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SHORT COMMUNICATION

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Magnetic resonance imaging of cyclodialysis clefts

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Abstract ● Background: Our purpose was to determine whether cyclodialysis clefts can be imaged with magnetic resonance imaging (MRI). ● Methods: Surgical cyclodialysis clefts extending approximately 3 clock hours were created in four New Zealand white rabbits. Eyes were scanned with an ocular MRI coil. Images obtained after intravenous gadolinium, topical gadalinium, and gadolinium injected into the cleft were compared to images obtained without contrast. Two human eyes were also scanned for cyclodialysis clefts with MRI. ● Results: Direct injection of gadolinium into the suprachoroid space yielded definitive localization and delineation of the cyclodialysis cleft. Cyclodialysis clefts could also be imaged following enhancement with topical or intravenous gadolinium. Without contrast medium, the clefts could not be clearly identified in rabbits. In a patient with hypotony and choroidal effusion following cataract surgery, a cyclodialysis cleft and enhancement of the suprachoroidal space were found with intravenous administration of gadolinium. MRI from a patient with a trabeculo-suprachoroidal shunt also demonstrated gadolinium enhancement of the suprachoroidal space. ● Conclusion: Cyclodialysis clefts can be imaged using gadolinium-enhanced MRI in rabbits and humans.

Introduction

Cyclodialysis clefts are formed by a disinsertion of ciliary of muscle fibers from the sclera, allowing aqueous to drain into the suprachoroidal space. Hypotony usually results, and, in this circumstance, gonioscopy to identify the location and margins of a cleft can be difficult. Imaging of clefts has been achieved by ultrasound biomicroscopy [3]. MRI, with its ability to delineate soft tissue planes, offers another potential diagnostic aid for this entity, especially in conjunction with small surface ocular coils [6]. We utilized such a coil with small field-of-view MRI to localize cyclodialysis clefts in rabbits and two patients.

Materials and methods

The animals used for our study were treated in accordance with the *Principles of laboratory animal care* (NIH publication no. 86-23, revised 1985), the resolution of the Association for Research in Vision and Ophthalmology, and our institutional guidelines. Cyclodialysis clefts were surgically created in four New Zealand white rabbits weighing between 2 and 3 kg. The rabbits were anesthetized with an intramuscular injection of ketamine (35 mg/kg) and xylazine (5 mg/kg) for the procedure. Radial sclerostomies were created 4–5 mm posterior to the limbus, and a cyclodialysis spatula was advanced toward the limbus in the supraciliary space. The scleral spur was separated, the tip of the spatula was visualized in the anterior chamber, and the spatula was rotated to create cyclodialysis clefts. Clefts of 3–5 clock hours were created superonasally.

Postoperatively, the rabbit eyes received a drop of phospholine iodide 0.125% and combination antibiotic and steroid ointment.

