Case Report

Imaging of Hydrogel Episcleral Buckle Fragmentation as a Late Complication After Retinal Reattachment Surgery

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Summary: Hydrogel encircling bands were introduced in the early 1980s as a product that was superior to bands composed of silicone rubber or silicone sponge for the surgical treatment of retinal detachment. Late complications consisting of orbital swelling and diplopia requiring band removal began to be reported in the early 1990s. Pathologic studies of these expanded fragments of hydrogel material after removal showed in vivo hydrolysis with foreign body reaction and dystrophic calcification. We report the imaging findings in five patients in whom this late complication developed. Hydrogel fragmentation has a characteristic imaging appearance consisting of a circumferential orbital mass associated with rim enhancement. This appearance should prompt inquiries regarding previous scleral buckle procedures with hydrogel bands. Familiarity with this appearance will avoid misinterpretation and unwarranted biopsy before band removal.

One of the objectives of retinal reattachment surgery is to relieve significant vitreous traction on the detached retina by indenting the sclera (buckling) to mechanically support the areas under traction. Silicone rubber bands are commonly placed circumferentially around the episcleral surface of the globe with grooved pieces of silicone rubber or sponge placed beneath the band, if necessary, to achieve a buckle of greater height.

Episcleral bands composed of MAI, a hydrophilic polymer (copoly[methyl acrylate-2-hydroxyethyl acrylate]) cross-linked with ethylene diacrylate, were introduced in the early 1980s as a superior product to bands composed of solid silicone rubber or silicone sponges for producing scleral buckles (1, 2). The softness and elasticity of this hydrogel substance were thought to guard against the scleral erosions occasionally seen with solid silicone rubber. As with silicone sponge, this gelatinlike polymer had the ability to absorb antibiotics; however, unlike sponge, its inherent lack of dead space theoretically made it less prone to infection. Enthusiasm over its use began to wane in the early 1990s owing to the unanticipated instability of the product in vivo (3, 4). An increasing number of reports of swelling and fragmentation of this buckling material, producing orbital discomfort and diplopia 7 to 10 years after implantation, led to its discontinuation in 1995. We report the imaging features of this late complication in five patients treated for retinal detachment with scleral buckle procedures using MIRAgel (Mira, Waltham, MA) encircling bands.

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Imaging was performed in five patients with diplopia and orbital discomfort as part of an orbital mass workup between April 1998 and October 1999. All patients had originally undergone procedures between 1987 and 1990 for rhegmatogenous retinal detachment using a MIRAgel encircling band sutured to the sclera in all four quadrants with satisfactory apposition of the detached retina flap. Imaging studies were obtained before band removal. Demographic and clinical data pertaining to these five patients are presented in the Table 1. At the time of presentation, clinical examination showed restricted eye motion associated with varying degrees of extrusion of the buckle beneath the upper or lower lid ipsilaterally (Fig 1A). Intraoperative descriptions of the buckle material consistently noted fragmentation of the buckle material, which was often encased by granulation tissue, making complete removal of the hydrogel band difficult. In case 2, the surgeon elected to leave a portion of the implant behind to avoid an increased risk of globe rupture. Pathologic samples were limited to the fragmented buckle in four of five patients (Fig 1B). One patient (case 1) had undergone a biopsy before removal to exclude orbital tumor suggested by the radiologist. The specimen showed foreign body reaction and dystrophic calcification. Cultures were negative in all cases.

