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Postsurgical Imaging of the Globe

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Interpretation of globe imaging after ophthalmologic surgical intervention, just like postoperative imaging in any location, can create a diagnostic dilemma if the radiologist is not familiar with the type of surgery performed and the nature and location of any implanted devices. Certain implants and devices may create artifacts on computed tomography or magnetic resonance imaging, and some contain ferromagnetic components that may be damaged if inadvertently placed in the magnetic resonance imaging. We review several common ocular surgical procedures, as well as a few orbital surgical procedures and discuss many implants and devices and their appearance on cross-sectional imaging. Familiarity with these procedures and their imaging appearance can diminish the chance of misinterpretation.
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Interpretation of globe imaging after ophthalmologic surgical intervention, just like postoperative imaging in any location, can create a diagnostic dilemma if the radiologist is not familiar with the type of surgery performed and the nature and location of any implanted devices. Common procedures performed on the globe include corneal surgery, cataract surgery, repair of retinal tears, and implantation of glaucoma drainage devices. Orbital procedures, such as treatment of paralytic lagophthalmos with metallic implants, and procedures performed before globe implant placement are also important to understand.

Ophthalmologists rarely rely on cross-sectional imaging for routine postoperative assessment of patients after ocular surgery and instead reserve imaging for concerns such as infection or foreign bodies. Certain implants and devices may create artifacts on computed tomography (CT) or magnetic resonance imaging (MRI), for example, prosthetic components used for scleral buckle treatment of retinal detachment can have air-attenuation; mimicking intraorbital air from trauma or infection. Certain ocular implants contain ferromagnetic components that may be damaged if inadvertently placed in the MRI. We review several common ocular surgical procedures, as well as a few orbital surgical procedures, and discuss many implants and devices and their appearance on cross-sectional imaging.

Retinal Detachment

In 1929, at the Ophthalmological Society of Eastern France, Gonin proved his hypothesis that retinal detachment was caused by breaks in the retina.[1] Actually, a tear-causing separation of the retina from the underlying retinal pigment epithelium (RPE) with fluid buildup in the subretinal space defines rhegmatogenous retinal detachment (in Greek, rhegma means "rent" or "rupture"). Rhegmatogenous retinal detachments are diagnosed via indirect ophthalmoscopy. B-scan ultrasonography, usually performed by the ophthalmologist, is used to identify the degree of retinal tear or to identify the site of retinal tear that is not well seen on indirect ophthalmoscopy (Fig. 1).[2] If surgical correction is not sought, progressive accumulation of fluid will lead to complete retinal separation and eventual permanent blindness.

Surgical treatment is aimed at the creation of a chorioretinal scar (retinopexy) at the separation site and mechanical apposition of the retina to the RPE. Apposition promotes reattachment and retinopexy is aimed at preventing redetachment. Retinopexy is accomplished by laser photocoagulation, freezing (cryotherapy), or heating

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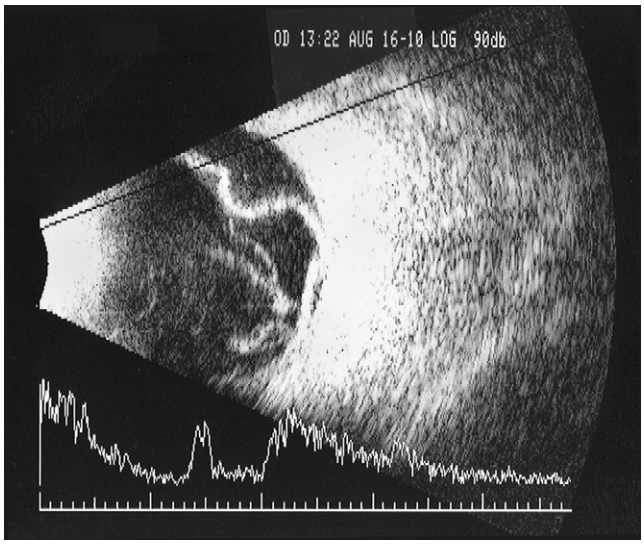

Figure 1 B-scan ultrasound of a retinal detachment.

