to encompass 360° of rotation, three times, for the access port with an RFID tag, with this implant placed along its short and long axes [2–7]. A previously described, qualitative scale was used to characterize the results, as follows [2–7]: 0, no torque; +1, mild or low torque, the implant slightly changed orientation but did not align to the magnetic field; +2, moderate torque, the implant aligned gradually to the magnetic field; +3, strong torque, the implant showed rapid and forceful alignment to the magnetic field; +4, very strong torque, the implant showed very rapid and very forceful alignment to the magnetic field.

4. Evaluation of MRI-related heating

4.1. Phantom and experimental set-up

The access port with an RFID tag was assessed for MRI-related heating at 3-T/128-MHz using a standardized test methodology [2,4–7,10]. For this test, a plastic American Society of Testing and Materials (ASTM) International phantom (dimensions of the head/torso phantom: head portion – width, 16-cm; length, 29-cm; depth, 18-cm; torso portion – width, 60-cm; length, 43-cm; depth, 18-cm) was filled to a depth of 10-cm with gelled-saline (i.e., 1.32-g/L NaCl plus 10 g/L polyacrylic acid in distilled water) and the implant was placed in a position that would result in potentially substantial MRI-related heating (i.e., where there is a high uniform electric field tangential to the implant, ensuring extreme radiofrequency heating conditions for this experimental setup, based on an analysis of the ASTM International phantom and the MRI conditions used for this assessment). A relatively high level of RF energy was applied during the MRI-related heating experiment, as previously described [2,4–7].

Fig. 1. The access port with an RFID tag that underwent testing for MRI issues.
4.2. Temperature recording and placement of thermometry probes

A fluoroptic thermometry system (Model 3100, LumaSense Technologies, Santa Clara, CA) was used to record temperatures measurements for the access port with an RFID tag. Three thermometry probes (Model SFF-2, LumaSense Technologies, Santa Clara, CA) were placed, as follows: Probe #1; sensor portion of the probe placed at one end of the implant, in contact with the connector; Probe #2; sensor portion of the probe placed at the other end of the implant; Probe #3; sensor portion of the probe placed in the middle of the implant. In addition, a reference probe was positioned in the phantom approximately 35-cm across from the implant [2–4,10].

4.3. MRI conditions

MRI was conducted during the heating test at 3-T/128-MHz (Excite, Software HDx, Software 14X,M5, General Electric Healthcare, Milwaukee, WI) using a transmit body radiofrequency (RF) coil. MRI parameters were applied to generate a relatively high level of RF energy, producing an MR system-reported, whole body averaged specific absorption rate (SAR) value of 2.9-W/kg (fast spin echo pulse sequence; axial plane; TR, 425-ms; TE, 14-ms; echo train length 4; Bandwidth 16-kHz; matrix size, 256 × 256; field of view 40-cm; section thickness, 10-mm; number of slices, 40) [4–7]. The landmark position (i.e., the center position or anatomic region for the MRI) and section locations were selected to encompass the entire area of the access port with an RFID tag.

4.4. Protocol

The gelled-saline-filled phantom was placed in the 3-T MR system room and allowed to equilibrate to the surrounding temperature for more than 24 h. The access port with an RFID tag was positioned in the phantom and the fluoroptic thermometry probes were applied. Baseline temperatures were recorded at 5-s intervals for 5 min, and MRI was then performed for 15- min, recording temperatures at 5-s intervals [2–7]. Post-MRI temperatures were recorded for 2-min at 5-s intervals. Proper fluoroptic thermometry probe positioning relative to the implant was confirmed immediately before and after the evaluation for MRI-related heating. The highest temperature changes are reported, herein.

“Background” temperatures (i.e., without the implant present in the phantom) were also recorded in the gelled-saline-filled ASTM International phantom [4–7,10]. Accordingly, the temperature changes were recorded at the same fluoroptic thermometry probe positions and at the same time intervals as those used when measuring the temperatures for the access port with an RFID tag as part of a proper MRI-related heating assessment [4–7,10]. The highest temperature change obtained from this evaluation is also reported.

