A. PRINCIPLES, TECHNIQUE AND OUTCOMES

1. INTRODUCTION

The use of scleral buckles in conjunction with chorioretinal adhesions around retinal breaks forms the basis of therapy for many rhegmatogenous retinal detachments. The history of the development of scleral buckling has been dealt in an earlier chapter. The value of this history is that it shows us the stepwise recognition of principles, each of which allowed a new subset of patients to be treated successfully.

2. BUCKLING PRINCIPLES

Approach to buckling is highly individualized and controversy exists regarding the details of the surgical technique but surgeons generally agree on four basic steps in closing the breaks and reattaching the retina (Box 29.1).

**Box 29.1: Basic steps in buckling**

1. Conducting thorough preoperative and intraoperative examination with the goal of locating all retinal breaks
2. Retinopexy: Creating a controlled injury to the retinal pigment epithelium (RPE) and retina to produce a sterile chorioretinal adhesion surrounding all retinal breaks so that intravitreal fluid can no longer reach the subretinal space
3. Employing an appropriate technique such as scleral buckling and/or intravitreal gas for approximation of neurosensory retina (break) with RPE
4. Minimal damage to the eye and adnexa during the surgical procedure

If the surgeon follows these basics and applies modern surgical techniques, retinal reattachment may be expected following a single operation in more than 80% of uncomplicated primary detachments, and in more than 90% following additional procedures.

3. REATTACHMENT FORCES INFLUENCED BY SCLERAL BUCKLES

Localized indentation of the sclera, choroid and pigment epithelium alters the geometry and physiology of the eye that helps to close and maintain closure of all retinal breaks. Reattachment can result from several beneficial effects of the scleral buckle.

*Reduction of vitreoretinal traction* is achieved by displacing the eye wall, retina and vitreous gel centrally. Scleral buckle relieves this vitreoretinal traction by decreasing the magnitude and probably changing the direction of vitreous traction on the retinal tear. Circumferential scleral buckles help to reduce transretinal traction by decreasing the diameter and circumference of the vitreous base. Reduced vitreous traction diminishes the flux of vitreous fluid through retinal tears, thus promoting re-apposition of the retina to the retinal pigment epithelium (RPE). The capability of scleral buckle to relieve traction and promote retinal adhesion is confirmed when scleral buckles are used to treat retinal detachments without the use of any chorioretinal adhesions. One randomized study found no difference in retinal reattachment rates with the use of scleral buckles whether or not any retinopexy was used.

Scleral buckling may also *displace subretinal fluid* (SRF) away from the break into other parts of the subretinal space. If enough SRF is displaced, the retinal break may be immediately closed by direct contact with the pigment epithelium. The SRF elsewhere is then absorbed and
the retina becomes reattached. Whether a retinal break can initially be completely flattened against the pigment epithelium without drainage of SRF depends on the elevation of the scleral buckle and the degree to which SRF in that area is displaced by the buckling effect.

Alternatively, the buckling effect may displace the SRF through the retinal break into the vitreous cavity. This effect can sometimes be achieved by scleral depression when examining the retina intraoperatively.

Another effect may also be responsible for postoperative flattening of a retinal break on a scleral buckle. Even when a retinal break is still open, force induced by absorption of SRF tends to bring the retina into contact with the pigment epithelium. Since, there is some resistance to flow of liquid vitreous through a retinal break due to the buckle, this causes a slight lower pressure in the subretinal space than in the preretinal space. The pressure difference induces a retinal reattachment force that tends to re-approximate the retina to the pigment epithelium.

The distance between the RPE and a retinal tear is reduced when the eye wall is indented by a scleral buckle which is important in determining whether the retina will reattach or remain detached. The closer the retinal tear is to the RPE, the greater is the chance of retinal reattachment. Retinal reattachment force is inversely proportional to the cube of the distance from the retinal hole to the RPE on the buckle. Halving the distance from the retinal tear to the buckle causes an eightfold increase in the retinal reattachment force. Most retinal tears within 3 mm of the RPE will spontaneously reattach without drainage of SRF and this appears to be confirmed by clinical observations. This explains why nondrainage operations are successful even when the retinal break remains separated from the scleral buckle at the end of the procedure.

Scleral buckles can also displace vitreous fluid away from the tear, plugging the tear with solid vitreous gel. The movement of fluid from the vitreous cavity through the tear is impeded when the tear is occluded by solid vitreous gel. Larger scleral buckles may displace much of the fluid vitreous, leaving solid vitreous gel in the vitreous cavity to plug retinal breaks.

Altering the normal concave internal surface of the eye wall by scleral buckling may also modify the intraocular fluid currents produced by eye movement and reduce the harmful effects of these currents. Rotatory eye movement induces flow of fluid in the subretinal space. The slope of the scleral buckle directs some SRF through the retinal break into the vitreous cavity.

Most of these effects are synergistic, and several are probably operative in each case. It is the balance between the forces promoting retinal attachment and the forces promoting retinal detachment that determines whether the retina remains attached or detached. The use of a scleral buckle overcomes the forces tending to detach the retina in most eyes, allowing successful treatment of rhegmatogenous retinal detachments.

4. PREOPERATIVE MANAGEMENT

This is intended to maximize the chance of successful surgery and recovery of vision by preventing the progression of detachment and identifying preoperative ocular problems that might complicate the operative procedure or adversely affect the postoperative course.