(diathermy). In 1958, Arruga[3] suggested the use of a suture surrounding the globe to create apposition at the retinal break. Currently, 2 surgical techniques can be used to attain apposition, scleral buckling and intraocular tamponade. At the discretion of the surgeon, both techniques may be used in succession or simultaneously on the same globe.

Scleral Buckling

Scleral buckling for treatment of retinal detachment achieves apposition of the retina to the RPE through circumferential indentation of the eye wall overlying the retinal tear. When suture material was used for buckling as originally proposed by Arruga, erosions through the sclera, choroid, and retina with deposition of suture material into the vitreous was an infrequent complication.

Subsequently, suture encased with polyethylene tubing was developed but with minimal improvement in outcomes and removal of eroding tubing often caused retinal redetachment.[4] Eventually, flat, pliable, and inert silicone materials were developed, markedly decreasing the incidence of erosion.[5] In the early 1980s, silicone hydrogel [copoly(methyl acrylate-2-hydroxyethyl acrylate)], a hydrophilic polymer, was used. It was found that over time that these implants could degrade from hydrolysis and fragmentation and present as a mass or a cyst, with a clinically confusing appearance.[6,7]

On CT imaging, the hydrogel buckle will appear as a soft-tissue mass distorting the globe, often containing dystrophic calcification.[8,9] This hydrogel buckle often demonstrates capsular enhancement on postcontrast MRI and CT imaging.[8,9] hydrogel was restricted from clinical use in 1995 largely because of the problems of degradation and fragmentation.[3,6,7]

At present, a common surgical technique employs the use of silicone sponges to indent the eye wall supported in place by an encircling scleral buckle (Fig. 2). Scleral buckling devices composed of solid silicone are hyperattenuating on CT whereas porous silicone sponges are air-attenuation on CT examination. On T1-weighted and T2-weighted MRI, solid silicone buckles, as well as porous silicone sponges, appear hypointense and are often not directly visualized but are identified by deformity of the globe (Fig. 3).[3,8-10] Sponges can be applied radially or circumferentially relative to the rectus muscles and may be placed in the absence of a scleral buckle. In this instance, it is important to recognize the prosthesis and not mistake it for air or a possible infectious process.

Intraocular Tamponade

Tamponade agents work by closing the retinal tear and the inherent buoyancy characteristics of the agent promote apposition of the retina and the retinal pigment epithelium.[2,3] Two agents are commonly used, gases, such as sulfur hexafluoride (SF6) or octafluoropropane (C3F8). Perfluoro-n-octane liquid is a dense liquid used during vitrectomy surgery to appose the retina to the retinal pigment epithelium and is always removed after surgery (during eye closure). Silicone oil (polydimethylsiloxane) has also been used for this use but is commonly left within the eye after surgery and removed at a later date. Vitrectomy with intraocular gas injection will result in a mixture of air, gas, and vitreous. An air-fluid level with the remaining vitreous will be present with no discrimination between air and gas being detectable. Vitrectomy with intraocular silicone injection will produce an oil-induced chemical shift artifact. Fat saturation, or suppression of the silicone resonant fre-

