

Complications of Encircling Bands-Prevention and Management

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Abstract

Encircling bands are a simple and efficient technique of scleral buckling, commonly used alone, in conjunction with segmental scleral buckles, and in conjunction with trans pars plana vitrectomy (TPPV) to treat rhegmatogenous retinal detachment (RRD) by closing retinal breaks and relieve vitreoretinal traction. Complications associated with encircling bands are relatively rare, but can include severe and occasionally intractable “band pain”, infection, myopia, band intrusion and extrusion, ocular motility disturbances, anterior segment necrosis, and ocular perforation. The indications and rationale for encircling bands and guidelines to minimize and treat complications are discussed.

Keywords: Scleral buckling; Retinal detachment surgery; Encircling bands; Encircling band complications; Vitrectomy

Introduction

Encircling bands for rhegmatogenous retinal detachment

An encircling band is a simple and effective technique for creating a permanent 360° scleral buckle (encirclage or cerclage) to close anterior retinal breaks in rhegmatogenous retinal detachment (RRD). Encirclage is also used in conjunction with trans pars plana vitrectomy (TPPV) to reduce or prevent traction on the retina [1]. The indications for encirclage are summarized in Table 1.

Small breaks anterior to the equator, particularly in multiple quadrants
Anterior small retinal breaks under staphylomatous sclera
Suspected, undetectable, minute, anterior breaks, as in pseudophakia
Retinal dialysis with incipient retinal detachment
Relief of vitreoretinal traction
Extensive, dangerous, circumferential lattice degeneration in undetached quadrants

Table 1: Relative indications for encirclage in retinal detachment repair.

The buckling or indentation of the eye wall from an encircling band is achieved by shortening the circumference of the band around the eye, like tightening a belt. This decreases the diameter of the globe under the band to help bring the retinal pigment epithelium (RPE) in contact with the neural retina, closing retinal breaks and relieving vitreoretinal traction. Once retinal breaks contact the RPE, chorioretinal scarring from cryopexy or laser treatment adjacent to the breaks will seal them permanently.

Encircling band complications are rare but include malposition, exposure, intrusion, infection, motility disturbances, induced myopia, glaucoma, and chronic eye severe “band pain” [2-8].

A PubMed search was performed using the terms “cerclage”, “encirclage”, “encircling band and retinal detachment” was performed and all relevant articles retrieved that were published in English, French, and German as well as pertinent articles from their reference lists were reviewed. Based on our review of the literature and our experience, we offer guidelines for minimizing complications, especially those associated with too low or too high band indentation.

Avoiding complications of encirclage

Band malplacement: Treatment RRD with encirclage will likely fail if the band does not cover the retinal breaks. After cryopexy of the breaks, the position of the most posterior break in each quadrant is marked on the scleral surface with a Urrets-Zavalía localizer or another marking depressor or the wooden end of a cotton tip applicator. The grey mark on the sclera created by 10 seconds of focal pressure can be lightly burned with a low temperature ophthalmic pen cautery and remarked with a surgical pen to avoid the fading of the mark during surgery. The encircling band is generally placed at or about one mm posterior to the mark in each quadrant. A band has least tendency to slip anteriorly or posteriorly when placed in a great circle; however, this will not provide support of the vitreous base. A band may be placed to support the vitreous base or in irregular configuration when indicated. Silicone encircling bands are available in widths of 2, 2.5, 3.5, 4, and 5 mm, with wider bands used to close larger breaks. The buckling effect of a band is wider than the width of the band itself, extending from the band indentation towards the ora serrata, because the actual width of scleral indentation diminishes gradually on either side of the band.

After the band is slid over the sclera and under each rectus muscle sequentially such that the two free ends meet and cross in a quadrant, it is inspected to insure that it lies flat on the sclera in all quadrants without twists. The edges of a twist may traumatize an overlying rectus muscle or underlying staphylomatous sclera. A twisted band also creates small areas of dead space which predispose to infection.

Slipping out of position: If the band is not anchored securely on the sclera it may slip anteriorly or posteriorly. Anterior slippage will be limited by rectus muscle insertions and may cause motility disturbance by deforming recti insertions. Both anterior and posterior migration of the band is likely to result in reduced and mislocated scleral indentation with failure to close the underlying retinal breaks. To avoid slippage, a band is commonly and easily anchored to the sclera in each quadrant between adjacent recti by a horizontal mattress suture spread the width of the band (Figure 1). The scleral suture bites need to be just deep enough to anchor the band, preventing it from sliding on the sclera anteriorly or posteriorly. The sutures should be tied in approximation to the band so it slides easily through the sutures with band tension equally distributed around the eye. In contrast, segmental buckling is achieved by horizontal mattress sutures spread the width plus two times the height of a solid silicone buckle; the sutures are tied down to indent the buckle flush with the scleral surface (Figure 2). These buckle sutures may be under considerable tension because indentation of the globe by the buckle elevates intraocular pressure acutely, making the eye hard, resisting indentation, unless subretinal fluid has been drained which softens the eye. The larger the buckle volume, the greater the pressure elevation. If the scleral suture bites are too superficial, they will tend to tear out.