5. Evaluation of artifacts

MRI artifacts were evaluated for the access port with an RFID tag at 3-T/128-MHz with this implant attached to a plastic plate and positioned in a gadolinium-doped, saline filled phantom, as previously described [2–7]. The following pulse sequences were used [2–7]: (1) T1-weighted, spin echo pulse sequence; repetition time, 500 ms; echo time, 20 ms; matrix size, 256 × 256; section thickness, 10-mm; field of view, 24-cm; number of excitations, 2; bandwidth, 16 kHz; (2) Gradient echo (GRE) pulse sequence; repetition time, 100 ms; echo time, 15 ms; flip angle, 30°; matrix size, 256 × 256; section thickness, 10-mm; field of view, 24-cm; number of excitations, 2; bandwidth, 16 kHz.

Section locations were selected through the access port with an RFID tag to encompass the long axis (i.e., oriented along the small metal connector) and short axis of this implant to show the largest artifact sizes (i.e., prescribed from multiple localizer scans). The frequency encoding directions were parallel to the imaging planes. Planimetry software included with the MR system (accuracy and resolution ±10%) was utilized to determine the cross-sectional areas of the largest artifact for each pulse sequence and imaging plane [2–7]. Display parameters (i.e., window and level settings, magnification, etc.) were used in a consistent manner to ensure valid measurements for the artifact sizes. While there are obviously many possible MRI parameters that may be utilized to characterize artifacts for metallic implants, this technique has been presented in many prior reports and, thus, allows comparison to other implants that have undergone similar artifact assessments [2–7]. Importantly, a 3-T/128-MHz MR system was again chosen for this assessment because it represents the highest available static magnetic field currently in clinical use [8].

6. Evaluation of the effects of MRI at 1.5-T and 3-T on function

To determine if the RFID tag part of the access port exhibits a change in function or sustains damage associated with MRI, testing was conducted to evaluate the effects of exposures to the 1.5-T and 3-T static magnetic fields (Part 1) and to various MRI conditions at 1.5-T/64-MHz and 3-T/128-MHz (Part 2), as previously described [3,4,6]. The orientations for the samples and different MRI conditions were implemented to cover a range of possible scenarios with regard to having a patient with this implant undergoing an MRI examination at 1.5-T/64-MHz or 3-T/128-MHz.

6.1. Part 1

Nine samples of the access port with an RFID tag were attached in three different orientations (i.e., axial, sagittal, and coronal orientations — three in each position) to a plastic, copper-sulfate-filled phantom. The orientations of the implants were selected to encompass possible clinical placement scenarios for this implant in a patient undergoing an MRI procedure. The phantom with the attached samples was placed on the patient table of the 1.5-T and 3-T MR systems, respectively, and inserted in (i.e., past isocenter and out the back of the scanner to the farthest point) and out (i.e., approximately 0.5-m past the opening of the bore of each MR system) of the scanner 10 times [3,4,6]. Total exposure time to each static magnetic field was 20 min.

6.2. Part 2

Samples of the access port with an RFID tag were again placed on the copper-sulfate-filled phantom in the same manner used for the static magnetic field exposures. MRI was performed at 1.5-T/64-MHz (Magnetom, Software Numaris/4, Version Syngo MR 2002B DHHS Siemens Medical Solutions, Malvern, PA) and 3-T/128-MHz (Excite, Software G3.0-052B, General Electric Healthcare, Milwaukeee, WI), using a transmit/receive body radiofrequency coil and eight different pulse sequences, running sequentially, for approximately 2-min per pulse sequence (Table 1) [3,4,6]. The landmarking position (i.e., the center position or anatomic region for the MR imaging procedure) and section locations were selected to encompass all samples to ensure thorough exposure to these MRI conditions [3,4,6].
The function of each RFID tag was thoroughly evaluated before and after Part 1 and Part 2 conditions and involved comprehensive evaluations performed according to the manufacturer's specifications.