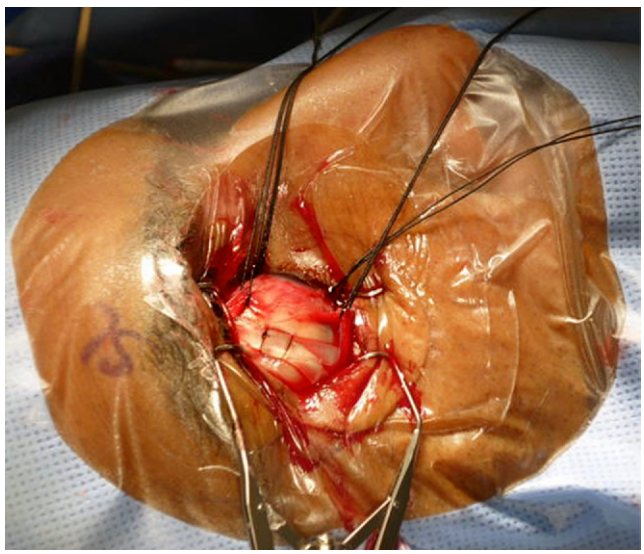

Figure 2 Intraoperative photograph of scleral buckle encircling globe and sutured to sclera. The globe is infraducted (rotated/directed inferiorly) and the cornea abuts the nasal aspect of the lower lid. (Color version of figure is available online.).

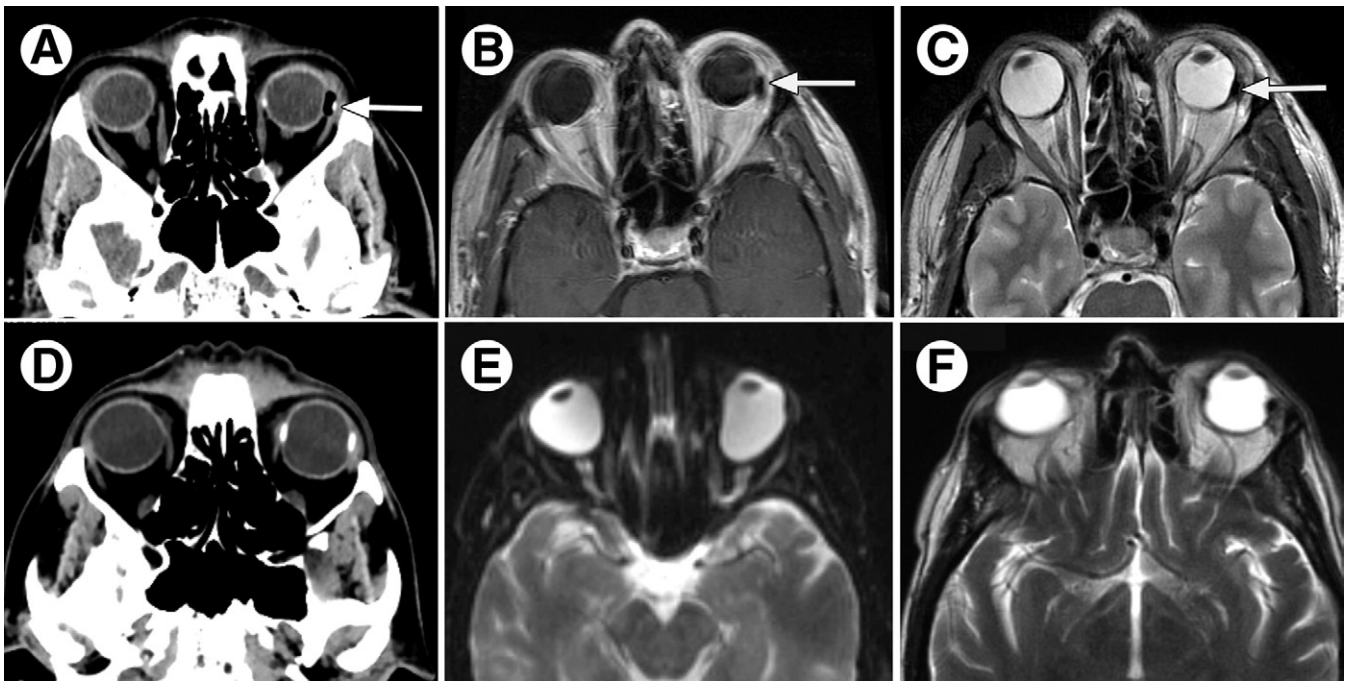

Figure 3 Axial CT without contrast demonstrates an air attenuation scleral sponge indenting the lateral aspect of the left globe (A), which is shown in the same patient on axial T1 (B) and axial T2-weighted (C) MRI. Axial CT image of scleral buckle (D) in another patient without sponge. Diffusion-weighted MRI showing distortion and flattening of the globe, which is an artifact of imaging (E). Fluid-attenuated inversion recovery image shows scleral buckle (F) with mild distortion of the globe.

