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MAJOR REVIEW

Scleral Buckle Removal: Indications and Outcomes

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Abstract. Primary scleral buckling has been an effective means to reattach the retina for over 50 years. After surgery, complications may arise that require scleral buckle (SB) removal. The most common indications for SB removal are extrusion, infection, and pain. I review the pertinent literature in an effort to develop guidelines for when to remove a SB. (**Surv Ophthalmol** 57:253–263, 2012. © 2012 Elsevier Inc. All rights reserved.)

Key words. complication • extrusion • infection • inflammation • intrusion • pain • removal • redetachment • scleral buckle • scleral buckling • surgery

I. Introduction

Scleral buckling with exogenous material is an effective and important method to reattach the retina.[36,101] Retrospective series have reported complications of scleral buckling, most commonly extrusion and infection, in 1.3–24.4% of eyes.[20,64,90,93] Complications of a scleral buckle (SB) may present up to decades after surgery without an age predilection and their manifestation can be protean. The dreaded consequence of SB removal is redetachment of the retina. I review the pertinent literature in an effort to develop guidelines for their removal.

II. Historical Note

A. EARLY SURGICAL TECHNIQUES

Scleral buckling as recognized today, with episcleral solid silicone or sponge implants, was developed in the United States by Harry Lincoff and Charles Schepens.[61,95] Scleral buckling was originally meant to be temporary, like a cast, but evolved to be a permanent implant because it was generally well tolerated.

Early scleral buckling techniques and materials, although no longer commonly encountered, should be considered when appropriate. Before the popularization of cryotherapy for retinopexy in 1962, lamellar scleral dissection was routinely used to apply diathermy to the retina during scleral buckling.[62] Diathermy could cause scleral shrinkage and, at times, necrosis.[8]

There were many variations of lamellar scleral dissection, including scleral resection, trapdoor scleral flaps, and rolling the edge of the sclera underneath itself to create an indentation.[5,12,51] Using scleral flaps and intrascleral implants had the perceived advantage of allowing mattress sutures to be passed more safely; a prospective, randomized study of 255 patients showed that the complications and anatomical and visual outcomes between intrascleral versus episcleral implants were equivalent, however.[27]

B. PRIOR BUCKLING MATERIALS

The first material for scleral buckling in the United States was polyethylene tubing with an intraluminal suture, but its rigidity made it prone

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to intrusion, erosion, and infection.[15] This led to the use of other materials such as polyviol, the Arruga suture, expansible gelatin, donor sclera, autologous fascia lata, plantaris tendon, collagen, and, catgut.[34,95,117] Absorbable materials are meant to last about 6 months and therefore typically do not cause permanent complications or necessitate removal.[51,58] All of these materials fell out of favor with the development of modern day silicone solid and sponge implants designed especially for the eye, which have the advantages of being easy to obtain, sterile, and pliable.[61,95]

C. SCLERAL ABSCESSES

In 1965 the rate of scleral abscess after scleral buckling was reported to be 4%.[63] Affected patients usually presented with pain, vitritis, and a creamy-white extrascleral lesion on post-operative day 4–9 and carried a risk of perforation if not treated with urgent SB removal.[59,63] Scleral abscesses developed underneath broad silicone elements (sponge or solid) and oftentimes were culture positive for *Staphylococcus* species.[63]

In 1970 Lincoff observed that the rates of scleral abscesses had declined dramatically, which he attributed to the replacement of diathermy with cryotherapy.[59] He demonstrated this principle in an animal model, supported by a subsequent clinical trial that consisted of 800 patients with retinal detachment.[59,63]

In 1980 Folk et al reported scleral abscesses in 28 out of 4,480 patients (0.58%) who had scleral buckling performed with cryotherapy and no diathermy.[24] He was able to induce a scleral abscess in a rabbit model by implanting *S. aureus*–innoculated silicone sponges without the use of diathermy or cryotherapy. Nineteen (19) out of 23 eyes developed scleral abscesses, and 13 of these eyes had a full-thickness scleral perforation underneath the infected SB to mimic subretinal fluid drainage sites.

