Magnetic resonance imaging compatibility of endoclips

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Background: Endoscopic clipping devices are now available for treatment of GI hemorrhage and microperforations. All commercially available endoclips are labeled as magnetic resonance imaging (MRI) incompatible. No data are available about the actual magnetic field strength at which endoclips are first deflected nor the clinical relevance of the magnetic fields on endoclips used in GI endoscopy.

Objective: To determine the compatibility of different endoclips with MRI.

Design: Prospective observational study.

Setting: Experiment on excised pig tissue in an MRI scanner.

Interventions: The physical deflection and strength of attraction of endoclips: Resolution Clip, TriClip, QuickClip, and Ethicon Endo-surgery Clip were measured in different positions by using an MRI scanner at a field strength of 1.5 Tesla. Endoclips that demonstrated deflection were attached to a pig stomach and tested for detachment at a 1.5-Tesla MRI field strength.

Main Outcome Measurements: Physical deflection and detachment from pig stomach mucosa in an MRI scanner.

Results: All endoclips except the one made by Ethicon Endo-surgery demonstrated physical deflection under the tested conditions. The magnetic attraction was strongest for the Resolution Clip (0.7 gauss) compared with the TriClip (1.2 gauss) and the QuickClip (26.8 gauss). Only the Triclip demonstrated detachment from the pig gastric tissue under testing conditions.

Limitations: A pig model and a small number of clips.

Conclusions: The Ethicon Endo-surgery clip is compatible with MRI. All other clips showed deflection in a magnetic field, but only the TriClip demonstrated detachment from gastric tissue, and hence should be considered MRI incompatible. (Gastrointest Endosc 2009;70:532-6.)

Endoscopic endoclip deployment technology was first developed in 1975 by Hayashi et al[1] and Kuramata et al.[2] Endoclips have been extensively used in Japan, Europe, and in the rest of the world over the past 2 to 3 decades. They are primarily used for the control of GI bleeding and for closure of perforations, fistulas, and anastomotic leaks.[3] In addition, clips have been used to anchor catheters, feeding tubes, and stents to the GI wall to prevent their migration, and as anatomical markers for other endoscopic and nonendoscopic treatments.[3] For each of these indications, endoclips of different sizes, shapes, and colors have been developed to fulfill a specific purpose. Currently, there are a number of different types of endoclips available, manufactured by various companies. The 4 most commonly used endoclips are the Resolution Clip (Microvasive Endoscopy, Boston Scientific Corp, Natick, Mass), the TriClip (Cook Endoscopy, Winston-Salem, NC), QuickClip (Olympus America, Melville, NY), and, recently, the Ethicon Endo-surgery Clip (Ethicon Endo-Surgery, Cincinnati, Ohio).

Most endoclips are sloughed from the mucosa and passed in the bowel movement within 2 weeks; however, a longer duration of endoclip retention has been reported. A recent study by Jensen et al[4] reported a median

Abbreviations: ASTM, American Society for Testing and Materials; MRI, magnetic resonance imaging.

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clip retention time of 8 weeks for the Resolution Clip, which was significantly higher than for the TriClip or the QuickClip. Also, another study of clip retention, by Shin et al,[5] using a porcine model, reported that the Resolution Clips remained attached to the site of application for the entire 5 weeks of the study duration. In comparison, most of the TriClips (67%) detached within the first week after application, and 80% of clips dislodged within the first 2 weeks of follow-up.[5] This raises concerns regarding the timing of magnetic resonance imaging (MRI) scans in these patients, because most of the available endoclips, besides the Ethicon Endo-surgery Clips, are considered MRI incompatible. The purpose of this study was to determine the MRI compatibility of different commercially available endoclips and to measure the relative strength of attraction with respect to the magnetic field (gauss) among the MRI incompatible clips and to evaluate whether the endoclips deflect or detach from the gastric tissue at the standard MRI field of 1.5 Tesla.

Capsule Summary

What is already known on this topic

- All commercially available GI endoclips are labeled as magnetic resonance imaging (MRI) incompatible, but it is unknown at what magnetic field strength clips are deflected.

What this study adds to our knowledge

- In a comparison of 4 commercial endoclips placed in porcine stomach mucosa and undergoing MRI, all except the Ethicon Endo-surgery Clip demonstrated physical deflection.

MATERIALS AND METHODS

Four endoclips were tested for MRI compatibility with respect to physical deflection caused by a strong magnetic field in an MRI scanner at a field strength of 1.5 Tesla. Information regarding the clips tested is listed in Table 1, and the endoclips are shown in Figure 1. The clips were first tested to determine whether there was any deflection caused by the magnetic field. Clips that did show deflection were further tested to determine the degree of deflection compared with the other clips.

To determine whether a clip was deflected from the magnetic field, the clip was placed in a well-defined position in an enclosed clear plastic container on graph paper with horizontal and vertical lines spaced at 0.25 inches (Fig. 2). The plastic container with a clip was placed on the patient table in the MRI scanner, with the clip located at the center (left-right) of the bore and its orientation parallel to the direction of the main magnetic field. The clip was moved through the isocenter of the bore and was returned to the starting location. The position of the clip on the graph paper was observed to determine whether the clip had moved from its original position. The clip was subsequently tested with its orientation perpendicular to the magnetic field. Both orientations were repeated with the clip at the edge of the bore of the magnet. The endoclip magnetic attraction was also tested with a portable magnet with a field strength of 0.5 Tesla (Fig. 3).

The clips that demonstrated deflection were further tested to determine the degree of deflection compared with the other clips. Each clip was tested separately and was suspended from the top of the small plastic container. This was done so that the smallest amount of translational or rotational deflection could be observed. The clip was moved along a line toward the isocenter by starting from a distance of 20 feet. Distance was measured by using a marked rope that extended from the isocenter. The distance at which the clip was first observed to be deflected was noted. The strength of the magnetic field was measured with a gauss meter (model 5070F; W. Bell, Orlando, Fla) at that distance (Table 2). A clip that was observed to first be deflected at a greater distance and in a lower magnetic field was judged to have a ''stronger attraction'' to the magnetic field compared with a clip that was first deflected at a shorter distance and higher magnetic field.

The endoclips that demonstrated deflection (Resolution Clip, TriClip, and QuickClip) in the above experiment were further evaluated the effect of the magnetic field on endoclips attached to gastric tissue in a dissected pig stomach that had been opened longitudinally to expose the luminal surface. One clip of each type was placed along the same fold in the stomach at a distance of 0.5 to 1 cm from each other (Fig. 4). The pig stomach was placed in a plastic container and passed through the MRI scanner at different angles to the direction of the magnetic field. The clips were observed for any deflection and detachment from gastric tissue. The endoclip that demonstrated detachment from the gastric tissue was defined as MRI incompatible.

RESULTS

In this observational study, the Ethicon Endo-surgery Clip was found to demonstrate no physical deflection under the magnetic field of 1.5 Tesla. Other endoclips, including the QuickClip, TriClip, and Resolution Clip, were observed to have a physical deflection under the study settings. Among these endoclips, the Resolution Clip was found to have the strongest attraction, followed by the TriClip, and then the QuickClip (Table 2).

When the QuickClip, TriClip, and Resolution Clip were deployed to a gastric fold in an excised pig stomach and tested, all endoclips demonstrated deflection in the