quency ("sili sat"), should be obtained on T1- and T2-weighted sequences, as well as conventional nonsuppressed T1- and T2-weighted sequences, to clearly delineate the silicone oil from the remaining vitreous. On a 1.5-T magnet, silicone oil resonates at 290 Hz less than water, compared with 220 Hz less than water for fat.[10]

Cataract Removal

The 2 most common surgeries performed for treatment of cataracts include phacoemulsification and extracapsular cataract extraction (rarely performed in the United States anymore, this technique was used before development of ultrasonic surgical tools safe enough for intraocular use).[9,10] The patient is rendered pseudophakic with implantation of a prosthetic lens, which is not well visualized on CT and MR imaging (Fig. 4). Patients may also be left aphakic, defined as the absence of a lens, this is limited to cases where implantation of foreign material, such as a prosthetic lens, causes a dramatic inflammatory response.

Glaucoma Drainage Devices

The Ahmed glaucoma valve is one of the most common instruments used for the treatment of glaucoma which is uncontrollable by medical management. Simplistically, the device works by draining intraocular fluid into a reservoir in an attempt to bring down elevated intraocular pressure. The device is sutured to the sclera, most commonly in the superotemporal quadrant, and is covered by conjunctiva (Fig. 5). Complications for Ahmed glaucoma valves include tube erosion, hypotony, and endopthalmitis.[11] Endophthalmitis is infection of all intraocular tissue. It develops in 0.1% of intraocular surgeries; however, it can cause retinal necrosis leading to blindness and needs to be treated with intraocular injection of antibiotics. Endophthalmitis is easily identified by B-scan ultrasound and is often used in conjunction with the clinical examination, if the ophthalmoscopic view is poor.[12]

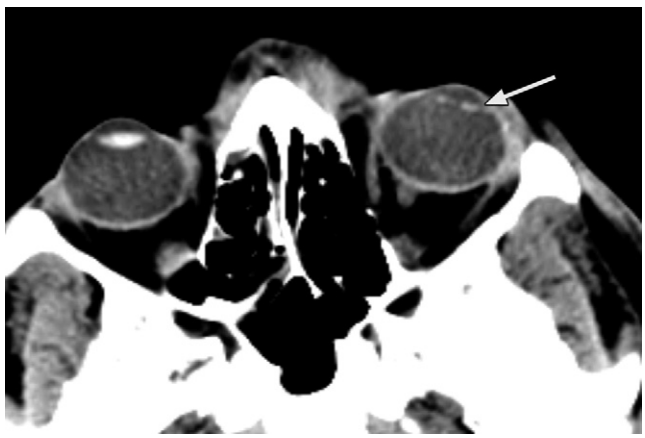

Figure 4 Axial noncontrast CT illustrates a thin, barely perceptible, left lens prosthesis.