Imaging features of the hydrolyzed bands are listed in the Table. All four patients who underwent MR imaging were studied on 1.5-T scanners. MR examinations were performed as dedicated orbital studies to include axial and coronal T1-weighted (500/15/1 [TR/TE/excitation]) and T2–weighted (2000/80/1) sequences, with contrast-enhanced T1-weighted studies obtained in three of the patients. All examinations showed a lobulated, circumferential mass encircling the globe. Thin-section, high-resolution CT scans in the axial and coronal planes were obtained in three of the five patients. In cases 2 and 3, CT scans showed chunklike areas of calcification within the mass (Fig 2). Additionally, in case 1, there was evidence of calcification within the pathologic specimen, which corresponded to focal areas of hypointensity on MR images (CT was not obtained in this case). In all patients for whom MR studies were available, there was an identical appearance of a markedly expanded buckle that was isointense with muscle on T1-weighted images and hyperintense on T2-weighted images (Figs 3 and 4). Contrast-enhanced images, which were avail-

Hydrogel fragmentation: clinical and imaging data

Case No.	Age (y)/Sex	Interval between Surgery and Presentation	Presenting Symptoms	CT Findings	MR Findings	Surgical Findings	Pathologic Findings
1	62/M	9	Progressive orbital swelling, restricted gaze, O.S.	NA	T2 hyperintense; T1 isointense; peripherally enhancing	Expanded, fragmented buckle material partially adherent to episcleral tissue	Fibrosis with calcification, foreign body reaction (biopsy)
2	71/F	10	Swelling beneath upper lid, O.S.	Circumferential soft tissue mass surrounding globe, partially calcified	T2 hyperintense; T1 isointense; peripherally enhancing	Expanded, fragmented buckle material, partially removed	Multiple elongated segments of rubbery, white synthetic material (gross only)
3	60/F	7	Diplopia, pressure, and pain, O.D.	Circumferential soft tissue mass surrounding globe, partially calcified	NA	Expanded, fragmented buckle material	Multiple elongated segments of rubber, white synthetic material (gross only)
4	67/F	8	Pain and orbital pressure, restricted motion, O.S.	NA	T2 hyperintense; T1 isointense	Expanded, fragmented buckle material	Multiple elongated segments of rubbery, white synthetic material (gross only)
5	67/F	8	Intermittent diplopia	Circumferential soft tissue mass surrounding globe	T2 hyperintense; T1 isointense; peripherally enhancing	Expanded, fragmented buckle material	Multiple elongated segments of rubber, white synthetic material (gross only)

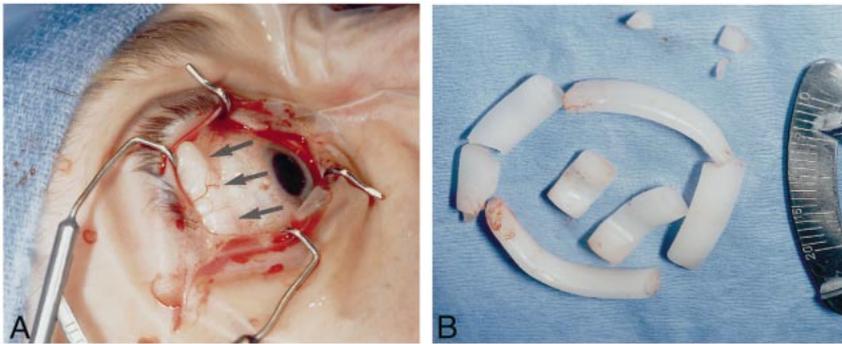Note.—O.S. indicates left eye; O.D., right eye; NA, not applicable.

FIG 1. Case 4. *A,* Intraoperative photograph shows extruded, swollen band surrounding right eye (*arrows*). *B,* Surgical specimen shows expanded fragments of the hydrolyzed buckle material.
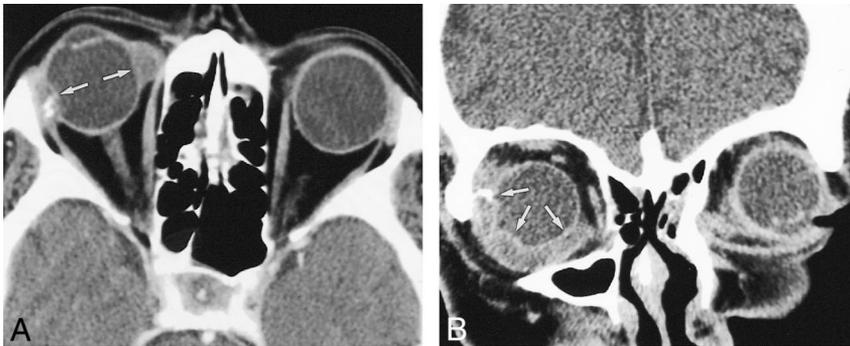