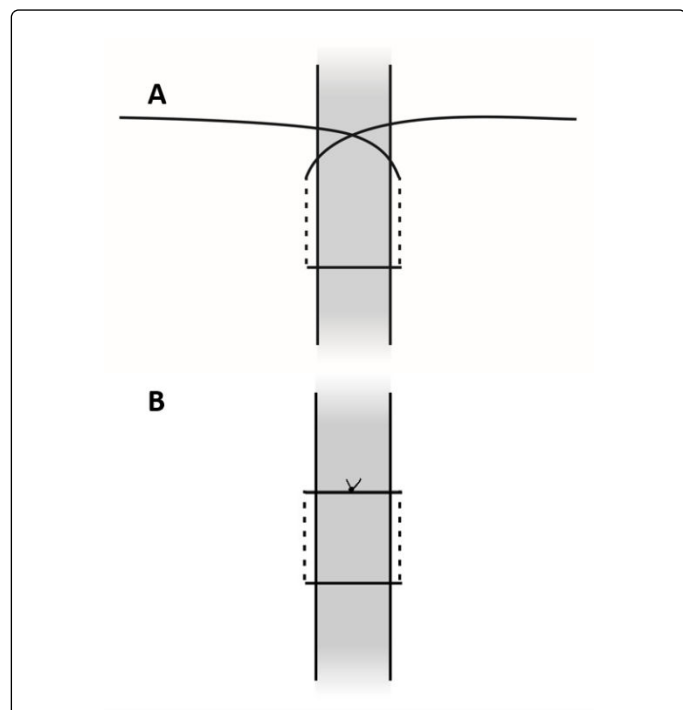


Figure 1: Diagrams showing a horizontal mattress suture (5-0 braided white Dacron), which is easy to tie and inert, anchoring a band before and after tying the suture. The dotted line represents the intrascleral suture bites. On the right, after tying the suture properly the band is anchored on the ocular surface but not indented by the suture. Left: cross-section illustration of a solid silicone scleral buckle on the surface of the sclera before the horizontal mattress suture is tied. Right: cross-section showing the buckling suture tied under tension to indent the buckle into the sclera.

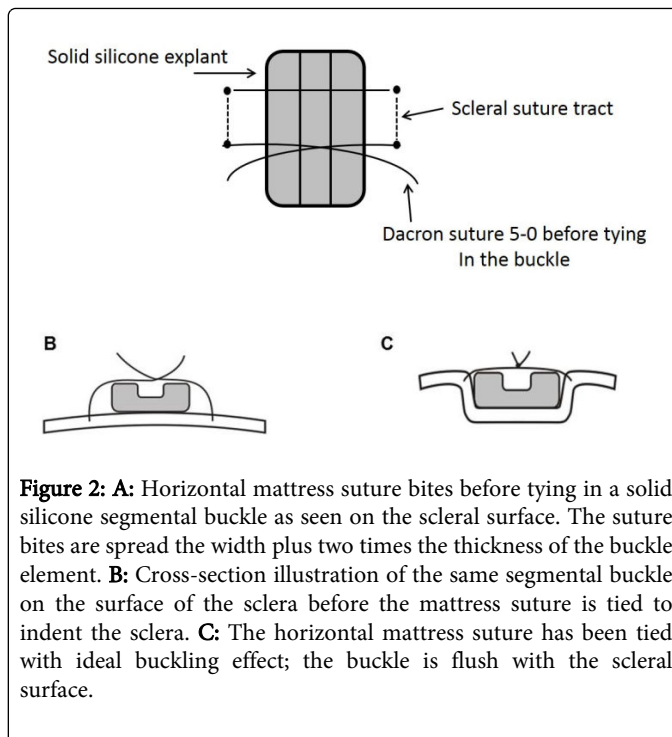


Figure 2: **A:** Horizontal mattress suture bites before tying in a solid silicone segmental buckle as seen on the scleral surface. The suture bites are spread the width plus two times the thickness of the buckle element. **B:** Cross-section illustration of the same segmental buckle on the surface of the sclera before the mattress suture is tied to indent the sclera. **C:** The horizontal mattress suture has been tied with ideal buckling effect; the buckle is flush with the scleral surface.