7. Results

7.1. Magnetic field interactions

With regard to the findings for magnetic field interactions at 3-T, the mean deflection angle was 4° ± 0 and the mean torque value was 0 ± 0 for the access port with an RFID tag.

7.2. MRI-related heating

The evaluation of MRI-related heating indicated a highest temperature rise of 1.7 °C in association with MRI performed for 15-min at an MR system-reported whole body averaged SAR of 2.9-W/kg. The highest background temperature rise was 1.6 °C.

7.3. Artifacts

The artifact test results for the access port with an RFID tag are displayed in Table 1. Artifacts appeared as low signal intensity voids that were moderate in size in relation to the size and shape of this implant. The GRE pulse sequence produced larger artifacts than the T1-weighted, spin echo pulse sequence. Fig. 2 shows examples of the artifacts related to the use of the gradient echo pulse sequence for this implant. The maximum size of the artifact as seen on the GRE images extends approximately 15-mm relative to the size and shape of the access port with an RFID tag (Table 2).

7.4. Effects of MRI at 1.5-T and 3-T on function

The evaluation of the functional aspects of the RFID tags after exposure to 1.5-T and 3-T static magnetic fields and different MRI conditions at 1.5-T/64-MHz and 3-T/128-MHz indicated that each RFID tag retained its full functionality. Notably, there was no change in the content encoded on each RFID tag and no evidence of damage.

Table 1
Parameters used to expose the samples of the access port with an RFID tag to 1.5-T/64-MHz and 3-T/128-MHz MRI conditions.

<table>
<thead>
<tr>
<th>Pulse Sequence</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
<th>#6</th>
<th>#7</th>
<th>#8</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-SE</td>
<td>700</td>
<td>700</td>
<td>700</td>
<td>5000</td>
<td>20</td>
<td>3.7</td>
<td>628</td>
<td>3400</td>
</tr>
<tr>
<td>T2-SE</td>
<td>3000</td>
<td>100</td>
<td>12</td>
<td>113</td>
<td>3</td>
<td>1.1</td>
<td>10</td>
<td>103</td>
</tr>
<tr>
<td>T1-FSE</td>
<td>100</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>25</td>
<td>8</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>T2-FSE</td>
<td>30 cm</td>
<td>30 cm</td>
<td>30 cm</td>
<td>30 cm</td>
<td>30 cm</td>
<td>30 cm</td>
<td>30 cm</td>
<td>30 cm</td>
</tr>
<tr>
<td>Field of View</td>
<td>Axial</td>
<td>Axial</td>
<td>Axial</td>
<td>Axial</td>
<td>Volume</td>
<td>Volume</td>
<td>Axial</td>
<td>Axial</td>
</tr>
<tr>
<td>Section Thickness</td>
<td>10 mm</td>
<td>10 mm</td>
<td>10 mm</td>
<td>10 mm</td>
<td>3 mm</td>
<td>3 mm</td>
<td>10 mm</td>
<td>1 mm</td>
</tr>
<tr>
<td>Imaging Plane</td>
<td>Axial</td>
<td>Axial</td>
<td>Axial</td>
<td>Axial</td>
<td>Volume</td>
<td>Volume</td>
<td>Axial</td>
<td>Axial</td>
</tr>
<tr>
<td>3-T MRI Conditions</td>
<td>TR (ms)</td>
<td>700</td>
<td>700</td>
<td>700</td>
<td>5000</td>
<td>20</td>
<td>3.7</td>
<td>628</td>
</tr>
<tr>
<td>3-T MRI Conditions</td>
<td>TE (ms)</td>
<td>10</td>
<td>100</td>
<td>100</td>
<td>113</td>
<td>2.7</td>
<td>1.2</td>
<td>10</td>
</tr>
<tr>
<td>3-T MRI Conditions</td>
<td>Flip Angle</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>25</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>3-T MRI Conditions</td>
<td>Field of View</td>
<td>30 cm</td>
<td>30 cm</td>
<td>30 cm</td>
<td>30 cm</td>
<td>30 cm</td>
<td>30 cm</td>
<td>30 cm</td>
</tr>
<tr>
<td>3-T MRI Conditions</td>
<td>Section Thickness</td>
<td>10 mm</td>
<td>10 mm</td>
<td>10 mm</td>
<td>10 mm</td>
<td>3 mm</td>
<td>3 mm</td>
<td>10 mm</td>
</tr>
<tr>
<td>3-T MRI Conditions</td>
<td>Imaging Plane</td>
<td>Axial</td>
<td>Axial</td>
<td>Axial</td>
<td>Axial</td>
<td>Volume</td>
<td>Volume</td>
<td>Axial</td>
</tr>
</tbody>
</table>