FIG 2. Case 3. *A* and *B,* Contrast-enhanced axial (*A*) and coronal (*B*) CT scans show circumferential soft tissue mass surrounding the globe with focal, dystrophic calcification and a peripherally enhancing rim (*arrows*).
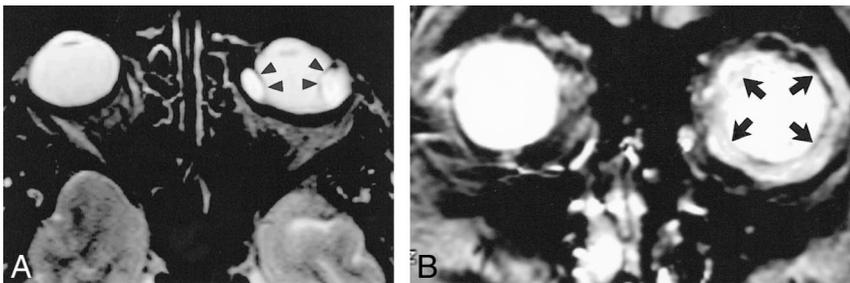

FIG 3. *A* and *B,* T2-weighted axial (*A,* case 2) and coronal (*B,* case 4) MR images (2000/80/1) show circumferential, hyperintense mass (*arrowheads, arrows*) surrounding the globe. Increased T2 signal reflects increased water content and swelling of hydrolyzed buckle material.
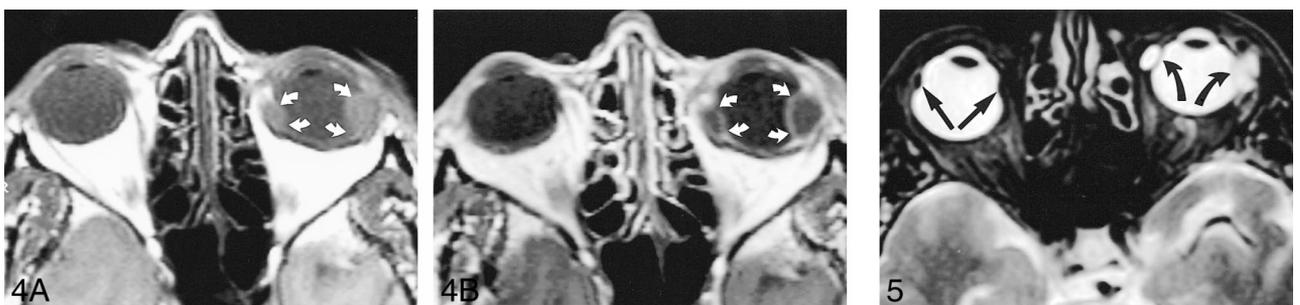

FIG 4. Case 2.
A and *B,* Noncontrast (*A*) and contrast-enhanced (*B*) T1-weighted axial images (500/15/1) show soft tissue mass isointense with muscle, with peripheral rim of enhancement (*arrows*) corresponding to thick, fibrous capsule and foreign body reaction seen at pathologic examination.

FIG 5. Case 1. T2-weighted axial image (2000/80/1) shows normal profile of an uncomplicated encircling silicone band in the right orbit (*straight arrows*) as compared with hydrolyzed, fragmented hydrogel buckle in the left orbit (*curved arrows*). An uncomplicated hydrogel band would be expected to have a similar profile to that of the silicone band.

able in three of the four patients examined with MR imaging and in two of the three patients examined with CT, exhibited a characteristic pattern of rim enhancement (Figs 2B and 4B). One patient (case 5) had previously undergone an uncomplicated scleral buckle procedure using a silicone rubber band involving the contralateral globe 1 year before the ipsilateral procedure in which the hydrogel band was used. Comparison with the uncomplicated globe underscored the marked swelling of the hydrogel band, which initially had an identical profile to that of the silicone band (Fig 5).