Scleral abscesses are uncommon today. It is likely that both the trend away from diathermy and subretinal drainage, along with better anti-infection precautions, are responsible for this.

D. HYDROGEL

Hydrogel, also known as MAI, the Refojo implant, or MIRAgel, was a permanent SB material that is no longer commercially available.[39,57,87] The product was made of poly(methyl acrylate-co-2-hydroxyethyl acrylate) and was used from 1980–1995.[39,57,87] Initial advantages were that hydrogel could expand in size and seemed less prone to infection and extrusion because of its lack of pores, absorption and release of antibiotics, and pliability.[39,108] Complications of hyodrogel were first reported in 1992 and typically presented 5–15 years after surgery.[37,67,79] One series of 82 eyes with hydrogel found complications in 7 (8.5%) eyes, most of which required SB removal.[67]

Complications of hydrogel SBs are the result of an increase in size and include pain, anterior SB migration, diplopia, and orbital mass affect.[49,56,76,90,91] What triggers hydrogel to swell years after surgery is unknown. Extrusion and infection, common reasons for removal of silicone elements, are less likely with hydrogel.[43,56,90] Rarely, intraocular complications such as erosion and intrusion or a retinal cyst occur.[32,67,79]

Hydrogel SBs are known to cause atypical orbital lesions, and a history of SB surgery is not always reported by the patient.[6,7,37,57] Therefore, the diagnosis should be kept in mind with atypical orbital processes of unknown etiology. A B-scan ultrasound of a swollen hydrogel implant 10 years after surgery had a characteristic reflective outer contour with an acoustically silent center.[113] Seven to 10 years after surgery, computed tomography (CT) of three cases of expanded hydrogel SB showed rim enhancement with dystrophic calcification,[54] and magnetic resonance imaging of four cases demonstrated high water content (hypointense on T1-weighted images and hyperintenese on T2-weighted images), making the hydrogel SBs appear as fluid-filled cysts.[7]

Hydrogel SB removal is technically challenging and, although it has been removed in total as a single piece,[57] more often the material has a gel-like consistency and therefore fragments.[43,67,79] Postsurgical pathology and ancillary laboratory studies have confirmed chemical degradation and dystrophic calcification of hydrogel years after implantation.[13,67,125] Cryotherapy to freeze hydrogel and facilitate its successful removal is reported.[55] The authors felt freezing hydrogel to be safer and faster than using traditional instruments. Another surgical technique used to facilitate removal is intraoperative injection of boric acid into the capsule to dehydrate the hydrogel.[89] This was successful in two patients, but the long-term risks of a caustic chemical like boric acid are unknown. These adjunctive methods were used because a single piece of hydrogel had swollen to a gel-like consistency; their utility may be limited where hydrogel has already fragmented, however.

III. Indications for Scleral Buckle Removal

A. CONJUNCTIVAL EXTRUSION

1. Presentation

One of the most common reasons for silicone SB removal is extrusion through the conjunctiva.[18,20,76]

Some studies use the term extrusion synonymously with infection, because infected implants often develop fistulas and extrude, and extruding implants are almost always contaminated.[98] Other studies distinguish extrusion from acute signs suggesting clinical infection.[20,123]

Typical signs and symptoms of extrusion include foreign body sensation, pain, and/or a red eye.[120,123] An unusual symptom of extrusion is hemolacria, reported in three patients for years prior to the detection of SB extrusion.[70] In these cases, cultures from the fistula or removed SB grew *Staphyloccocus aureus.*

2. Intrascleral Elements

Intrascleral SB techniques are now uncommon, although occasionally scleral flaps are still used to help support mattress sutures or to create imbrication. In 1980, Yoshizumi reported SB extrusion in 17 out of 209 (2.4%) eyes operated on over a 25-year period.[12] All SBs in this study were placed intrasclerally, and the extruded SBs were made of polyethylene tubes, solid silicone, and sponge silicone. Risk factors for extrusion were multiple surgeries, temporal location, anterior implant placement, and a large implant (thick, wide, or spanning more than 180°).[123] Symptoms presented 6 days to 8.5 years after SB placement. The implant was removed in 16 cases, and one spontaneously re-epithelialized. The author did not specify over what period of time re-epitheliazation occurred.

