



## Case report

## Metallic intraocular foreign body as detected by magnetic resonance imaging without complications— A case report



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## ARTICLE INFO

## Article history:

Received 11 November 2016

Received in revised form

14 April 2017

Accepted 20 June 2017

Available online 22 June 2017

## Keywords:

Intraocular foreign body

Metallic

Magnetic resonance imaging

## ABSTRACT

**Purpose:** To describe a case and present unique images of a metallic intraocular foreign body that was identified in a 12-year-old male patient who underwent routine magnetic resonance imaging (MRI) to assess neurodevelopmental delay.

**Observations:** We present MRI and diagnostic imaging of a metallic intraocular foreign body in a young patient with no known history of trauma or reason for the existence of metal in the eye area. Computed tomography scan was performed to confirm the presence of the intraocular foreign body, followed by optical coherence tomography and electroretinogram to assess visual status. It was determined that no surgical intervention was currently required as no visual impairment or ocular toxicity was identified. The patient continues to be monitored.

**Conclusions and importance:** This case presentation highlights the novel imaging features of a metallic intraocular foreign body, unexpectedly detected with MRI.

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## 1. Introduction

Magnetic resonance imaging (MRI) of the brain has become an increasingly accessible diagnostic modality and the resultant investigational scans can provide invaluable information related to neurodevelopmental outcomes. An MRI uses an external magnetic field in combination with a radio wave frequency pulse to excite hydrogen nuclei, resulting in a clear contrast of anatomical features. MRIs deliver higher resolution and better discrimination of structures than other commonly available non-invasive imaging modalities, such as ultrasound or computed tomography (CT). In children, longitudinal imaging of the brain can provide clinicians with the ability for comparative assessment over time, however some modalities, such as CT, are not optimal for the developing cerebral anatomy of a pediatric population. This is primarily due to the associated level of radiation exposure. For these reasons, MRI is

often the chosen imaging modality in children when serial imaging is anticipated.

Generally, prior to MRI study, the patient or caregiver is carefully interviewed to rule out the presence of any metal artifact due to previous trauma or surgical intervention. Often, if the history is unknown, a skull x-ray or CT is performed to rule out the presence of ferromagnetic foreign body prior to MRI. MRI is contraindicated if a metal foreign body is suspected because the magnetic force may cause a metallic foreign body to move, causing serious damage to surrounding tissues.<sup>1–3</sup>

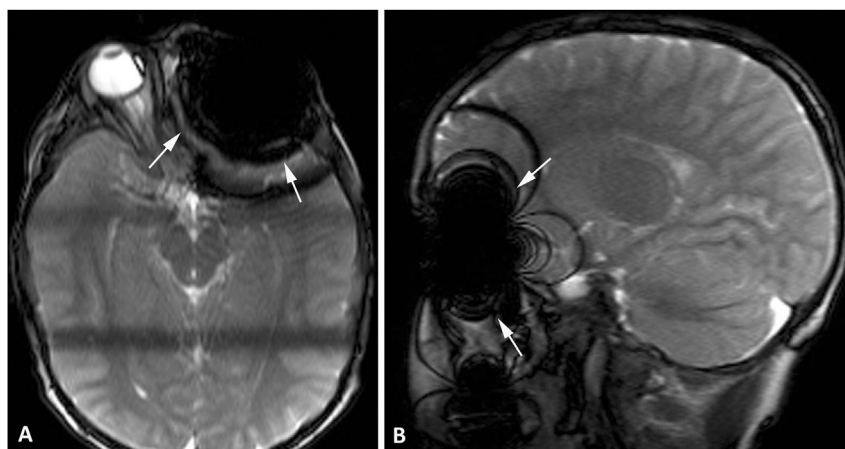
Here, we describe a unique case of a metallic intraocular foreign body that was identified in a patient by MRI and present the corresponding images.