Insufficient or too much band indentation (buckling): After threading the band under each of the rectus muscles, the two ends of the band are each held on the surface of the sclera between two adjacent rectus muscles with a broad smooth forceps so they cross without stretching the bands. The crossed ends are then pulled away from each other, tangent to the globe, stretched and shortened the desired amount and then clamped or held together where they cross with a broad smooth forceps. They are then fastened together where they overlap by two sutures of white 5-0 braided Dacron tightly tied with square knots or clove hitches or with a commercial cuff or tantalum clip (Figure 3). The shortened band must be securely fastened to itself or the intended buckling effect will be lost.

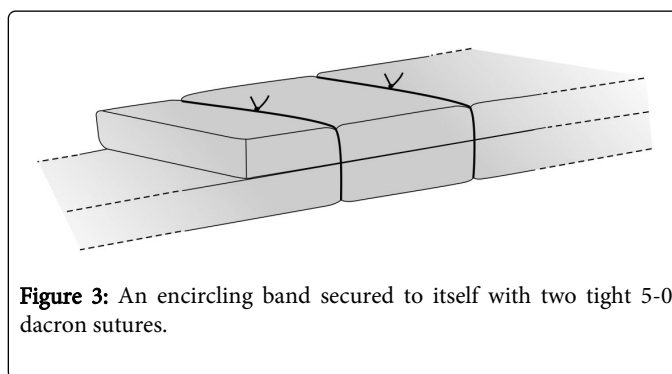


Figure 3: An encircling band secured to itself with two tight 5-0 dacron sutures.

The buckling effect, circumferential globe indentation, produced by shortening the band must be appropriate. Too little shortening will give insufficient buckling and too much shortening will cause too high a buckle predisposing to complications. The correct amount of therapeutic scleral indentation or buckling from a band in most circumstances is 1-2 mm and may be achieved by a technique suggested by Thomas Poole (personal communication): shorten an unstretched band 6mm for each 1mm of scleral indentation. This is based on the calculations shown in Table 2.

<p>"Poole's Rule" of band shortening for 2mm of buckling, (C_1-C_2)</p> <p>C_1 the initial band circumference = $2\pi r_1$, (r_1=radius of the circle described by the band)</p> <p>For 2 mm indentation, the new circumference, $C_2=2\pi(r_1-2)$</p> <p>C_1-C_2=the amount of band shortening for 2mm of indentation</p> <p>$C_1-C_2=2\pi r_1-2\pi(r_1-2) = 2\pi r_1-2\pi r_1 + 4\pi$</p> <p>$C_1-C_2, = 4\pi$, about 12 mm</p>

Table 2: "Poole's Rule" of band shortening for 2 mm of buckling, (C_1-C_2).

This 12 mm shortening does not take into account the elasticity of silicone bands. If the intraocular pressure is normal before shortening the band 12 mm, the band indentation of the globe will cause acute intra-ocular pressure elevation and the hard eye resists indentation causing the band to stretch. After the intraocular pressure gradually returns to normal, the stretched band returns close to its unstretched length and will have been shortened less than 12 mm. To compensate for band stretching, if a band is shortened around a normotensive globe, the band must be shortened approximately 14-16 mm to achieve 2 mm of indentation.

Little or no stretching of the band occurs if the eye has been softened by substantial subretinal fluid drainage before shortening the

band. If the eye is hypotonous but not collapsed after drainage of a small quantity of subretinal fluid, when the band circumference is shortened 12 mm, the eye pressure will rise close to normal and the actual band shortening will be close to 12 mm with about 2 mm of indentation since there is little band stretching. However, after drainage of a large volume of subretinal fluid, the globe is hypotonous and collapsed, although gentle pressure on the globe during actual external drainage should be maintained from cotton tipped swabs or digital pressure on the equator in a quadrant away from the drainage to avoid complications secondary to hypotony [4]. The collapsed eye should be reformed expeditiously by trans pars plana injection of balanced salt solution, air or gas into the central vitreous, with a 30 gauge needle, 3.5 mm from the limbus in a phakic eye and 3.0 mm in a pseudophakic eye, avoiding the horizontal meridians. Sufficient volume should be injected to reform the eye but leave it soft as estimated by palpation of the sclera with a sterile gloved finger [5]. Only then is the encircling band tightened to achieve the appropriate scleral indentation, normally a shortening of about 12mm, which will raise the intraocular pressure to normal or high normal. If a collapsed eye is reformed by tightening an encircling band rather than by intraocular injection, hourglass deformation of the globe will occur with chronic severe band pain and possibly other complications (Figure 4). The encircling band should not be used to restore intraocular pressure after drainage but simply to achieve the proper scleral indentation.