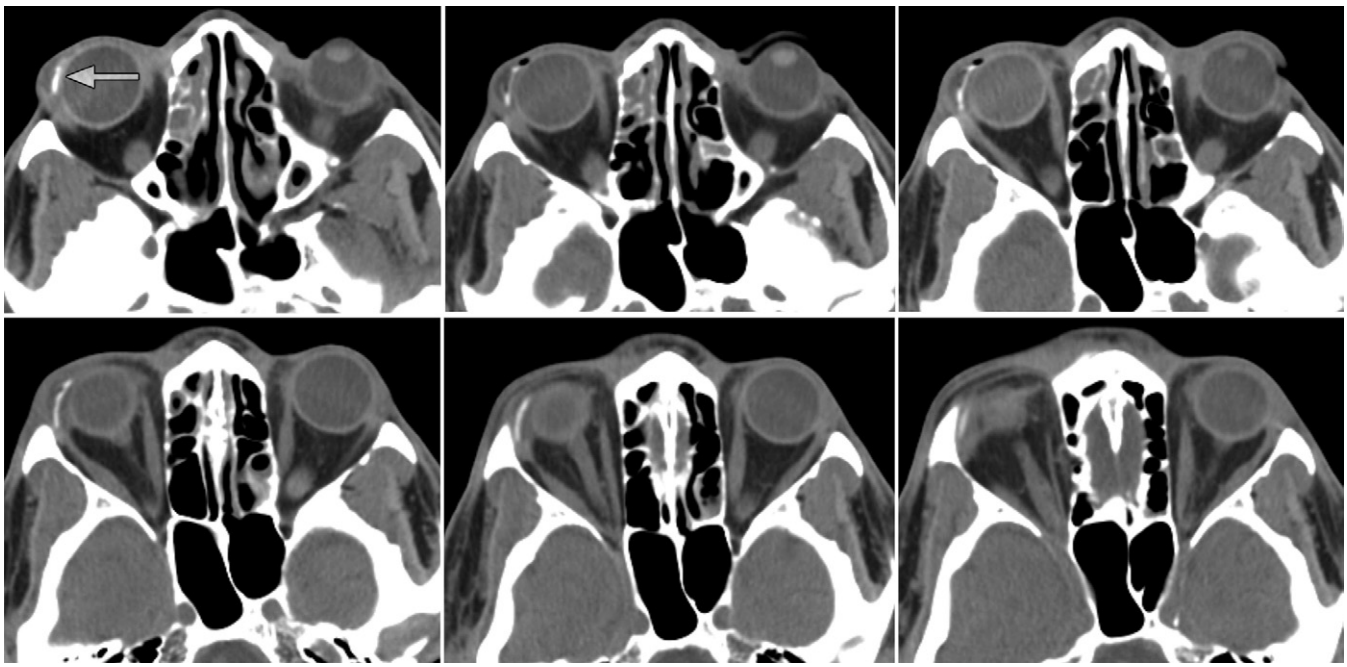

Figure 5 Sequential axial CT images performed without contrast demonstrates a glaucoma drainage device along the right anterolateral orbit abutting and slightly indenting the globe.

Gold, Platinum, and Platinum/Viridium Weight Eyelid Implants

Gold, platinum, and platinum/Viridium weights are implanted in the upper eyelids for the treatment of paralytic lagophthalmos (Fig. 6). Gold or platinum are used because of their high specific gravity, allowing a small implant size, and they are inert and rarely, if ever, cause rejection.[13] Gold and platinum appear hyperdense on CT imaging. Complications from eyelid implants include infection, entropion (inward turning of the lid margin), corneal ulceration, blepharoptosis (droopy lid), and the rare inflammatory reaction to the metallic material.[14] Most of these complications are diagnosed clinically, with the extent of inflammation and infection being determined by CT imaging when necessary. Currently, in vitro studies have demonstrated the safety of gold, platinum and platinum/Viridium eyelid implants up to 7 Tesla; however, in vivo studies have yet to demonstrate safety with respect to heating and implant dislocation.[15] Recognition of metallic eyelid implants for treatment of lagophthalmos secondary to cranial nerve VII palsy should prompt careful scrutiny of the nerve and its nucleus of origin for pathologic conditions.