## 2. Case report

In 2009, a 10-year-old Caucasian male with developmental delay underwent a routine MRI study to assess for intracranial abnormality. He had a brain MRI done at the age of 5 years that was uneventful and showed no intraorbital abnormality. As a standard

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**Fig. 1.** Magnetic resonance (MR) images of orbits. Localizer images of a low-resolution gradient-echo T2-weighted sequence from a 1.5-T MR system in axial (A) and sagittal (B) planes show a typical susceptibility artifact (arrows) that obscures the anatomical structures of the left orbit and surrounding regions. Such artifacts are typically associated with ferromagnetic substances.

procedure, the child's parents were interviewed prior to the scan to rule out any contraindications to MRI scan. There was no history of ocular metallic objects or surgical devices.

The MRI was performed on a 1.5-T MR system (Siemens Avanto, Erlangen, Germany) using a 12-channel head coil. The scan was started with a localizing sequence, which is a low-resolution gradient-echo T2-weighted sequences (Time of repetition: 6.58 ms; time of echo: 3.29 ms). On the initial localizing images, marked susceptibility artifacts were observed in the left orbit (Fig. 1), suggesting presence of ferromagnetic metallic objects. The MRI scan was immediately stopped for fear of intraocular injury. Radiographs of the orbits were obtained right after the MRI, which confirmed the presence of a radiopaque foreign body in the left orbit. The child did not report any pain or discomfort during or immediately after the MRI. A low-dose non-contrast computed tomography (CT) scan was performed 3 weeks after the MRI, which showed an intraocular location of the foreign body (Fig. 2).

Following the detection of the intraocular foreign body, a complete ophthalmic examination was performed. This was done under general anesthesia, as the patient's developmental delay made him uncooperative to an office assessment. It was during this examination that a point of entry of the foreign body was identified, associated with a small iris defect near the limbus at the 3 o'clock position and a corresponding small sector cataract (Fig. 3). A foreign body granuloma was located embedded in the retinal layers, just nasal to the optic nerve (Fig. 4). Both the mechanism of the injury and the composition of the foreign body remain unknown.

The patient's vision was 20/20 in both eyes despite a mild epiretinal membrane in the macula of the left eye.

The initial decision was made to not surgically remove the metallic foreign body because its location was non-vision threatening and surgical removal could possibly result in damage to the optic nerve and permanent vision loss. There was no indication of acute local inflammation and the foreign body was well encapsulated in a granuloma. The patient is still monitored closely and undergoes complete eye exams, OCT and electroretinogram (ERG) every six months in order to ensure that no visual impairment or further complications of possible metal toxicity develop. At last follow-up, in 2016, the patient's vision remains 20/20, the cataract and ERM have shown no signs of progression and ERGs remain normal with no evidence of metallic retinal toxicity.

### 3. Discussion

MRI scans of a metallic intraocular foreign body are very rare, primarily due to the magnetic susceptibility and resultant tissue damage, making the procedure contraindicated. We believe this may be the largest metallic IOFB reported that underwent MRI without evidence of ocular damage.

There are very few reports in the published literature demonstrating MRI of a metallic intraocular foreign body in vivo.<sup>1–4</sup> Most recently, Zhang and colleagues in China described two cases of very small ( $\leq 0.5$ mm) intraocular ferromagnetic particles visualized using MRI.<sup>4</sup> The authors suggested that these small fragments, even though too small to be visualized by x-ray or CT imaging, may be safely visualized on MRI because the particles did not appear to be large enough to cause ocular damage.

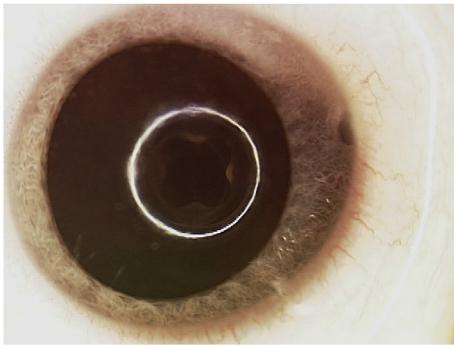
In 1988 Williams et al. used a rabbit model to observe the movement of ferromagnetic foreign bodies in and around the eye, sclera, and orbit undergoing MRI.<sup>5</sup> They found a size threshold of  $3 \times 1 \times 1$ mm was required to demonstrate movement when exposed to the magnetic field.<sup>5</sup> In our case, it was determined from a follow-up CT scan (Fig. 2) that the intraocular foreign body of our patient was spherical, measuring at 3.5 mm. Because we did not have comparative orbital imaging prior to the MRI, it is unknown if the foreign body demonstrated any movement in our case, although there were no visible signs of acute retinal or intraocular trauma on examination within a week of the MRI.

