Ex Vivo testing of a Ferromagnetic Detector for Evaluation of Bullets and Aneurysm Clips: A Potential Screening Device Prior to MR of Patients with Metal of Unknown Magnetic Properties.

Bryan A. Pukenas MD, Alexander C. Mamourian MD

Division of Neuroradiology, Department of Radiology
University of Pennsylvania Hospital, Philadelphia, PA

Purpose

MR imaging is presumed hazardous in many patients with retained bullets, shot, and some aneurysm clips. Even though most bullets and aneurysm clips are safe to scan, radiologists should be hesitant to perform MR in patients with metal when the composition is unknown. The purpose of this study was to test the effectiveness of a commercial ferromagnetic metal detector, currently used for routine screening of patients who may be inadvertently carrying metal objects into the scanner, to discriminate nonferrous metal from ferrous ex vivo with the consideration of its potential use to screen for implanted metal.

Methods

Test objects consisted of various metallic objects from a personal collection which included nine aneurysm clips, two unfired bullets, one bullet found on a street, a penny, a small steel bolt, a Star-Edwards heart valve, and a paperclip. To determine ferrous properties of each object a magnet was placed over each device and objects demonstrating attraction were considered ferrous. Testing then was performed with a FerrAlert™ Halo Prescreen (Kopp Development, Jensen Beach, FL) ferromagnetic detector which was set to a sensitivity sufficient to detect a standard small paperclip. A deflection angle test was performed on the aneurysm clips in a 1.5 Tesla and 3.0 Tesla MR magnet according to the American Society for Testing and Materials guidelines to determine their magnetic properties. Objects were passed through the FerrAlert™ Halo Prescreen detector in a subject’s armpit to simulate an imbedded object.

Findings/Discussion

Data from the evaluation of seventeen objects are reported. All ferrous objects and none of the nonferrous objects were detected by the device (table 1). The two ferrous aneurysm clips studied that deflected greater than 80° in the 1.5T and 3.0T magnets were also detected by the device (table 2).

MRI in patients with implanted metallic objects has resulted in death but has also been reported to be safe in a subset of patients with bullets of unknown composition. While imbedded projectiles from handgun and shotgun injury are nearly always nonferrous, concerns remain in cases where the object is in a vulnerable location because some tested bullets and steel shot have magnetic properties.

The potential to detect implanted ferrous metal prior to entry into an MR unit would greatly reduce the potential for adverse outcomes as well as allowing many patients who are currently considered unsafe to scan to be imaged. The FerrAlert™ Halo Prescreen ferromagnetic detector emits no electromagnetic radiation and uses Hall effect sensors to detect ferrous objects which allows discrimination of metals magnetic properties.

Summary/Conclusion

The FerrAlert™ Halo Prescreen device can distinguish clinically relevant nonferrous and equivalent ferrous objects ex vivo even when not in the immediate proximity of its hall effect sensors. A device using this principle has the potential to provide additional information regarding the nature of imbedded bullets that may allow some patients with retained projectiles to have MR exams. While we are not currently using the device for this purpose, we have demonstrated that its sensitivity supports further evaluation to this end.

References


Table 1: Objects, Ferrous Property, and FerrAlert TM detection

<table>
<thead>
<tr>
<th>Object</th>
<th>Ferrous</th>
<th>FerrAlert TM detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Clip</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Steel Bolt</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Paper Clip</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Sundt-Kee Encircling Clip</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Ferrous Triangular Clip</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Discharged Copper Bullet</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Unfired Copper Bullets (Casing Removed)</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Star-Edwards Stilastic Ball Valve</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>nonferrous aneurysm clips</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Penny</td>
<td>NO</td>
<td>NO</td>
</tr>
</tbody>
</table>

Table 2: Aneurysm clip and angle of deflection

<table>
<thead>
<tr>
<th>Aneurysm Clip</th>
<th>Ferrous</th>
<th>Angle of Deflection 1.5T</th>
<th>Angle of Deflection 3.0T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrous Triangular Clip</td>
<td>YES</td>
<td>83</td>
<td>96</td>
</tr>
<tr>
<td>Sundt-Kee Encircling Clip</td>
<td>YES</td>
<td>84</td>
<td>86</td>
</tr>
<tr>
<td>nonferrous aneurysm clips</td>
<td>NO</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>nonferrous aneurysm clips</td>
<td>NO</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Using a ferromagnetic detection system before MRI may boost safety, detecting implanted or embedded items that may contraindicate the exam.

Source: Diagnostic Imaging

A ferromagnetic detection system may detect implanted or embedded items in patients referred for MRI examinations, according to a study published in the American Journal of Roentgenology.

Magnetic resonance images are becoming more common, particularly as clinicians try to avoid using CT scans to limit radiation exposure to their patients. However, MRI has its own risks because of ferromagnetic implants or foreign bodies that may be exposed to the powerful magnetic fields.

Researchers from University of Southern California and Loyola Marymount University in Los Angeles investigated the feasibility of using a ferromagnetic detection device to screen patients for implants and foreign objects before undergoing MRI.

Volunteers were recruited for screening with a “pillar-type” ferromagnetic detection device. Sixty-seven different implants and other objects were chosen for testing (43 pulse generators, five electronic devices, six stents, three CSF shut-off valves, three orthopedic implants, four bullets, and three “other). The volunteers were first screened without any ferromagnetic objects on their body. After confirmation of the system’s function, objects were attached to the volunteers’ body in a realistic in situ location.

The tests found 58 true-positive, four true-negative, no false-positive, and five false-negative findings for a sensitivity of 92 percent and specificity of 100 percent.

The researchers concluded that this type of screening may be used not only for detection of external ferromagnetic objects, but also for implanted or embedded items. They suggest further research to determine the system’s use in the clinical setting.

Source URL:
http://www.diagnosticimaging.com/mri/ferromagnetic-detection-system-screens-patients-mri

Links:
Detection of Ferromagnetic objects inside the body

TECHNICAL BULLETIN

A conventional airport metal detector is incapable of detecting conductive material, ferromagnetic or non-ferromagnetic, below the surface of the skin of a human or animal body. A Ferromagnetic Metal Detector (FMD) is potentially capable of detecting a ferromagnetic object inside the body. The human body cannot shield the presence of a detectable ferromagnetic object.

FERRALERT™ has no detection limitations with regard to locating ferromagnetic material inside a non-ferromagnetic object, or human body. Nevertheless, if our product does NOT react, one should NOT automatically assume that there are no ferromagnetic risks.

If a ferromagnetic non-superficial object is detected, we most certainly recommend further investigation by following your facility's recommended practice. In many facilities a plane film X-Ray (see picture right) is used to investigate the presence of a foreign object.

FERRALERT™ allows the confirmation of the detection of a ferromagnetic object as well as define the object's location. The confirmation procedure involves scanning the person again to determine whether the alarm is activated at the same location on the body.

WARNING!
This device has not yet been fully evaluated for its efficacy in detection of ferromagnetic objects inside the body, such as IMPLANTS.