3. Episcleral Elements

Episcleral silicone sponges are reported to extrude at a rate of 3.4–24.4%,[38,93,107] and solid silicone bands at a rate of 0.0–1.2%.[38,90,120] Three studies with a relatively large number of SBs removed (n = 46–72) reported extrusion as the first or second most common reason for SB removal.[18,56,76] Other studies have shown that multiple sponges, larger sponges, and infection are risk factors for extrusion.[1,31,93]

Brown et al hypothesized that the discrepancy in extrusion rate between solid and sponge explants was the result of the configuration of the SB rather than the material itself.[11] In a retrospective study, they reported 1-year follow-up on 552 patients who had a circumferential silicone sponge placed with sutured ends to avoid sharp edges. The extrusion rate with this technique was 0.4%,[11] comparable to the extrusion rates of solid silicone bands.

4. Alternative Treatment Options

Primary closure or conjunctivalplasty has a low success rate.[123] There are few reports of other options. Sclera and pericardium have been used as a patch graft with variable success and have the theoretical potential for transmitting infection.[71,112,115] Autologous fascial grafts have been used as well, although they carry the risk of complications such as ptosis at the donor site.[22] Conjunctival extrusion can also be managed with topical antibiotic drops, with one reported case of a monocular patient who was treated for 11 years with prophylactic antibiotics.[96] Rarely, a SB completely extrudes on its own.[93]

B. SKIN EXTRUSION

Extrusion through skin is a much less common complication of SB, with only five reported cases.[50,81,82,111,118] The patients' ages ranged from 36 to 81 years, and they presented anywhere from 4 to 9 years after SB surgery. One case in an elderly, demented woman first appeared as an eyelid ulceration and was misdiagnosed as a chalazion for a year prior to correct diagnosis, made with the help of CT.[82] Four cases were SB extrusions through the superior eyelid, and one case extruded above the eyebrow.[111]

Of the five cases, three were silicone sponges and two were silicone bands. Three patients had associated strabismus, and the other two patients did not have ocular motility described. Only one case had a positive culture that grew *S. albus,* and this patient also had a concurrent corneal ulcer.[50] Four cases of extrusion through the superior eyelid required surgical removal of the SB, and in one case, the SB completely extruded above the eyebrow on its own.[111] All wounds closed and healed well after removal of the SB.

C. EXTRAOCULAR INFECTION

1. Introduction

Closely associated with SB extrusion is infection, which can be defined as a clinical diagnosis of infection and/or culture positive infection. In addition, for reasons indicated in the previous section, some studies consider extrusion and infection as one entity.

Defined as clinically diagnosed infection, the rates of extraocular SB infection are reported to be 0.5–5.6%.[31,59,93] Typical signs and symptoms include irritation/discomfort, discharge, chemosis, and injection—although there are other presentations. Less common signs of infection include intraocular inflammation,[80] scleritis,[88] and conjunctival granuloma.[74]

Russo et al classified 31 cases of silicone sponge infection as occurring either early (2–8 weeks) or late (2 months–4 years).[93] They hypothesized that early infections, presenting with acute, active signs, were caused by contamination at the time of surgery and that late infections, presenting with chronic, indolent signs, were from mechanically extruded SBs that were secondarily infected. This hypothesis was not supported by any documented difference in mechanical factors (i.e., size of the SB, age of the patient) between the two groups.