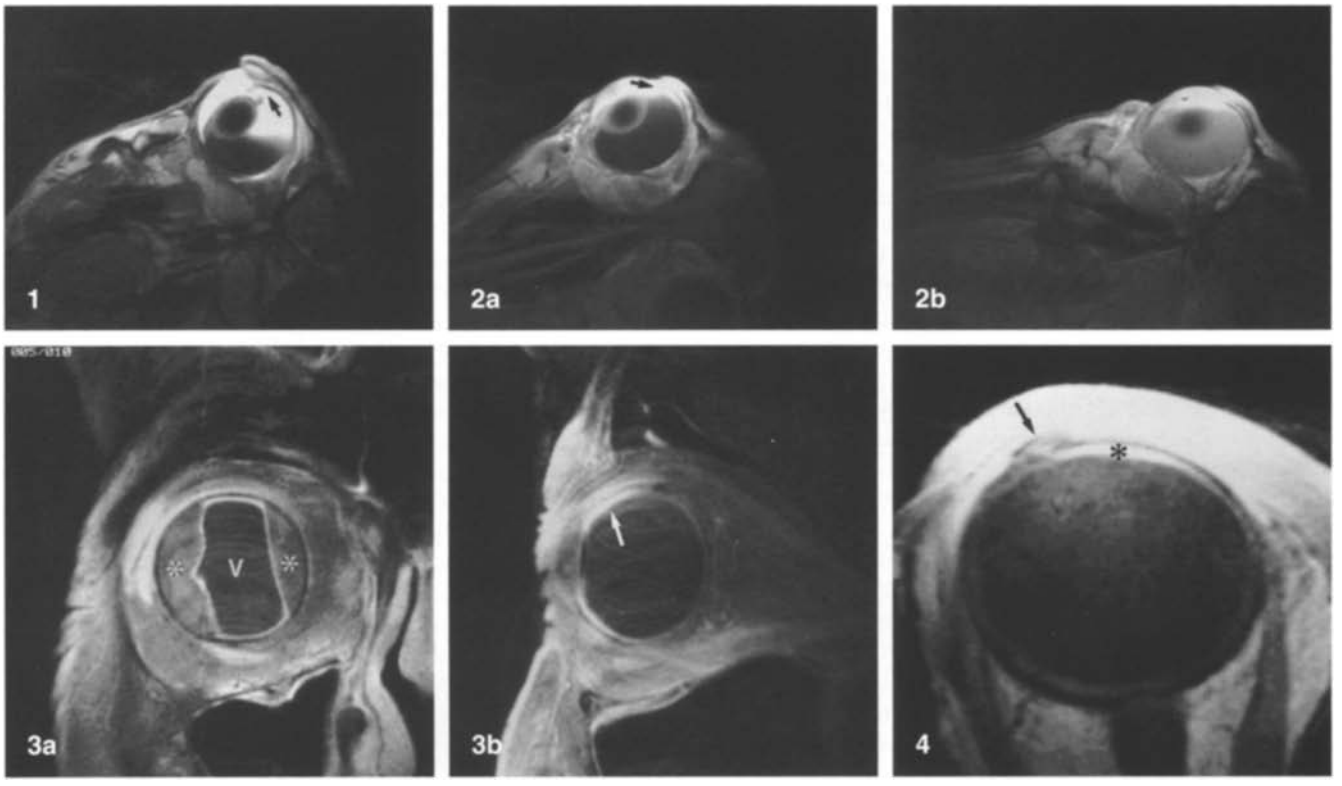

Fig. 1 Image of cyclodialysis cleft in a rabbit after direct injection of gadolinium into the cleft. The arrow indicates the location of the cyclodialysis cleft and the fluid in the suprachoroidal space

Fig. 2 **a** MRI of rabbit cyclodialysis cleft 30 min after intravenous administration of gadolinium. The *arrow* indicates the location of the cyclodialysis cleft. **b** MRI of same rabbit 6 days later, providing an image of an eye with a closed cleft. Note the enhancement of the anterior chamber with IV gadolinium

Fig. 3 **a** Coronal image from patient 1 following intravenous injection of gadolinium, demonstrating choroidal detachment. *Asterisks* Fluid in suprachoroidal space, *v* vitreous cavity. Note the mild enhancement of the suprachoroidal space, indicating leakage of contrast from vessels or from aqueous draining into this space. **b** Sagittal image from the same patient following intravenous injection of gadolinium, showing enhancement of the suprachoroidal space anteriorly in the region of the cyclodialysis cleft (*arrow*)

Fig. 4 Axial section from patient 2, 15 min after intravenous injection of gadolinium, in the region of the trabeculo-choroidal shunt. The *arrow* indicates the position of the trabeculo-suprachoroidal shunt. Note enhancement of the suprachoroidal space (*asterisk*)

Imaging was performed within 12 h and again 6 days after surgery. The initial images were obtained within 12 h because closure of the surgically created clefts in rabbits occurred within a few days postoperatively. The rabbits were scanned using a General Electric Signa clinical imager with a field strength of 1.5 T and a custom-made receive-only 1.25-in. (3.2-cm)-diameter surface coil. Gadolinium-DTPA (Magnevist; Betlex Labs, Wayne, N.J.) was used as an intravenous bolus or diluted 1:6 with sterile water for drops or intracameral injection.

Patient 1

The first patient was an 84-year-old woman with a history of cataract extraction with posterior chamber intraocular lens. The patient was diagnosed with a cyclodialysis cleft and hypotony after falling and sustaining a blunt injury to her eye. She had 20/80 vision and an intraocular pressure ranging from 2 to 4 mm Hg. On gonioscopy, a cyclodialysis cleft was identified extending from 11 to 1 o'clock superiorly. Examination of the fundus revealed choroidal detachment. After obtaining informed consent, MRI was performed with intravenous injection of gadolinium. Subsequent to her MRI, the patient was treated with argon laser to the cleft [5], with improvement of the vision to 20/40, normalization of the intraocular pressure, and resolution of the choroidal effusions.

Patient 2

The second patient was a 79-year-old woman (patient of King Y. Lee, MD, Kansas City, Mo.) with neovascular glaucoma and poor intraocular pressure control on maximum tolerated medical treatment. A suprachoroidal shunt (Visionex, Sunnyvale, Calif.) was placed inferonasally [4]. After obtaining informed consent, MRI with intravenous administration of gadolinium was done 4 weeks later, at which time intraocular pressure was 10 mm Hg.

Intravenous administration of gadolinium in humans is an approved usage of this drug and may enhance imaging of the eye [1, 2]. Intracameral injection and topical application are investigational routes of administration of gadolinium in humans.