4.1. Eye Patching

Both eyes may be patched to limit the conjugate movements of the eyes. Patching reduces the inertial forces induced by eye movement and prevents extension of a subtveal detachment, especially important if the macula is threatened. Detachment of the macula usually results in some permanent macular damage and limits the postoperative visual acuity. When both eyes are patched, boundary of the detachment rarely advances. It can cause flattening of a highly elevated retinal detachment in some eyes. This reduces both the risk of surgical complications and the chance of failure, because when the retina is highly elevated, identification, localization and treatment of retinal breaks is more difficult and selection of the scleral buckle height and configuration is more uncertain. Flattening may circumvent drainage of SRF and its associated complications. Also, when a large amount of SRF is drained, an intravitreal injection of fluid or gas may be needed to restore the intraocular volume which can again cause other complications. Patching may accelerate settling of mild or moderate vitreous hemorrhage allowing improved visualization of the fundus avoiding vitreous surgery.

Patching is used only 24–48 hours prior to surgery. Patching both eyes can cause disorientation and even temporary psychosis in some elderly patients. The risk of injury from falling is also increased. Intermittent patching can be used in these patients who cannot tolerate continuous patching. Surgeons have even tried to immobilize the eye with the help of sutures beneath the rectus muscles, alone or combined with retrobulbar anesthesia and bilateral patching, but this may not be practically feasible.

4.2. Preoperative Activity and Head Positioning

Bed rest seems to reduce the amount of eye movement, thereby decreasing vitreoretinal traction. Strict bed rest is
usually unnecessary. When the head is positioned such that the retinal break is in a dependent location, SRF may pass through the break into the vitreous cavity and vitreous gel may also be in contact with the break causing functional closure of the break.

4.3. Serous Choroidal Detachments

These are often present in eyes with rheumatogenous retinal detachment. These eyes have an increased risk of intra- and postoperative complications [proliferative vitreoretinopathy (PVR)] and a reduced success rate. These eyes are preferably treated with topical cycloplegic and steroid drops till the surgery is contemplated. Oral steroid treatment may be used if there are prominent choroidal detachments. We usually do not delay surgery to treat serous choroidal detachments.

4.4. Prevention of Infection

Infectious conjunctivitis or blepharitis is treated medically before retinal reattachment surgery. Broad spectrum topical antibiotics are used preoperatively to reduce the bacterial flora on the conjunctiva and lid margins. This is intended to reduce the risk of endophthalmitis or infection of the scleral buckling material. A technique without drainage of SRF may also help to reduce the risk of endophthalmitis.

4.5. Open Angle Glaucoma or Glaucoma Secondary to Retinal Detachment

Eyes with raised pressure are treated to control the intraocular pressure (IOP) before the surgery. This minimizes the risk of corneal edema, permits more effective scleral depression and lessens the risk of complications related to sudden hypotony in cases in which drainage of SRF is necessary. Conjunctival sparing technique or vitreous surgery may be chosen as appropriate.

4.6. Cataract

If precludes optimal visualization, cataract surgery can be done prior to buckling or simultaneous cataract and vitreous surgery chosen.

4.7. Posterior Chamber Intraocular Lens

There may be significant posterior capsular opacity compromising visualization. A large Nd:YAG laser capsulotomy is performed to allow fundus examination in these cases.

4.8. Vitreous Hemorrhage

In cases where vitreous hemorrhage prevents effective visualization of the fundus, bed rest, elevation of the patient’s head and bilateral patching often results in hemorrhage settling down. If a retinal break can be seen that accounts for the configuration of the detachment, conventional retinal reattachment surgery is performed.

4.9. Anesthesia

To assess the risks of anesthesia and the need for modification of preoperative management, the patient’s general medical condition is evaluated before surgery. Drug and other allergies are ascertained. Physical examination is performed with emphasis on the cardiovascular and pulmonary systems. The goal is to identify potential medical problems and to tailor laboratory testing to the patient’s need.

The procedure can be performed under either local or general anesthesia. The choice of anesthesia depends on specific features of the case and also on the preferences of the surgeon and the patient. The increased frequency of outpatient scleral buckling surgery has decreased the use of general anesthesia at many centers. Majority of scleral buckling procedures are now performed under local anesthesia. Advantages of local anesthesia include shorter operating time, quicker postoperative recovery, and reduced risk of morbidity and mortality in select cases. Potential risks with local anesthesia include globe perforation, optic nerve damage and injection into the optic nerve dural sheath (potentially causing grand mal seizures or brain stem respiratory suppression). A common disadvantage with local anesthesia is inadequate analgesia. General anesthesia is necessary for children, deaf patients, mentally retarded individuals and those who speak only a foreign language.

A peribulbar approach may be employed for anesthesia during the procedure. This reduces the risk of ocular perforation compared with retrobulbar injections. A 1:1 mixture of 2% lignocaine and 0.5% bupivacaine is used at the junction of the temporal and central-thirds of the inferior orbital rim beneath the globe and just medial to the supraorbital notch. A total of 7–10 mL of anesthetic is injected, with two-thirds of the mixture delivered inferi orly and one-third given superonasally.