The most commonly reported organisms in SB infections are *Staphylococcus* skin flora, presumably from the patient's eyelids. Microbiology trends in these reports vary slightly based on location.[78,84,100,119] More recent series have documented a rise in mycobacterial and polymicrobial infections.[84,100]

2. Biofilm

Biofilm is an extracellular polysaccharide or glycocalyx that bacteria secrete to maintain themselves on prosthetic devices such as urinary catheters and heart valves.[29] There are two reports about biofilm on SBs.[2,41] The first, published in 1991, reported biofilm detected with transmission electron microscopy on 11 out of 17 extruded specimens.[41] Both silicone sponge and solid silicone contained biofilm on their surface, and in silicone sponges the biofilm extended 5 mm from the cut end into the pores. The second, published in 1999, identified biofilm on 5 out of 28 specimens.[2] Three specimens with biofilm were covered by conjunctiva, and the authors concluded that bacteria must have been inoculated at the time of SB surgery, 5–6 months prior to SB removal.

3. Antibiotic Soaking

In 1984 a large prospective, randomized study was carried out with silicone sponges to determine if pre-soaking in antibiotics would decrease rates of extrusion or infection.[1] Over a 7-year enrollment period, 921 cases were included. Roughly half received SBs that had been pre-soaked with penicillin and gentamicin for 30 minutes. Of note, the sponges were first squeezed with forceps to break up the porous spaces and allow entry of antibiotics, and Lincoff argued against this practice, which allows entry of bacteria into porous spaces.[1] Twenty-four (24) SBs (2.6%) required removal for extrusion or infection, only three of which had been pre-soaked in antibiotics. The authors advocated pre-soaking of silicone sponge implants to reduce extrusion and infection rates by seven-fold.

In 2007 Lorenzano et al challenged the practice of antibiotic pre-soaking with a large retrospective study.[66] Over an 11-year period, 1,124 cases of silicone sponge implants were reviewed. The study included 735 SBs without antibiotic soaking and 389 SBs pre-soaked in gentamicin for 30 minutes. There were three cases of delayed extrusion in the non-antibiotic group, but this was not statistically significant, and the authors concluded that pre-soaking in antibiotics did not reduce the rate of infection or extrusion.

D. PAIN

Pain is commonly associated with other SB complications such as extrusion or infection and is an important consideration in deciding when to remove a SB.[123] Pain alone can be the primary reason for SB removal.

In 1977 Schwartz et al reported pain as a primary indication for SB removal in only 5 out of 152 patients (3%).[98] The removed SB material was made of polyethylene tubing, gelatin, solid silicone, or sponge silicone. In 2003 in Le Rouic's series, 15 out of 90 patients (16.5%) had pain as a presenting symptom.[56] The removed SB material was hydrogel, solid silicone, or sponge silicone. The same year, Deuokule et al found pain was the second most common indication (29 out of 72 patients, or 40%) for SB removal.[18] The removed SB material was solid or sponge silicone. Nuzzi et al had pain as the primary indication in 30 out of 43 SB removals (70%).[76] The removed SB material was hydrogel, silicone band, or silicone sponge.[76] In two of these four series, pain was more likely to be associated with a solid silicone band than a silicone sponge and was completely relieved by SB removal.[18,76]

Based on these retrospective studies, pain as a primary indication for SB removal has increased over the past four decades. None specified the qualitative or quantitative nature of pain that required SB removal, nor did they discuss the timing of pain in relation to the initial SB surgery or SB removal.

E. INTRAOCULAR ISSUES

1. Erosion and Intrusion

Scleral buckle erosion and intrusion into the eye occurs in 3.8–18.6% of eyes[116,124] and is probably more common with intrascleral implants.[73] In a study of 49 postmortem eyes, erosion and intrusion was present in 21.7%.[116] The study did not specify if any of these eyes had clinical signs or symptoms, but it is possible that sub-clinical erosion and intrusion is under-recognized. In addition, erosion and intrusion was detected after an enucleation that was associated with conjunctival epithelial ingrowth.[14]