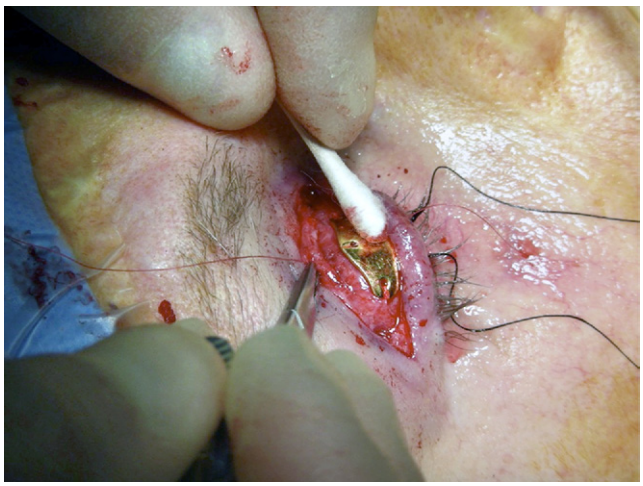

Figure 6 Intraoperative photograph of gold weight positioned on top of the tarsal plate. The gold weight is sutured to the tarsal plate, underlying the orbicularis muscle and skin of the upper lid. (Color version of figure is available online.)

Ocular Implant

Orbital procedures performed before globe implant placement include enucleation (globe only), evisceration (contents of globe removed with sclera left behind), and orbital exenteration (removal of the entire orbital contents; Fig. 7A-C). Evisceration is thought to permit better motility of the ocular implant by leaving the scleral muscular attachments intact.

Ocular implants used include hydroxyapatite, aluminum oxide, and porous polyethylene (medpor), with all appearing hyperdense on CT (Fig. 7D-F) and low signal intensity on T1-weighted and T2-weighted imaging.[9] MRI with intravenous contrast is the test of choice for postoperative evaluation of ocular implants with respect to vascularization.[16,17] The Hydroxyapatite orbital implant is highly favored due its low rate of infection and extrusion when compared with the other motility implants, although these cannot be used in all patients.[18]