When local anesthesia is used, an anesthesiologist is usually in attendance to administer intravenous medications and monitor vital signs. Local anesthesia is quite effective in procedures lasting less than 2 hours; if required, either retrobulbar or peribulbar anesthesia may be supplemented during the procedure with a sub-Tenon’s capsule irrigation or local infiltration of additional anesthetic. This can be administered via a flexible catheter or with a blunt cannula. Intravenous sedation may also be helpful in some cases. These agents may cause respiratory depression and therefore require close monitoring by skilled personnel.
The use of peribulbar anesthesia in conjunction with general anesthesia is superior to general anesthesia alone for vitreoretinal surgery with scleral buckling. There is a lower incidence of ocular cardiac reflex and surgical bleeding intraoperatively. Patients also have better postoperative analgesia and a lower incidence of postoperative nausea and vomiting.\(^{25,26}\)

If general anesthesia is chosen, one technical point must be noted. When nitrous oxide is used, it is discontinued 10–15 minutes before injection of an intravitreal bubble of air/gas, where required.\(^{19,20}\) In a patient receiving nitrous oxide by inhalation, there can be marked elevation of IOP intraoperatively, with loss of gas volume postoperatively as the soluble nitrous oxide is discharged in the exhaled gases.\(^{16,17}\)

5. PREPARATION OF THE SITE

The patient’s head is positioned to improve exposure of the eye. The chin is elevated slightly. After giving anesthesia, the operative field is prepared for surgery. Careful use of antisepsis can minimize the risk of postoperative infections. The lid margins and periorcular skin are prepared with 10% povidone iodine solution followed by application of 5% povidone iodine solution. The lashes may be trimmed preoperatively or isolated by adhesive drapes. A sterile drape is applied to cover the communication between the operative and nonprepared portions of the face. The goal is to isolate and protect the surgical field from contamination. An incision is made in the plastic drape in the plane of the palpebral fissure, and the free margins of the cut drape are rolled posteriorly over the lid margins and held securely in place. This is followed by a copious irrigation of the conjunctival sac with sterile saline that washes away most debris from the ocular surface.

6. PUPILLARY DILATATION AND CORNEAL CLARITY

The pupil is maximally dilated preoperatively with mydriatic drops to permit effective indirect ophthalmoscopy. This is supplemented by additional medications during the operation, as necessary. Corneal clarity is necessary throughout the operation, and the corneal epithelium is removed if it becomes cloudy.

7. EXPOSURE OF THE OPERATIVE FIELD

The palpebral fissure is opened widely with a sturdy speculum that produces maximal opening of the palpebral fissure. A lateral canthotomy is performed if additional exposure is needed. A 360° peritomy is performed in most eyes; limited peritomy is used when planned surgery is confined to one or two quadrant/s (segmental or radial buckle). We routinely use a limbal peritomy as this approach allows good exposure of the sclera and better coverage of the buckle with less postoperative irritation than with a posterior peritomy. The limbal peritomy is supplemented with two radial incisions to enlarge the circumference of the conjunctival opening and prevent tearing of the conjunctiva as it is retracted to expose the sclera. Posterior peritomy (8 mm) is needed in patients with filtering blebs or recent limbal wounds. A conjunctival peritomy 4 mm posterior to the limbus provides a wider opening, and radial incisions are usually not needed.\(^{20,21}\) It also allows later closure of the cut edges with a running suture. Blunt tipped tenotomy scissors are inserted in the sub-Tenon’s space in each quadrant and spread to expose the sclera. The muscle insertion is engaged with a muscle hook (preferably fenestrated) placed on the sclera posterior to the muscle insertion. It is passed in a circumferential direction and then brought anteriorly to engage the muscle tendon. The muscle hook should glide along the sclera with ease. Significant resistance usually means engagement within muscle tendon or entanglement with the Tenon’s tissue. Damage to the vortex veins is prevented by avoiding going posterior to the equator and engaging the muscle anteriorly. While hooking the superior rectus muscle, care is taken to avoid including the superior oblique muscle tendon, which inserts beneath and posterolateral to the lateral margin of the superior rectus insertion. The muscle hook is kept anterior and a temporal to nasal pass is made to avoid engaging the superior oblique tendon. Once the muscle insertion is engaged, attachments of overlying Tenon’s fascia are either stripped from the muscle with cotton tipped applicator or divided with scissors. Care should be taken not to strip too posteriorly to avoid damaging the levator muscle superiorly or the inferior oblique muscle and Lockwood’s ligament inferiorly. A bridle suture is then placed around the muscle using the hook eyelet\(^{19}\) or a reverse needle. Black silk is an effective traction suture. All four recti muscles are bridled in this manner. These sutures permit rotation of the globe and exposure of the quadrants during surgery.

After all recti muscles are isolated, the condition of the sclera is inspected in each quadrant by rotating the globe. Wherever there is marked scleral thinning or ecchymosis, extreme care is used when localizing, marking and treating retinal breaks. Scleral thinning is more frequent in the superotemporal quadrant and may appear as gray blue areas or radial blue line in the equatorial or pre-equatorial area, or as localized bulging of the sclera.\(^{31,32}\) Similarly, special care is required if there has been previous scleral dissection or if the sclera is soft as a result of previous surgery.
Temporary disinsertion of a rectus muscle is rarely necessary, although it is occasionally performed to adequately expose an area. This usually occurs with breaks beneath muscles or in eyes with small orbits. After the muscle has been isolated and elevated with a muscle hook, a double armed absorbable 6-0 suture is passed through the body of the muscle parallel to the insertion and just posterior to the hook. A central knot may be placed. The suture is then passed in a single or double loop through the end of the muscle to occlude the anterior ciliary arteries. Using the suture and hook, the muscle is elevated from the sclera and cut, leaving a small portion of insertion intact on the sclera. The arms of the suture are secured and the muscle is allowed to retract posteriorly. A 4-0 silk traction suture is placed through the insertion. After completion of scleral buckling, the muscle is re-sutured to the insertion with the double armed suture.