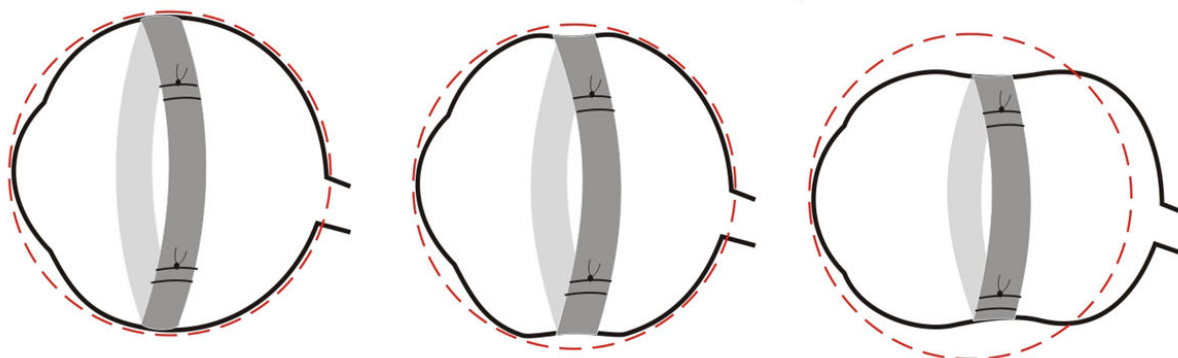


Figure 4: **A:** Left, the band has not been sufficiently shortened and has failed to achieve any indentation. The red dashed line outlines the anterior-posterior circumference of the eye. **B:** Center, the band achieves proper indentation; there is little or no increase in axial length. **C:** Right, the band has been over-tightened; the buckle effect is too high and the eye is deformed in an hourglass configuration with induced myopia from increased axial length.

Ocular ischemia: Anterior segment ischemia can occur from an encircling band and may be prevented by avoiding over-tightening of the band, limiting band height to about 2 mm as described above or shortening of the band between 10% and 25% of the circumference of the eye [6]. Encirclage on patients with sickle cell disease should be avoided because compression of the long posterior ciliary and choroidal vessels and intraoperative pressure fluctuations tend to induce intra-ocular sickling with intraocular ischemia.

Posterior segment ischemia after cerclage has been described as a very rare late postoperative complication, diagnosed by pigment epithelial irregularities posterior to the encircling band with constriction of visual field and diminished electroretinogram amplitudes; it is thought to be caused by choroidal venous obstruction

[7,8]. This also can probably be avoided by correct band placement and tightening.

Band pain: Chronic severe ocular pain lasting many months to more than a year is caused by over-tightening of the band with distortion of the long posterior ciliary nerves and is associated with hourglass deformation of the globe and induced myopia from globe elongation (Figure 4) [9,10]. Unremitting band pain requires cutting of the band which can be left in place. In cases of severe hourglass globe deformation, peripheral visual field loss is present and, although rare, anterior segment necrosis [11], angle closure glaucoma from ciliochoroidal congestion anterior to the band or deformation of the anterior segment may occur [9].

Diplopia: Heterotropia associated with encirclage is minimized by gentle and careful exposure and retraction of the rectus muscles and

assuring that the encircling band lies cleanly under all of the recti muscles without splitting any insertion. To minimize scarring around the muscles, the rectus muscle sheaths should be preserved if possible and not denuded with a cotton-tipped applicator. Small solid silicone elements when used with bands also have less tendency to cause heterotropia than large sponge explants [12-14]. Encircling sponges, in particular, tend to cause more deformation of muscles and scarring. Diplopia after buckling is usually transient but has been reported to be permanent with an incidence of about 4% [10,15-17]; however, in our experience, permanent heterotropia after solid silicone explants and/or a solid silicone band is extremely rare, much less than 1%. Heterotropia also may be caused by direct injury to ocularotary muscles or nerves during surgery or periocular anesthetic injection [18]. For this reason, we prefer parabulbar irrigation anesthesia rather than retrobulbar or peribulbar local anesthesia [19].

Extrusion (exposure): Extrusion or exposure of a band is an infrequent complication generally caused by poor closure of Tenon's fascia and conjunctiva but may also be caused by low grade infection associated with the band or sutures. Re-operation, recovering with Tenon's and conjunctiva, is often necessary [20-22]. Vitamin C deficiency may also contribute to poor healing.