Based on the shape and size of the foreign body in our case, we speculate that this foreign body is likely a metallic pellet from a ball bearing (BB) high velocity rifle. These pellets commonly contain an iron core accompanied by a coating of either zinc or copper. Iron has magnetic properties that could have resulted in the obscurities present in the MRI. The content of the metallic foreign body is of significant interest because of possible future retinal toxicity. Since the precise composition and origin of the foreign body is unknown, it is important to understanding the different elements and their effect on the eye.

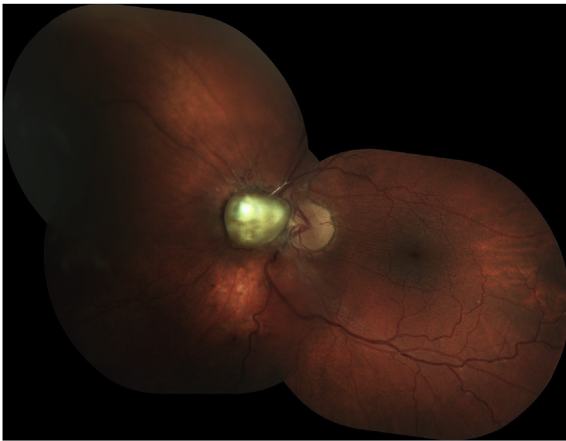
A review from 2013 by Ugarte and colleagues describes the roles of iron, zinc, and copper in both retinal physiology and disease.<sup>6</sup> The decomposition of iron in the eye can cause pathological changes such as ocular toxicity as well as retinal inflammation and atrophy.<sup>6</sup> Additionally, histology studies from humans and rabbits with iron intraocular foreign bodies (ocular siderosis) has



**Fig. 2.** Computed tomography (CT) confirming the 3.5-mm intraocular metallic foreign body. Low-dose non-contrast CT images in coronal (A) and axial (B) planes obtained 3 weeks after the magnetic resonance imaging showed intraocular location of the foreign body (arrows). The foreign body is located immediately nasal to the optic disc.



**Fig. 3.** External photo of the point of entry between the iris and limbus at the 3 o'clock position contingent with a small traumatic cataract.



**Fig. 4.** Montage image of the left eye with the foreign body granuloma nasal to the optic nerve and a mild macular epiretinal membrane.

demonstrated retinal degeneration. Although the effects of zinc deficiency have been studied, we are not aware of any publications describing retinal abnormalities that may be attributable to zinc exposure or zinc overload. Studies have shown that copper-containing intraocular foreign bodies are extremely toxic to the retina.<sup>6</sup>

The large darkened area observed in the MRI (Fig. 1) is a magnetic susceptibility artifact. Susceptibility artifacts, also known as metallic artifacts, are commonly encountered in clinical MRI secondary to presence of even small quantities of metals such as iron, nickel, or cobalt. These substances become highly magnetized

when they are placed in the MR scanner, creating a massive distortion of the magnetic field around them.<sup>7</sup> Susceptibility artifacts can cause signal loss and massive geometric distortion of anatomical structures. In our case, a radiopaque foreign body is confirmed on both radiography and CT.

#### 4. Conclusions

In summary, we presented a case of metallic intraocular foreign body that was detected by MRI in a 10-year-old patient. Fortunately, this patient did not appear to have experienced damage to the ocular tissues as a result of the MRI and maintains adequate macular architecture and normal visual acuity, although regular monitoring continues. This case highlights the unique appearance of a metallic intraocular foreign body on MRI, and also the need to be vigilant in pre-MRI screening.

#### Patient consent

The parent of this patient provided written consent to publish these case details related to their child in a deidentifying manner at the office of Calgary Retina Consultants, in Calgary, Alberta.

#### Funding

No funding or grant support.

#### Conflicts of interest

The following authors have no financial disclosures: AP, BW, AI, AE.

#### Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

#### Acknowledgements

None.

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