(T1-SE, T1-weighted spin echo; T2-SE, T2-weighted spin echo; T1-FSE, T1-weighted fast spin echo; T2-FSE, T2-weighted fast spin echo; GRE, gradient echo; 3D, three-dimensional; FGRE, fast gradient echo; MTC, magnetization transfer contrast; EPI, echo planar imaging; N/A, not applicable; GRE, gradient echo; SE, spin echo; SAR, specific absorption rate).

Fig. 2. MR images showing artifacts at 3-T for the access port with an RFID tag (gradient echo pulse sequence). A, Section location oriented to the long-axis of the implant. B, Section location oriented to the short axis of the implant.
Table 2
Summary of MRI artifacts at 3-T for the access port with an RFID tag.

<table>
<thead>
<tr>
<th>Pulse sequence</th>
<th>T1-SE</th>
<th>T1-SE</th>
<th>GRE</th>
<th>GRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imaging Plane</td>
<td>(long axis)</td>
<td>(short axis)</td>
<td>(long axis)</td>
<td>(short axis)</td>
</tr>
<tr>
<td>Signal Void Size</td>
<td>1443-mm²</td>
<td>1235-mm²</td>
<td>2414-mm²</td>
<td>2320-mm²</td>
</tr>
</tbody>
</table>

(T1-SE, T1-weighted spin echo; GRE, gradient echo).

8. Discussion

8.1. Magnetic field interactions

The tests performed to study the magnetic field interactions of the access port with an RFID tag demonstrated that the average deflection angle was 4° and there was no torque. These results are related to the particular materials used to make this implant, which include titanium, polysulfone, silicone, tungsten, and ferrite. Notably, this access port is mostly made from nonmetallic materials, which provide “counterweight” to the relatively small metallic components (i.e., titanium, tungsten, ferrite) and, consequently, there are relatively low magnetic field interactions. In consideration of this information, there is no risk related to movement or dislodgment of this implant. Accordingly, a patient with this implant can undergo an MRI examination using an MR system operating at 3-T or less [8].

8.2. MRI-related heating

MRI may generate substantial temperature rises in certain metallic implants, resulting in serious patient injuries [8]. Therefore, as a routine procedure to ensure safety in patients with implants that have metallic components, MRI-related heating is evaluated using a standard, in vitro methodology which involves recording temperatures in various positions while subjecting the implant to worst case MRI conditions (i.e., positioning the implant in a phantom that lacks blood flow/perfusion and using a relatively high whole body averaged SAR for 15-min, simulating an excessive time period for the application of a single pulse sequence) [1–8,10,12]. The findings indicated that the highest temperature change measured for the access port with an RFID tag implant was 1.7 °C, while the background temperature rise using the same MRI conditions was 1.6 °C. Of note is that most of the small metallic components associated with this implant are encased in nonmetallic, non-conducting materials (i.e., polysulfone and silicone), which essentially insulates and isolates most of the metallic parts (i.e., with the exception of the relatively small connector). Accordingly, excessive MRI-related heating under, even the most extreme MRI conditions, is highly unlikely. The recorded temperature rises will not create a hazard to a patient with this implant under the MRI conditions used for this evaluation. Even though a higher whole body averaged SAR level could have been used for this heating assessment (e.g., whole body averaged SAR, 4-W/kg), this was considered to be adequate for this study. Extrapolating the temperature rise to a whole body averaged SAR of 4-W/kg yields a temperature rise of 2.3 °C, which is still an acceptable temperature elevation for a human subject (particularly when one considers body temperature rises related to being in a hot climate or associated with exercise), especially in consideration of the importance of performing a diagnostic MRI examination.