A series of 22 cases found that erosion occurs an average of 7 years after surgery (range, 2 months–15 years),[124] although it has been reported up to 30 years after surgery.[53] Early signs can be insidious and may include a prominent, sharp SB indentation on dilated fundus examination before frank erosion occurs. Other presentations of erosion and intrusion include hypotony, vitreous hemorrhage, retinal detachment, and endophthalmitis.[19,23,73] The site of erosion and intrusion is often at the edge of the implant and has been associated with diathermy, an encircling band, high myopia, a tight SB, and glaucoma.[73,75,114,116,124]

Management of erosion and intrusion depends on the presenting signs and symptoms. Asymptomatic patients have been observed without progression.[28,53,99] Cutting the encircling band without removing the SB may be performed to relief pressure and avoid globe perforation.[110,114,124] When the SB is removed and the perforation site cannot be sutured closed, cyanoacrylate glue, scleral patch grafting, or imbrication with scleral folding have been used with success.[19,73] Vitrectomy alone without removing the SB was used in a case of erosion and intrusion with vitreous hemorrhage.[26]

Intraocular suture erosion and intrusion has also been described. One group collected nine eyes with 5-0 Dacron suture erosion that first appeared 8 years after surgery.[114] All eyes were myopic (range, 6–12 diopters), and the sutures were associated with the band, as opposed to a segmental element. This was presumably the result of increased pressure on the relatively thin band.

2. Endophthalmitis

Endophthalmitis after SB surgery is extremely rare, as the procedure is largely extraocular. Patients present with signs and symptoms such as pain, decreased vision, hypopyon, vitritis, and an exudative retinal detachment.[40,78,106] Possible routes of bacterial entry at the time of surgery include the site of subretinal fluid drainage, the site of intraocular injection (i.e., air, saline, gas), or accidental needle perforation during suturing.[40] Postoperative scleral necrosis or erosion is also thought to cause endophthalmitis.[23]

Ho and McMeel had 2 cases of endophthalmitis in 10,000 surgeries, both of which grew out *S. epidermidis.*[40] The first patient had undergone two operations, and the presumed source of bacterial entry was the subretinal fluid drainage site. This patient had a delay in endophthalmitis diagnosis, never had the SB removed, and did poorly with only light perception vision. The second patient's presumed site of entry was an intravitreal air injection site. She was treated aggressively with pars plana vitrectomy (PPV) within 12 hours of presentation and did not have her SB removed. With repeated vitreous lavage and subconjunctival, intravitreal, intracameral, and intravenous antibiotics, she achieved a final visual acuity of 20/40.

In 1999 three patients with MRSA-infected SBs presented with a scleral abscess and endophthalmitis.[78] They were managed aggressively with prompt SB removal, antibiotics (a combination of intracameral, intravitreous, and intravenous imipenem and/or vancomycin) and in one case PPV. All three recovered 20/30 vision or better.

In 2007 a subretinal abscess was reported in association with endophthalmitis after SB surgery.[106] The SB was removed and culture grew out *Pseudomonas.* Despite SB removal, intraocular inflammation worsened, and the patient improved only after receiving intravitreal amikacin and vancomycin.

3. Recurrent Detachment

Rossi et al removed SBs in 11 patients who presented with a recurrent retinal detachment where the SB was judged to be counterproductive.[92] The number of solid versus sponge SBs was almost equivalent. The new breaks were located in all four quadrants, and patients presented anywhere from 35–215 days after SB. Repair was accomplished with PPV and removal of the SB to achieve a more favorable retinal contour.

4. Choroidal Effusion

Choroidal effusions were found in 5 out of 49 (10.2%) postmortem eyes.[116] Four were hemorrhagic, and one was associated with angle-closure glaucoma.[116] The mechanism of choroidal effusion after SB surgery is thought to be vortex vein compression.[33,35] Hemorrhagic choroidal effusion was found at autopsy 11 years after SB placement.[116]

Kreiger et al reported a case of choroidal effusion that resolved with SB removal.[52] The patient was a 25-diopter myope who had a broad SB placed with two encircling bands for a large, posterior retinal break. The choroidal effusion developed 1 year postoperatively and resolved with removal of one encircling band and loosening of the other.