8. LOCALIZATION AND INTRAOPERATIVE EXAMINATION

Accurate localization of the break enables accurate placement of the buckle on the sclera and this is critical to the success of scleral buckling surgery. The surgeon should carefully examine the retina 360° with binocular indirect ophthalmoscopy and scleral indentation. The investment of few minutes at this time will pay dividends. The area of retinal detachment is carefully re-evaluated to confirm important features (Box 29.2).

**Box 29.2: Intraoperative fundus examination confirms**
- The number and location of retinal breaks
- The extent of the detachment
- The amount of elevation
- Whether the macula is detached
- The features of vitreoretinal traction and epiretinal membrane formation

Important lesions that were not disclosed preoperatively may become apparent. The position of each retinal break is marked externally on the sclera. For small flap tears or atrophic hole, a single mark on the posterior edge of the break is sufficient. Larger flap tears and non-radial tears require localization of both the anterior horns and the posterior most edge of the break. In areas with multiple closely spaced tears or retinal dialysis, marking the most posterior extent and the circumferential extent of the breaks is adequate. Several instruments for localization and for marking the sclera have been described. If sharp scleral markers are used for localization, it is important to inspect the sclera thoroughly. We use the MS locator and indent for approximately 5 seconds. The scleral mark can then be enhanced with a sterile pen, cautery or both.

The locations of other lesions or areas to be supported by the scleral buckle are also marked on the sclera. These include areas of lattice degeneration, areas of prominent vitreoretinal traction and areas of peripheral retinal distortion due to contracture of epiretinal membranes. Thus, the location of each retinal break and each important area of vitreoretinal traction is identified so that a scleral buckle of suitable size and configuration can be prepared.

During this time of examination and localization of retinal breaks, the IOP is repeatedly estimated by tactile means. If the eye softens markedly, this indicates rapid outflow through the trabecular meshwork. This is an important sign if a nondrainage procedure is planned, because it suggests that a sizable scleral buckling effect can be obtained if necessary. A significant decrease in the height of SRF from the preoperative examination usually indicates good RPE function and suggests that a non-drainage procedure probably will be successful.

While marking each retinal break, the surgeon assesses whether the pigment epithelium can be positioned near the retinal break by scleral indentation alone. This helps to determine whether subsequent drainage of SRF would be necessary. Also the amount of retinal elevation is assessed in areas where drainage of SRF may be attempted. This is particularly important if drainage is considered anterior to the equator, because in many eyes the retina is relatively flat anteriorly, although substantial SRF may be present posteriorly.

There are two main pitfalls to avoid in retinal break localization. First, the examiner must avoid indenting the sclera with the shaft rather than the end of the indenter as this will cause the mark to be placed too far posteriorly. Second, in bulbar retinal detachments, retinal breaks appear to lie more posteriorly than their true location because of parallax. This can result in unnecessarily large and posterior buckles. Errors can be avoided by starting depression at the ora (where the retina is attached) in the meridian of the break and slowly shifting the depression mound posteriorly under fundus visualization. Another method is to first mark the least elevated margin of the break and then continue to the more elevated margins. This error is easier to avoid as experience is gained. The presence of pigment epithelial changes underlying the break and the location of the ora serrata in relation to the break are important clues to correct localization of retinal breaks in these eyes. Rarely, it may be necessary to drain sub-retinal fluid (SRF) to flatten the retina before localization. Indeed, this is part of a technique [drain-air-cryotherapy-explant (D-A-C-E)] used by some surgeons. Drainage softens the eye, and volume restoration requires air/saline injection through the pars plana. Further
drainage can sometimes be difficult, presumably because of choroidal swelling secondary to hypopyon.

Posterior retinal breaks are more difficult to localize, mainly because of problems in gaining exposure of the far posterior sclera. Visualization is aided by removal of the lid speculum, rotation of the eye in the opposite direction and use of a retractor to gain maximal exposure in the quadrant with the retinal break.

9. TREATING THE BREAKS

Retinal breaks are treated with one of the several modalities available to create an adhesion between the retinal pigmented epithelium (RPE) and retina. Thermal injury is most commonly utilized to achieve this reaction. Three energy sources are available for this purpose. Diathermy was in regular usage in the past, but is rarely utilized nowadays because of its unfavorable safety profile. With its development and subsequent popularity, cryotherapy has largely supplant ed diathermy. Laser photocoagulation is also used for retinopathy. The morphologic and cellular response of the retina and pigment epithelium to each of these energies is essentially similar.83 Chorioretinal adhesions formed by each of the above have similar strengths and are certainly adequate to maintain apposition of the retina and the RPE if there is no substantial traction on the retina, though the rapidity of onset of the chorioretinal adhesion is not the same for these three methods.84 Laser photocoagulation appears to induce a more rapid chorioretinal adhesion than cryotherapy or diathermy. The chorioretinal adhesion induced by laser starts within 24 hours of treatment and increases rapidly within the first 3 days, whereas the adhesion formed by cryopexy or diathermy takes at least several days to start to form and does not reach maximum strength until about 2 weeks.