Intrusion: Band intrusion through the sclera was reported to occur frequently in the past, 3.6-21.7%, depending on the material used [23,24]; however, with use of soft silicone bands intrusion is rare [25,26]. Band intrusion is more likely to occur over a staphyloma [27-29], especially if the band is too tight and particularly when scleral diathermy was performed in the past [23,29-31]. Early signs include a prominent, sharp edged scleral buckle indentation and later visualization of the buckle or sutures through very thin sclera. Intrusion may cause hypotony, vitreous hemorrhage, retinal detachment, and endophthalmitis [29,32,33]. Asymptomatic cases of intrusion have been observed. Cutting of a band without removal may help stop intrusion and the scleral indentation persists because of a sheath of episcleral scarring around the band. Self-relaxing encircling bands have been suggested as beneficial but remain unproven and unpopular [34]. Intrusion can be minimized by limiting band indentation to 2 mm or less and avoiding scleral diathermy for chorioretinal adhesion [6].

Glaucoma: Proper encircling band indentation will not result in permanent elevation of intraocular pressure; elevated intraocular pressure caused by acute scleral indentation returns to normal quickly in buckled or banded eyes with a normal coefficient of outflow. In eyes with or predisposed to open angle glaucoma or if the trabecular meshwork is compromised by inflammation or cellular debris entering the anterior chamber from the vitreous, intraocular pressure will return to normal more slowly.

Rare simple angle closure postoperatively in a predisposed hypermetropic eye is treated in the usual fashion by iridotomy [35]. However, secondary angle closure glaucoma may occur if the band is misplaced too anteriorly, is over-tightened or impinges on vortex veins causing ciliochoroidal congestion [36]. This typically occurs within a few days postoperatively, sometimes with shallow ciliary-choroidal detachment and/or anterior rotation of the ciliary body occluding the angle [37]. Topical and systemic medication for intraocular pressure control and intensive topical corticosteroids should be given to decrease inflammation. In cases of ciliary body anterior rotation or ciliochoroidal detachment, strong cycloplegic eye drops also are indicated, which relax and pull the ciliary body posteriorly. A too tight or misplaced band may require surgical revision.

Infection-endophthalmitis, orbital cellulitis: Endophthalmitis and orbital cellulitis are rare complications and may be minimized by careful surgical preparation and draping, excluding the skin and lashes from the surgical field. The silicone band and Dacron sutures are foreign bodies and should not touch the gloved hands, the skin or eyelashes to try to prevent contamination. Rare cases of endophthalmitis have been reported after explant removal, usually associated with intrusion [38,39]. The efficacy of the commonly performed prophylactic bathing the eye with antibiotic solution before closure to prevent endophthalmitis is unknown but it is probably a good procedure.

Perforation of the sclera by sutures: Scleral perforation by anchoring sutures occurs occasionally and may cause choroidal hemorrhage or even retinal perforation. Scleral perforation into the suprachoroidal space or choroid should be suspected if the suture pulled through the scleral tract is pigmented. Passage through the choroid may be associated with choroidal hemorrhage. Subretinal fluid draining from a suture tract may be an unexpected benefit of perforation into the subretinal space but should engender careful inspection to be sure the retina has not been perforated. Such a deep suture is usually replaced more superficially after the drainage has stopped, particularly if the suture is visible in the subretinal space. If a retinal perforation is suspected or confirmed, cryopexy of the retinal hole should be performed and the perforation may also be covered with the band or a buckle [40].

We use a spatula needle for intrascleral suture bites because it does not tend to cut into or out of the sclera. Nevertheless, passage of band sutures is very tricky if the sclera is staphylomatous. In our hands, encirclage and scleral buckling are most easily performed with operating loupes and binocular indirect ophthalmoscopy rather than with the operating microscope. Loupes offer adequate magnification and have the advantage of allowing good view of the sloping scleral surface from different angles. Binocular indirect ophthalmoscopy provides a panoramic view which is very helpful, allowing easy scleral depression by the examiner alone, and allows a better view through opaque media than the operating microscope. In Europe, binocular indirect ophthalmoscopy is a neglected skill in many centers, consequently, scleral buckling is often performed with the operating microscope which is considerably more difficult or cases which are ideally suitable for buckling are rather performed with pars plana vitrectomy, such as detachments with small anterior breaks in young phakic patients.

Conclusion

An encircling band is a simple, inexpensive, useful and elegant surgical technique for retinal detachment repair, alone or combined with segmental buckles or TPPV. Appropriate case selection, careful preoperative evaluation, and proper placement and tightening of a band will minimize complications. Circumferential band buckling or indentation of 2mm is usually adequate and easily achieved by following simple guidelines.

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