Results

Figure 1 shows an MRI scan of a cyclodialysis cleft in a rabbit, immediately after injection of diluted gadolinium into the anterior chamber. This assured the adequacy of the surgical procedures and demonstrated that MRI with gadolinium could identify surgically induced cyclodialysis clefts. Figure 2 a shows an MRI scan of a rabbit cyclodialysis cleft 30 min after intravenous injection of gadolinium. The maximal enhancement of the cleft image occurred between 15 and 30 min after administration. Enhancement of the cleft image was transient, with minimal enhancement 1 h or longer after injection. Images with topical gadolinium were less well defined than those obtained with intravenous gadolinium. MRI of the same rabbit days later (Fig. 2 b) demonstrated a closed cleft with only the enhancement of the anterior chamber but not the suprachoroidal space.

We used the same surface coil to image cyclodialysis clefts in two patients. Figure 3 a shows the choroidal detachment of the patient with cyclodialysis cleft following blunt trauma. Figure 3 b is an enhanced MRI scan of the patient eye with the superior cleft delineated. Figure 4 shows enhancement of the suprachoroidal space on MRI with intravenous gadolinium in a patient with a trabeculo-suprachoroidal shunt. The images after gadolinium treatment showed early signal enhancement in the aqueous in the ciliary body region and the anterior chamber, followed by gradual signal enhancement in the suprachoroidal region of the shunt.

Discussion

Cyclodialysis clefts may cause hypotony and decreased vision, as in our first patient. Cleft localization can be difficult secondary to the changes associated with hypotony, which may interfere with examination techniques such as gonioscopy. Without the ability to localize the cyclodialysis cleft, laser or surgical intervention is difficult or impossible. High-resolution ultrasound biomicroscopy recently has been shown to be helpful [3], We have demonstrated that cyclodialysis clefts can be imaged in rabbits using MRI with a small surface coil. Localization of the clefts requires examination of multiple sections. We have also presented imaging of the suprachoroidal space and cyclodialysis clefts in two patients. Intravenous administration of gadolinium produced optimal images in rabbits and humans 15–30 min after an intravenous bolus of gadolinium.

Direct injection of gadolinium into the anterior chamber in rabbits demonstrated drainage of aqueous through the cyclodialysis cleft into the suprachoroidal space. Similarly, following intravenous injection of gadolinium, although there may have been some leakage from the choroidal vessels, most of the gadolinium enhancement probably originated from aqueous containing gadolinium. Thus, gadolinium enhancement can demonstrate whether there is flow from the anterior chamber through the cyclodialysis cleft into the suprachoroidal space. We could not determine the actual flow rate of aqueous through the cleft, which would be dependent upon multiple factors, including the extent of the cleft and the permeability of the outer cleft wall to aqueous flow.

High-resolution anterior segment ultrasound allows direct and accurate determination of the circumferential extent of cyclodialysis clefts [3]. Correlation of the location of a particular MRI slice with a location on the eye wall was not a problem in our study. However, acute inflammation could lead to leakage of gadolinium, which may make precise localization of clefts more difficult. This could occur, for example, when surgical procedures are performed adjacent to the area of a cyclodialysis cleft, although this did not appear to be a problem in our experimental and clinical images.

The shortcomings of this MRI technique include the need for a special modified surface coil, which, like high-resolution ultrasound, may not be readily available. The clinical use of MRI for detecting cyclodialysis clefts may be limited by the high cost of the examination, the inconvenience for the patient, and the imaging resolution. There is also the small risk and inconvenience associated with the intravenous injection of gadolinium. Both the ultrasound biomicroscope and MRI have the ability to show an anatomical abnormality indicating a cyclodialysis cleft, which may assist in the delineation of the cleft prior to surgical management. MRI, however, may image the entire eye, in contrast to the limited penetration of the ultrasound biomicroscope. A direct comparison of MRI and anterior segment ultrasound would be of interest to assess the clinical value of these techniques for imaging cyclodialysis clefts.

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References

1. Bond JB, Haik BG, Mihara F, Gupta KL (1991) Magnetic resonance imaging of choroidal melanoma with and without gadolinium contrast enhancement. Ophthalmology 98:459–466
2. Cheng H-M (1991) Magnetic resonance imaging of the human eye in vivo. Optom Vis Sci 68:976–980
3. Karwatowski WS, Weinreb RN (1994) Imaging of cyclodialysis cleft by ultrasound biomicroscope. (letter) Am J Ophthalmol 117:541–534
4. Lee KY, Lashkari K, Kwong KK, Cheng H-M (1992) Magnetic resonance imaging of the aqueous flow in eyes implanted with the trabeculosuprachoroidal glaucoma seton. Invest Ophthalmol Vis Sci [Suppl] 33:948
5. Ormerod LD, Baerveldt G, Sunalp MA, Riekhof FT (1991) Management of the hypotonous cyclodialysis cleft. Ophthalmology 98:1384–1393
6. Rubin PAD, Bilyk JR, Shore JW, Sutula FC, Cheng H-M (1994) Magnetic resonance imaging of the lacrimal drainage system. Ophthalmology 101: 235–243