Scleral buckling alone often causes reattachment of the retina by closing retinal breaks so that the SRF is later absorbed. Though this is combined with retinopathy, the chorioretinal adhesion occurs after the retina is in contact with the RPE and therefore does not contribute to initial closure of the breaks.

9.1. Diathermy

It is produced by delivering high frequency (MHz) current through the tissues which generates heat because of tissue impedance. Diathermy is now rarely used because of the following reasons:

- Causes immediate shrinkage and subsequent necrosis of the sclera
- Raises IOP due to shrinkage
- Penetration of diathermy through intact sclera to the retina depends on the scleral thickness. Variations in scleral thickness result in nonuniform and unpredictable transmission of energy to the retina, which can cause choroidal and retinal bleeding, and retinal holes.
- The highest intensity diathermy applications actually rupture sclera, choroid and Bruch's membrane, resulting in scar tissue formation across the entire ocular wall.
- For optimal diathermy application, a lamellar scleral dissection is required to place diathermy burns in a grid pattern in the bed of the scleral dissection with a blunt tipped electrode.

Transscleral and transconjunctival diathermy without scleral flaps may be administered with a modified diathermy electrode which causes less scleral damage than conventional diathermy.69 However, because of the full thickness damage that occurs with diathermy, vortex vein ampulla and long posterior ciliary arteries and nerves must be avoided, even with scleral flaps.

9.2. Cryotherapy

It was introduced by Bietti67 and Deutschmann.71 Its use in ophthalmology was popularized by Lincoff72 in later part of 1960s and subsequently studied in extensive animal experiments by Kreissig.35 Cryotherapy offers several advantages.

It can be applied through full thickness sclera with causing significant damage and can be applied to treat detached retina.

Modern units use nitrous oxide gas to produce cooling up to −89°C. The temperature effect is confined to the tip of the probe by an insulating sleeve. A probe of 2.0–2.5 mm in diameter usually is used for retinal work. The treatment end point is retinal whitening without ice crystal formation.73 Slight whitening of the retina because of retinal edema is noted several minutes after freezing, which helps to assess the adequacy of treatment. If retinal treatment is impossible because of bulging retinal elevation, treatment of the pigment epithelium alone (although not ideal)85 may be performed, or treatment can be deferred until after drainage of SRF.

Certain precautions must be observed during cryotherapy. Cryotherapy should be applied while observing the fundus with the ophthalmoscope, using the cryoprobe in place of scleral depressor. Surgeon must indent only with the tip (not the shaft) of cryoprobe to avoid unnecessary posterior freezes.73 Initial freeze is applied to the most anterior aspect of the area requiring treatment to assess both location and the intensity of treatment. Small retinal breaks and atrophic retinal holes can be treated with single freeze centered on the retinal break. Larger breaks or lesions should be surrounded with 1–2 mm of contiguous treatment, although more than one row may be required anteriorly to extend the future adhesion
into the vitreous base. It can also be applied around selected areas of abnormal vitreoretinal adhesions, such as zones of lattice degeneration, but laser may be preferable if the retina is attached. Low intensity cryo marks can be given to suspicious areas that may harbor breaks. Sometimes, it is possible to determine whether a retinal break is present by the appearance of the freeze. \(^{79}\) Retinal breaks appear dark and are highlighted when the surrounding retina turns white from the cryotherapy. After cryotherapy application, no attempt should be made to remove the probe immediately. It must be held in place against the sclera for a few seconds to allow thawing of the frozen tissue. If the probe is moved while it is still adherent to the underlying tissue, scleral or choroidal rupture may occur. Before freezing is started, one must confirm that the lid is not in contact with the probe tip or has not come between probe and sclera while repositioning the probe. Treatment should not significantly overlap. Inability to immediately delineate what areas of the retina have been treated can lead to overtreatment if sequential freezes overlap much, and this should be avoided. However, an inadequate adhesion will result if the burns are not confluent in appropriate areas. Thus, the surgeon must form a visual image of the precise area of prior applications of cryotherapy, and considerable experience is usually required to master this technique. RPE in the bed of the retinal break does not need treatment. Cryotherapy loosens RPE cells and causes their dispersion within the vitreous. Unnecessary scleral depression of treated areas, which enhances dispersion of viable cells, should be avoided.

Disadvantages of cryopexy include the dispersion of viable pigment epithelial cells which can cause PVR, \(^{72,73}\) choroidal congestion and hyperemia which may complicate drainage of SRF through treated areas, breakdown of blood ocular barrier \(^7\) and development of postoperative cystoid macular edema (CME) and exudative detachments. \(^{80}\)

Despite these potential problems, cryopexy remains the choice of most retinal surgeons for the intraoperative treatment of retinal breaks during scleral buckling. \(^{83}\)

### 9.3. Photocoagulation

Another means of creating RPE-retinal adhesion is through laser application. Laser may be delivered through laser indirect ophthalmoscope or transcleral route.