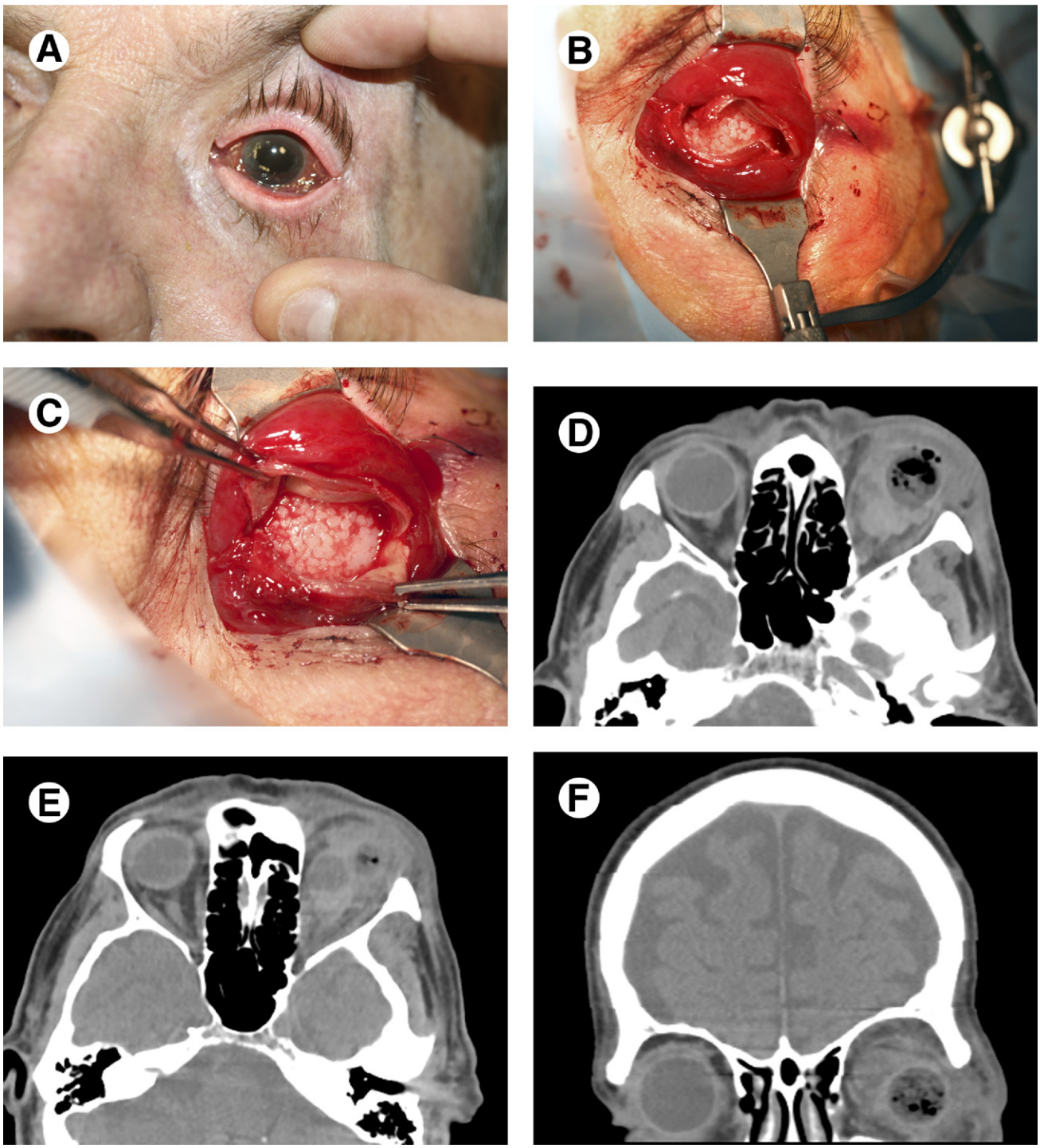

Figure 7 (A) Clinical slit-lamp photograph of eye before evisceration. (B) Orbital implant, composed of hydroxyapatite material. Surrounding the implant, you can see scleral flaps, which will be sutured over the implant, and conjunctiva, which will be the final layer to close over the implant. (C) Intraoperative photo of evisceration highlighting the scleral flap, being retracted with forceps. (D-E) Axial noncontrast CT images demonstrate soft-tissue density hematoma with fluid-fluid level posteromedial to the globe implant. (F) Coronal confirms inferolateral displacement of the orbital implant by the hematoma. (Color version of figure is available online.)

Pegs can be drilled into the core of hydroxyapatite implants (Fig. 8). The peg is coupled to a prosthetic, a thick convex shell made of medical grade plastic acrylic. These fit under the eyelids and are painted to match the appearance of the other eye. Implants fitted with pegs are thought to provide better motility to the prosthetic and improved cosmesis. Vascularized hydroxyapatite implant demonstrate decreased rates of infection at the drill site. Furthermore, fibrovascular incorporation of the peg coupling device improves peg retention. Vascularization of the central

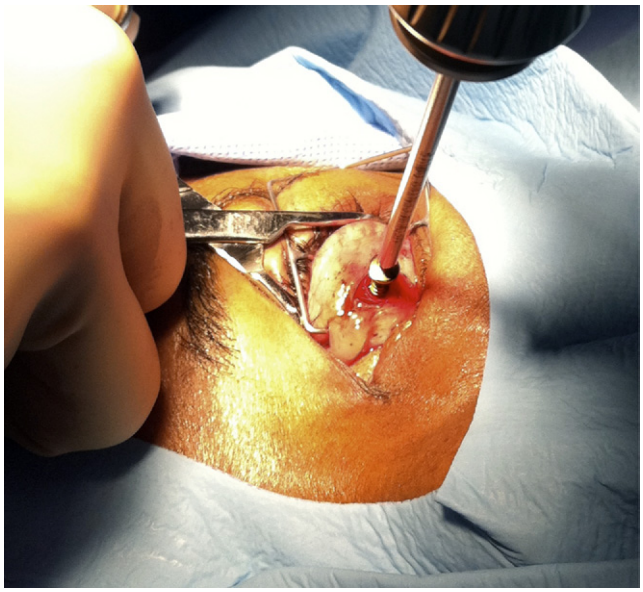

Figure 8 Intraoperative photograph of titanium peg being removed from hydroxyapatite implant. (Color version of figure is available online.)