5. Subretinal Fluid

Subretinal fluid accumulation as the result of choroidal vascular congestion has been described after scleral buckling with cryotherapy.[3,46,48,65,85] Fluorescein angiogram typically showed no pooling or leakage.[3,35,65,85] In a series of 11 patients who presented 9 weeks after surgery, SB removal in 2 patients did not appear to improve the choroidal circulation as assessed by indocyanine green angiography, but the fluid did eventually resolve 2 and 9 months after removal. The authors hypothesized that the cryotherapy caused the subretinal fluid, because removing the SB did not have an immediate effect.

6. Inflammation

Cystoid macular edema after scleral buckling occurs in rates that vary depending on time from surgery, presence of an epiretinal membrane, and lens status.[68,97,116] There are two cases of SB associated with cystoid macular edema and scleritis, and both were the result of scleral necrosis with infection.[17,21] The first presented almost 30 years after surgery with an exposed SB, purulent discharge, and macular edema without other signs of intraocular inflammation.[21] The second presented 2 years after surgery with headache and macular edema.[17] In both cases, infection was recognized only at the time of surgical exploration, which revealed scleral necrosis underneath the SB. Neither had culture confirmation, and both had resolution of macular edema with SB removal.

Posterior segment inflammation after scleral buckling may manifest as unilateral multifocal choroiditis that presents 3 years after SB surgery with decreased vision.[121] All signs and symptoms resolved with steroids and SB removal. The authors hypothesized that the multifocal choroiditis could have been a hypersensitivity reaction to the SB material.

7. Macular Distortion

Macular distortion from posteriorly placed SBs occurred in 4 out of 600 (0.7%) consecutive cases of SBs.[38] These were managed with SB removal with improvement of the macular distortion. One eye that had the buckle removed 5 weeks after SB surgery redetached 2 weeks later from three new breaks and was repaired successfully with a second SB. Final visual acuity was 20/50.[38]

Another case of macular distortion necessitating SB removal involved a 51-year-old man with degenerative retinoschisis and retinal detachment associated with a posteriorly located giant outer layer break.[103] A SB successfully reattached the retina, but had to be removed 6 weeks after surgery because of intolerable macular distortion. The retina remained attached with 20/20 vision.

F. ANTERIOR SEGMENT ISCHEMIA

Anterior segment necrosis was found at autopsy in 8.2% of eyes with SB,[116] and iris rubeosis and anterior segment ischemia are indications for SB removal.[10,18] The various theories about the etiology of anterior segment ischemia after scleral buckling include nonperfusion originating from the posterior ciliary arteries, the anterior ciliary arteries, or even from the retinal vasculature. Systemic factors such as age, atherosclerosis, and hematologic disorders likely contribute as well.

Disruption of the long posterior ciliary arteries by cryotherapy or compression from a SB could lead to nonperfusion of the anterior segment.[25] Anterior ciliary arteries travel within the rectus muscles and anastamose with the posterior ciliary arteries near the muscle insertions. Manipulation or disinsertion of muscles during SB surgery, particularly in older patients, could also compromise anterior segment perfusion.[94]

Besides compromised choroidal perfusion, abnormal retinal blood flow has also been demonstrated after scleral buckling with an encircling band. Three papers report an average of 50% decrease in retinal blood flow velocity after encircling SB surgery in four, five, and seven eyes using noninvasive laser Doppler imaging.[77,104,122] In eyes that had removal of the SB, an increase in retinal blood flow velocity was demonstrated.

Anterior segment ischemia is reported with segmental SBs as well.[69,72] Negahara et al measured blood flow velocity in 12 patients and demonstrated that the areas with a segmental SB had decreased blood flow velocity as compared to other areas of the same eye. Their technique measured blood flow velocity in the choroid, retina, and optic disc.