Indirect ophthalmoscope laser systems offer a valuable option to cryotherapy for certain routine scleral buckling operations. However, this treatment of retinal breaks during surgery requires clear visualization through the media and contact of the retinal break with the RPE. These features are not always present at surgery. In cases where cryotherapy cannot be appropriately performed or excessive treatment is feared, retinal breaks can be treated with laser therapy after the retina is totally reattached with a scleral buckle intraoperatively. It can also be applied postoperatively. \(^{85}\) Some surgeons prefer this technique as a routine. Confluent treatment around retinal breaks with medium intensity gray white burns should be applied and should be advanced to the ora serrata whenever possible. Treatment uptake in areas with atrophic or attenuated pigment epithelium may be difficult.

Laser treatment can be delivered with precise location and intensity. Compared with cryotherapy, laser causes less inflammation \(^{15}\) and does not cause dispersion of RPE cells into the vitreous cavity eventually leading to low incidence of postoperative PVR. \(^{86}\) It causes less breakdown of the blood ocular barrier. \(^{87}\) The thermal effect is confined predominantly to the retina and RPE, with little or no effect on the choroid or sclera. \(^{85}\)

Laser induces an adhesive effect between the retina and pigment epithelium within 24 hours, \(^{86}\) and carries less morbidity. \(^{85}\) Though photocoagulation cannot totally replace cryotherapy, proper selection of cases can avoid complications and promote the recovery of visual function. \(^{88}\)

Transscleral diode laser treatment using a specially designed "endolaser" probe was described originally by Peyman and associates in 1984. \(^{89}\) The long wavelength (810–840) penetrates the sclera and is absorbed by the pigment epithelium. It may be used to treat retinal pathology in the same way as diathermy, without its morbidity. \(^{85}\) The probe is held like a scleral depressor; perpendicular to the surface of the sclera, and medium gray lesions are created under fundus monitoring. Scleral damage is less than that associated with routine diathermy. \(^{91}\) Further experience is required to assess the relative value of this modality. It can be used to treat retina through existing silicone explants. \(^{85}\) However, it is more time consuming and requires more individual treatment spots than cryopexy. Potential complications include rupture of Bruch's membrane and the pigment epithelium, which may result in choroidal bleeding. Mild thermal effects on sclera may be seen as blue gray discoloration of the sclera.

### 10. METHODS OF BUCKLING

A scleral buckle is prepared to support all retinal breaks and other areas treated with cryotherapy or diathermy within the area of detachment. Retinal breaks and other abnormal areas, such as lattice degeneration, in attached retina may or may not be supported by the scleral buckle, depending on the features of the case. The configuration of the selected scleral buckle depends on the number, size, location and on other
physical features of the retinal breaks, as well as the location of any zones of abnormal vitreoretinal traction.

The buckling material may be sutured to the surface of the sclera (explant) or be placed beneath scleral flaps after lamellar scleral dissection (implant). The explant technique is very commonly employed nowadays. The implant technique has largely been given up for its morbidity to ocular tissues.

10.1 Explant Techniques

This was popularized by Ernst Custodis in 1953. He described placement of a polyvinyl explant that was sutured to the sclera overlaying any retinal break. We prefer episcleral explants because:

- They are easier and quicker to place
- There is minimal damage to the sclera
- The configuration and height of the buckling effect can be selected more easily
- The location and geometry of the buckling effect can be easily modified when necessary
- The technique can be used in almost all eyes, including those with thin sclera
- The risk of endophthalmitis is reduced if the scleral buckling material should later be involved by an infection and
- Use of episcleral explants is readily combined with cryotherapy.

The development and refinement of cryotherapy were major steps in the evolution of explants techniques. The ability to treat retinal pathologic conditions effectively without the need for scleral dissection has resulted in explant surgery becoming the procedure of choice for most retinal surgeons.

10.1.1. Buckling Materials

Various materials have been used in the past. By far the most popular, silicone, is a soft, synthetic rubber material. Medical grade silicone rubber, consisting of cross linked polydimethylsiloxane, is the most common buckling material used. It is produced in a variety of molded shapes that can be modified and used in either solid or sponge form. This solid silicone rubber material was originally described by Schepens and colleagues for use as scleral implants. Advantages of silicone material include:

- Nontoxic and nonallergenic
- Not affected by changes in temperature
- Can be sterilized by autoclaving
- Water insoluble
- Biologically inert and does not support bacterial growth
- Noncarcinogenic

Several properties of silicone rubber help in the buckling effect. Elasticity is a desirable quality when silicone rubber is used as a scleral buckling material. For example, in nondrainage procedures an encircling band can be tightened until IOP is elevated, and the elastic property of the band will cause further constriction and higher elevation of the buckling effect as IOP drops later. Stress relaxation results in lengthening of the band, and eventually its length stabilizes between the original unstretched length and the length at the end of the operation, so the band exerts little stress on the eye. This probably explains why silicone rubber is less likely to erode into the eye than rigid nonelastic materials.

Solid silicone rubber: Silicone rubber is available as symmetric or asymmetric tires, bands, strips and wedges of different shapes and sizes (see also Chapter 6). They are often grooved to permit placement of an encircling band. Tires have radii of curvature that approximate to that of the globe. Asymmetric tires provide increased buckle height posteriorly, decrease the likelihood of erosion anteriorly and permit more equatorial placement of an encircling element.