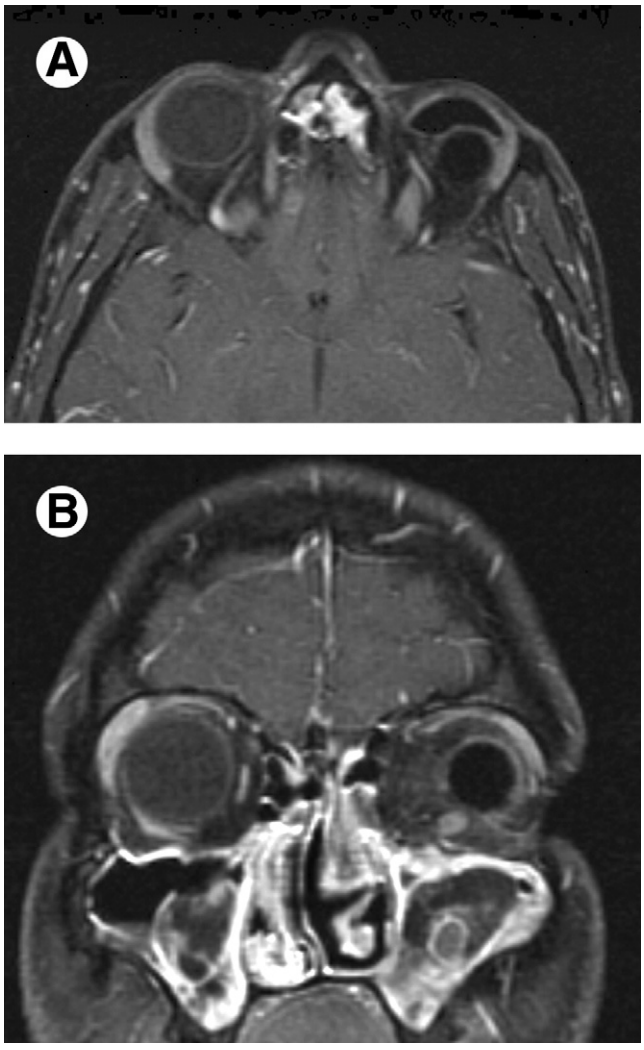

Figure 9 (A) Axial T1 fat-saturated MRI with peripheral implant enhancement and (B) T1 Fat-Saturated coronal image showing peripheral implant enhancement.

implant does not occur until approximately 9 to 15 weeks demonstrated by diffuse homogeneous enhancement. Prior to 9 weeks, the implant will present with peripheral enhancement, too early for safe drilling (Fig. 9).[17] A potential hazard to patients with certain orbital implants with magnetic prosthesis is the movement of the implant upon exposure to MRI requiring surgical reimplantation or correction due to the disruption by the magnetic field.[19]

Postsurgical Infection

Most often, postsurgical imaging of the orbits is performed with CT because MRI will have artifact due to the air-soft tissue interface. Although ultrasound can be used for primary globe infection, CT is still preferred when the globe is secondarily infected, to evaluate the adjacent sinuses in cases of subperiosteal abscess or orbital cellulitis. Clinical reevaluation, repeat CT and/or ultrasound may be useful for monitoring the size of postoperative fluid collections within the globe or the orbit.[9]

Conclusions

CT, MRI, and ultrasound can all be used for postsurgical imaging of the globe with CT as the mainstay for evaluation of postsurgical complications, such as hematoma and infection. Knowledge of the types of ophthalmologic procedures and device composition will facilitate accurate interpretation of post operative imaging findings.

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