Lincoff measured reduced pulsatile ocular blood flow (POBF) in 11 eyes with encircling solid silicone bands.[60] After cutting the encircling band, POBF normalized within 1 month, regardless of how long the band had been in place (range, 7 months–15.75 years). He observed no relationship between the height of the band and the reduction in POBF and concluded that retinal ischemia was not caused by venous congestion, but rather by a mechanical constriction of the globe that prevented expansion during systole.

G. DIRECT OPTIC NERVE INJURY

Direct optic nerve injury necessitating SB removal has been implicated in two cases, although the diagnosis was difficult to confirm.[38,105] The first was part of a larger series in 1978.[38] The authors described a radial silicone sponge placed for a posterior, superior nasal break and then electively removed after an unspecified amount of time for impingement on the optic nerve. There was no visual field loss or optic atrophy.

The second was described as a single case report in 1992.[105] A 22-year-old man with Eales disease had an uneventful retinal detachment repair with a posteriorly placed 5-mm sponge and silicone band. Vision was no light perception 5 hours after surgery, but improved after the radial sponge was removed and high-dose systemic steroids were administered. The intraocular pressure was normal throughout.

Direct optic nerve injury from mechanical impingement by a SB is difficult to prove, and there are other mechanisms of optic nerve injury during scleral buckling surgery that should be considered before removing a SB. Jarrett and Brockhurst described 11 cases of unexplained blindnes and optic atrophy in their 2,000 SBs.[45] They hypothesized that optic nerve atrophy could originate from instrumentation (i.e., retractor, cryotherapy) or stretching of the optic nerve intraoperatively.

H. REFRACTIVE SURGERY

There is one case of SB removal because of increased corneal steepening after LASIK surgery.[83] This patient was a 14-diopter myope who had an encircling SB placed 5 years prior to the refractive surgery. After LASIK, there was progressive corneal steepening believed to be caused by pressure of the SB on the iatrogenically thinned cornea. Removal of the SB produced three diopters of corneal flattening. Final best-corrected visual acuity was 20/60.

IV. Complications of Scleral Buckle Removal

A. INFECTION

Endophthalmitis may occur after SB removal.[42] A 36-year-old man had an encircling band removed for pain 2 years after placement. He presented 2 days later with typical signs of endophthalmitis, including pain, decreased vision, corneal edema, and hypopyon. Vitreous specimens grew out a *S. epidermidis* that responded to intracameral, subconjunctival, and systemic antibiotics. The presumed site of bacterial entry was either the subretinal fluid drainage site created 2 years prior or subclinical intrusion underneath the silicone band.

A scleral abscess from mycobacteria has been reported after a SB removal that was performed in an office. An 87-year-old man had an extruding segmental sponge removed 4 months after placement. Two months later, the encircling band was removed for acute conjunctivitis. Five months later, the patient presented with conjunctival inflammation and nodules that grew *Mycobacterium chelonae*. The infection progressed to a necrotic scleral ulcer and was ultimately controlled with debridement and aggressive antibiotic treatment. Of note, this eye developed a recurrent detachment 10 months later that was successfully repaired with a second SB. Maintenance antibiotic therapy was continued after the infection had cleared.

B. REDETACHMENT

A dreaded consequence of SB removal is redetachment of the retina. It should be kept in mind that redetachments may occur after any retinal detachment repair, even without SB removal, and not all associations are causative. The estimated rate of redetachment after SB removal varies from no increased risk[102] to 33%.[18,44,98,109] Risk factors for redetachment include vitreous traction,[64,126] shorter duration of SB,[98] retinal tears (as opposed to holes),[98] and unrecognized original breaks.[20,64]

Histological specimens have shown that the edges of cryotherapy areas have thin retina strongly adherent to Bruch's membrane,[116] making them vulnerable to new breaks. It should not be assumed that redetachment requires a PPV, as repeat SBs for redetachments have been successfully performed.[38,86]

V. Recommendations

A. DECISION-MAKING

The decision to remove a SB can be challenging, as each retinal detachment and patient is unique. Patient characteristics such as age, status of the other eye, reliability, and overall health should be considered. SB removal can be considered medically necessary if signs and symptoms are progressive or risk progression (e.g., endophthalmitis, scleral necrosis). If signs and symptoms are chronic and stable (e.g., extrusion), SB removal is elective.