Silicone sponge: Sponges have many air filled pockets that give them great compressibility and elasticity, and also make them considerably softer. Sponges are made in varying sizes and shapes, from 3 mm circular sponges to 5 × 7 mm oblong sponges. Sponges are predominantly used for radial buckles but can be used also for encircling the globe when either a high buckle is needed or when breaks are at varying distances from the ora. Disadvantages of sponges include uneven indentation when used for encircling the globe, increased risk of infection because of air pockets and greater likelihood of erosion through the conjunctiva. Cutting a cylindrical sponge lengthwise to half thickness or using oval sponges provides proper indentation of the sclera while avoiding an external bulge above the contour of the globe. This improves the cosmetic appearance and may avoid postoperative motility disturbance if the explant extends under an extraocular muscle.

In most cases a suitable buckling effect can be created with various combinations of silicone rubber pieces, using either sponge or solid rubber materials, or combinations of the two. The materials chosen depend on the experience and preferences of the surgeon. As a general rule, the buckling appliance must be sufficiently large to support the break(s) with a margin of at least 1–2 mm.

Hydrogel implant: The MIRA gel implant, a non-biologic hydrogel, was used until 1996, when the manufacturer stopped its distribution. It is associated with late onset complications such as extrusion, fragmentation, limitation of
ocular motility, and intrusion between 7 years and 11 years after implantation. Removing the hydrogel is difficult due to the friability of the material. The material must be gently "milked" from the sub-Tenon's location with a muscle hook, extracted with a cryoprobe, or carefully aspirated with a small gauge suction. There have been reported cases of scleral rupture and retinal incarceration during removal of the buckle material. Consequently, extreme care should be taken when traction is applied to the rectus muscles or when exploring the subconjunctival and sub-Tenon's space for buckle fragments.

**Biological materials:** Fascia lata, preserved human sclera, and gelatin also have been used for scleral buckles. Currently, these are rarely used and are discussed primarily for historical interest. Of these, gelatin is the most versatile. As it hydrates, gelatin gradually swells, providing increased buckle height a few days after surgery. Over 3–6 months, the gelatin, which is predominantly hydrolyzed collagen, is broken down and the buckling effect is lost. Gelatin can be used as either an implant or explant. This technique has been recommended for retinal detachments caused by a single retinal break and those caused by dialysis in children.

**10.1.2. Life of the Buckling Effect**
- **Ultrashort acting:** Temporary measures like suprachoroidal hyaluronate, the linen balloon, and the Lincoff balloon last only for a few days.
- **Short acting:** The buckle height obtained with segmental sponge explants persists for at least 3 years.
- **Permanent:** Permanent buckling effect can be created with an encirclage.

**10.1.3. Shape of the Buckle**
The shape of the buckling material can be varied. Usually silicone sponges in the forms of cylindrical rods and solid silicone in the forms of tires are used. Only bands or strips can also be employed. Rods generally give a greater indentation (a higher buckle) while the flattened tires give an indentation over a broader area. Other buckle shapes include ovoids in cross section, wedges and asymmetrical tires, to name a few.

**10.1.4. Scleral Suture Techniques**
Explants are secured to the sclera with partial thickness scleral sutures. These sutures are placed in a mattress fashion parallel to the long axis of the element being supported. Accurate and effective suture placement is critical to the success of explant procedures. A spatulated needle with side cutting edges alone (to minimize the risk of full thickness scleral perforation) with a 4-0 or 5-0 nonabsorbable suture such as polyester, nylon or polypropylene is used. When tightened, these sutures indent the explant and underlying eye wall.

Magnification with loupes or the operating microscope facilitates suture placement. The assistant stabilizes the eye by firmly holding the bridle or traction sutures on the recti adjacent to the quadrant of active interest. The suture is passed at the site marked previously on the sclera, at one-half to three-fourths depth over a distance of 4–5 mm. The intrascleral pass is parallel to the long axis of the scleral buckle (circumferential when circumferential buckle is applied and radial when the buckle is oriented radially). A horizontal mattress suture is created to hold the buckle in place. A combination of adequate depth and length is necessary for maximum suture strength. The needle tip should be visualized at all times as it is passed through the sclera. It is important to complete passage of the needle along the arc of the needle, avoiding posterior pressure or dragging on the hub of the needle, which may perforate through the remaining underlying sclera. It is important that the buckler bites be taken at the entry and exit locations, so that the scleral tissue will not tear when the suture is tightened. In addition, the knot can easily be rotated posteriorly when a circumferential scleral buckle is used, to minimize the risk of its erosion through the conjunctiva.