Discussion

Complications arising from scleral buckle procedures, which include postoperative extrusion or infection of the buckle material, have been reported to develop in 1.3% to 24.4% of patients (5–8). Although the literature contains several descriptions of the radiologic appearance of surgical materials used in scleral buckle procedures (9–11), to our knowledge this is the first report of the CT or MR appearance of orbital complications following use of these materials. All cases involved procedures in which the buckle was produced using a MIRAgel encircling band. MIRAgel and its precursor, MAI, are hydrophilic polymers that are permeable to water and other low molecular weight hydrophilic substances. The polymer is copoly(methyl acrylate-2-hydroxyethyl acrylate) cross-linked with ethylene diacrylate. It is softer than silicone rubber and therefore presumably less likely to produce scleral erosion or extrusion. It was initially thought that its ability to absorb and slowly release water-soluble antibiotics would lead to a reduction in infectious complications, offering an advantage over silicone sponges. Early reports supported these assumptions (1, 2). However, long-term follow-up studies (7–11 years) began to reveal complications ranging from bulging to intraocular erosion and migration of the buckle (3, 4, 8). At surgery, the fragmented bands were described as translucent, gellike, and friable. Surgical removal was complicated by a thick, fibrous capsule, which often fixed the swollen implant to Tenon's capsule, limiting the mobility of the globe. Removal of the fragmented implant in its entirety required meticulous technique but provided substantial relief of ocular discomfort and improved mobility, with a low risk of recurrent retinal detachment (12). Infrared spectroscopic analysis of recovered buckle fragments showed chemical alteration of the polymer, with hydrolytic degradation and swelling (3). The chemical alteration in vivo allowed the hydrogel to absorb more water. The implant changed from soft, spongy, opaque, and compact to friable, gellike, and translucent. The MIRAgel product was taken off the market in 1995 subsequent to these reports (personal communication, MIRA, Waltham, MA).

The appearance on imaging studies correlates well with the surgical and pathologic findings, reflecting the increase in its state of hydration. The T2 signal characteristics of the encircling band are consistent with the swelling and expansion of the buckle material observed intraoperatively with a marked increase in volume and T2 signal intensity. Previously published pathologic reports have described a surrounding fibrous capsule that corresponds to the enhancing rim observed in those patients who received contrast material (4). CT findings in cases 2 and 3 confirmed previously reported histologic evidence of calcification associated with changes of chronic inflammation documented in pathologic reports (13). The surgical and pathologic observations in case 1 were notable for dystrophic calcification as well, but were not clearly detectable on MR studies.

The observation of a ringlike soft tissue mass encircling the globe, which is isointense with vitreous on T2-weighted images, isointense with muscle on T1-weighted images, and shows rim enhancement, should prompt inquiries into the patient's previous surgical history. Dystrophic calcification is best delineated by CT. Documentation of the exact construct of the buckle material should be obtained from the treating ophthalmologist. Differential diagnostic considerations would include orbital abscess, but the circumferential morphology would be unusual, as would the lack of other clinical manifestations, such as fistula formation. An infiltrative orbital neoplasm, such as lymphoma, might also be considered in the absence of a relevant surgical history, but the T2 signal characteristics, ring enhancement, and the presence of dystrophic calcification would be inconsistent with this diagnosis. A complete surgical history, however, will aid in arriving at the correct diagnosis. Recognition of this characteristic appearance will help avoid unnecessary biopsy. Although the hydrogel product was pulled off the market in 1995, presentations of this late complication may occur for several years to come.

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