8.3. Artifacts

The extent of the artifacts for the access port with an RFID tag implant was somewhat surprising when one considers the outward appearance of this implant (Fig. 1), which seems to have minor metallic components compared with the nonmetallic parts (Fig. 1). However, because of the presence of the ferrite, even a small amount of this material (which is known to have a high magnetic susceptibility) can significantly impact artifact size [11]. For example, Shellock et al. [12] reported the presence of a relatively large artifact for a microstimulator (cylinder-shaped, 16-mm length × 2.4-mm diameter creating an artifact area size on GRE images of 3310-mm² on the long axis orientation × 3214-mm² for the short axis orientation) that has a ferrite core.

Nevertheless, from a practical view, MRI artifacts created by the access port with an RFID will only present possible issues if the imaging area of interest is in the area where this device implanted (i.e., subcutaneous pocket, in the subclavicular area). If this is an issue, the optimization of pulse sequence parameters can attenuate the artifact size related to this implant [13].

8.4. Effects of exposures to 1.5-T and 3-T static magnetic fields and MRI conditions at 1.5-T/64-MHz and 3-T/128-MHz

For RFID tags, it is vital that these devices exhibit the ability to retain their function after exposure to electromagnetic environments, especially the harsh electromagnetic environments that are associated with MR systems. Therefore, characterizing the functional aspects of an RFID tag that is incorporated in a medical implant is particularly important as part of the MRI testing that is necessary for these devices. In the present study, each RFID tag exposed to static magnetic fields (1.5-T and 3-T) as well as different MRI conditions at 1.5-T/64-MHz and 3-T/128-MHz showed normal function with no evidence of data corruption or damage. Steffen et al. [1] reported similar results from an investigation involving a variety of different RFID tags tested at 1.5-T and 3-T, with the caveat that the findings were “specific to the RFID tags that underwent testing” [1]. The frequency of the RFID tag compared with the frequency of the MR system must be taken into consideration to ensure that there is no interference generated by the operation of the scanner [1].

8.4.1. Possible limitations

Tests conducted on the access port with an RFID tag involved 1.5-T/64-MHz and 3-T/128-MHz MR systems, only. Therefore, it is unknown if possible adverse interactions, particular with respect to the functional aspects of the RFID tag, can occur in association with scanners operating above or below these particular static magnetic field strengths and frequencies. The decision to use MR systems operating at other field strengths and frequencies in patients with this implant should be made by an MRI-trained radiologist, based on careful consideration of the risk versus benefit for the MRI examination. Furthermore, the long-term effects of the MRI environment (e.g., multiple repeated exposures over and above those used under the conditions described in this study) on the ability of the RFID to function was not in the scope of the present investigation and, thus, this may also be considered a possible limitation.

9. Conclusions

A new access port with an RFID tag underwent comprehensive testing for magnetic field interactions, MRI-related heating artifacts, and to determine if the function of the RFID tag was compromised under conditions associated with 1.5 and 3-T MR systems. Based on the results of the tests that were conducted, this implant is acceptable [or, MR conditional, using current MRI labeling terminology [14]] for patients undergoing MRI examinations at 1.5-T/64-MHz and 3-T/128-MHz.
Acknowledgments

Special thanks to Sam Valencerina, B.S., R.T., (R) (MR) for his highly professional and invaluable assistance with the MRI test procedures.

References

[9] Shellock FG, Kanal E, Gilk T. Confusion regarding the value reported for the term “spatial gradient magnetic field” and how this information is applied to the labeling of medical implants and devices. AJR Am J Roentgen 2011;196:142–5.