The etiology of redetachment after SB removal is either proliferative vitreoretinopathy at the site of prior pathology or a new retinal tear, which may have been preventable with continued support of the vitreous base. Proliferative vitreoretinopathy occurs with younger patients, trauma, and inferior pathology. Risk factors for new tears include high myopia, lattice degeneration, and trauma. Patients with areas of traction or high-risk lesions (i.e., borders of excessive cryotherapy or untreated lattice) should have laser prophylaxis before SB removal.

In my opinion, redetachment after SB removal should not be considered an imminent threat. Regular dilated fundus examinations by a retinal specialist are necessary, looking for proliferative vitreoretinopathy and new retinal breaks.

B. SCLERAL BUCKLE REMOVAL

If possible, SB removal should be delayed until at least 2 weeks after placement to allow the retina to scar.[59] SB removal may be performed either in the office or the operating room with topical, local, or general anesthesia. A local injection should be performed with care as many eyes are myopic, and the anatomy of the globe is further distorted after SB surgery.[4] General anesthesia should be considered in cases where scleral necrosis or erosion and intrusion are suspected as the globe may perforate.

Often the SB can be removed with only opening one quadrant of conjunctiva or using a pre-existing site of exposure. Knowledge of which elements were used and where their ends lie are crucial, as dissecting the capsule without a clear plan is perilous. When this information cannot be obtained from an operative note or direct communication with the original surgeon, SB details can sometimes be deduced by examining the conjunctiva and looking at the indentation characteristics on dilated fundus exam.

Depending on the indication, there are various degrees of SB removal. The encircling band can be cut and left in place.[60] The segmental element can be removed with the encircling band left in place. Most often all elements are removed.[1] Sutures can be removed or left in place, depending on if they are causing problems and their accessibility. Irrigation with antibiotics should be considered, particularly with an extruding or infected SB.[30]

SB removal complicated by globe perforation is an extremely challenging situation. High myopia and solid silicone are risk factors for scleral necrosis. Soft and discolored sclera, indicating necrosis, occurs more often under silicone sponges than solid silicone elements.[90] If scleral necrosis or erosion and intrusion are suspected, patch materials and sutures should be readily available to avoid expulsion of intraocular contents. In a pinch sclera can be folded on itself to close the defect and act as buckling material. If there are intraocular issues such as recurrent retinal detachment or endophthalmitis present, a concurrent PPV may be beneficial.

Removed SBs and sutures should be sent to microbiology for Gram stain and culture. If the SB is grossly abnormal, it can be investigated further. Pathology of removed SBs has shown encapsulation,[16] dystrophic calcification,[9] and partial biodegradation of silicone material.[47]

VI. Conclusion

After over 50 years, the technique of scleral buckling surgery remains largely unchanged, and the safety and outcomes of the procedure with or without SB removal are excellent. Trainees should be educated on the complications of SB and how to avoid them. Newer imaging techniques may lead to a better understanding of complications of scleral buckling.

VII. Method of Literature Search

PubMed was searched for *scleral buckle removal, scleral buckling removal, MIRAgel, sclera,* and *hydrogel.* Papers were excluded if they did not include cases of SB removal. Cases of SB segmentation after retinopathy of prematurity were excluded. Temporary balloon implants were excluded. For intraocular complications, patients with a history of PPV were excluded. For non-English articles, only the abstract was used.

Reasons for SB removal included extrusion, infection, pain, erosion, other intraocular issues (endophthalmitis, recurrent retinal detachment, choroidal effusion, subretinal fluid, inflammation, macular distortion), anterior segment ischemia, and direct optic nerve injury. Each of these terms was searched in PubMed again with the Boolean search [*scleral buckle and scleral buckling*].

VIII. Disclosure

The author reports no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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