**Suture dimensions:** The buckling effect should support both the anterior and posterior aspects of the break. The size of the buckle element should be such as to extend 1–1.5 mm beyond the break edges, both posteriorly and on the sides. Anteriorly, the effect should extend to the ora. The suture bites are usually taken 2–3 mm wider than the element to be used, depending on the desired height of the buckling effect. A good rule is to place sutures 1.5 times the width of the implant apart. For a 3 mm sponge, sutures are placed 7.5 mm apart to close a retinal break 3 mm wide. To ensure that the most posterior edge of the retinal break is supported, the surgeon places the posterior suture a minimum of 2–3 mm posterior to the scleral localization mark. The anterior sutures are usually taken along the line of the ora, to reduce the risk of leakage of SRF through the break anteriorly. The sclera is marked with calipers straddling the location of the retinal break. As the globe is nearly spherical, the distance measured by calipers (chord length) is shorter than the distance along the surface of the sclera (scleral arc length). However, because of the relatively small curvature of the eye compared with the usual width of the scleral sutures, this difference is not clinically significant in most cases. One or two mattress sutures may be used, depending on the size of the break and whether SRF will be drained. If the sutures tear out, they are replaced with a scleral bite further away from the explant. When one is suturing posteriorly, the vortex veins and their tributaries must be avoided. Thin sclera also presents problems, and sometimes long suture passes are not
possible in this case. Several short bites in areas of thicker sclera may be effective. For a radially oriented buckle, the suture arms should be 2–3 mm apart than the diameter of the buckling material.

When SRF is not drained, it is often helpful to extend the buckling effect farther posteriorly, because this minimizes the chance of persistent leakage through the break due to radial folding of the retina over the buckle. When a mattress suture is necessary in a far posterior location, a shorter needle can be used. It may be difficult to safely pass the needle in a posterior to anterior direction when one is working posterior to the equator. Here, a double armed suture is used. Alternatively, a crossed mattress suture may be used, which may be converted to a simple mattress suture.

Once the suture is in place, temporary ties are applied initially and the prepared buckle placed under the same. The sutures are mildly tightened and fundus examination done to assess the buckle effect produced.

The buckle effect is determined by several interrelated factors:
- Buckle effect increases when the distance between the intrascleral limbs of each mattress suture is increased. A high scleral buckle is produced by suture bites 3–4 mm wider than the silicone element
- Greater the separation of sutures, the higher the buckle
- The tighter the sutures over the explants, the higher the buckle.

Therefore, the sutures serve both to position and secure the explant and also to regulate the height of the buckling effect. Suturing technique also depends on other factors. In soft eyes, a long intrascleral pass may be difficult, and multiple short bites can be taken, but with increased risk of tearing out if knotted under tension over the explant. A similar technique may be used if the vortex veins is present, the suture bites are made wider than usual. The use of cyanoacrylate adhesive to support suture bites in thin sclera has been described.

10.1.5. Configuration of the Buckle

The size and the type of the retinal break usually dictate the width and length of the explant. Placement of the explant material can be either segmental or encircling.

Segmental: Segmental buckles usually are reserved for detachments with single or closely spaced retinal breaks less than one-two clock hour/s in total extent or with posterior breaks without much PVR, especially detachments with dialysis and detachments with minimum SRF. This type of surgery is often done without drainage of the SRF. Segmental buckling can be accomplished by suturing a piece of solid silicone to the surface of the sclera, but the most popular material is silicone sponge. Segmental buckling was appropriate for two-thirds of rhegmatogenous retinal detachment (RRD) in one study and has fewer complications than encircling buckle. It has definite advantages, which include relative ease of placement and minimal change in refractive error. For posterior breaks, segmental elements allow closure of the break while avoiding the side effects of larger posterior encircling elements.

A segmental buckle may be circumferential or radial, depending on the orientation of retinal pathology, or a combination of the two may be used. Radical segmental buckles are used in settings of single and/or posterior break. They minimize the amount of radial retinal folding, which results from the decreased circumference of the eyeball when a circumferential scleral buckle is used. Breaks that are likely to fish-mouth are best buckled by radial sponge. Circumferential segmental buckle are preferred with multiple retinal breaks in the same or different quadrants. Segmental buckling is described in a later chapter.

Encircling: Although segmental buckles effectively close isolated tears, they do not provide retinal support elsewhere. Specifically, areas of vitreoretinal traction away from the segmental element are not supported, which may result in the formation of new retinal breaks. Encircling procedures are particularly indicated in:
- Cases with multiple breaks in different quadrants
- Aphakia and pseudophakia: Because of the problems with poor visualization, encircling procedures usually are indicated in pseudophakic cases
- Myopia
- Diffuse vitreoretinal pathologic conditions such as extensive lattice degeneration or vitreoretinal degenerations
- PVR of grade B or greater
- Eyes without a recognizable retinal break.

Either a sponge or solid silicone can be used for an encircling buckle. Sponge may be preferred if retinal breaks are located at varying distance from the ora. Because of their compressibility, encircling sponges tend to result in a variable undulating contour to the buckle unless multiple sutures are placed in each quadrant. The necessary width and location of the encircling element depends on the pathology.

If a flap tear is being supported with a circumferential segmental buckle beneath an encircling element, its posterior edge should lie on the center of the crest of the buckle. The buckling effect should extend for 1 clock hour or 30° on either side of the tear and extend anteriorly to the ora serrata.

If the encircling element is supporting pathologic conditions in attached retina, such as a retinal break, lattice
Section 4  Retinal Detachment: Basics

degeneration or prominent vitreoretinal adhesions, the most posterior aspect of the condition needs to be supported by the encircling element. If no specific pathologic factor is to be supported, the encircling element should support the posterior margin of the vitreous base (about 3 mm posterior to the ora serrata nasally and 2 mm posterior to the ora temporal).

We prefer a solid silicone band, 2.5 mm wide (# 240), to support the vitreous base or vitreoretinal pathologic condition in attached retina. The encircling band is secured to the sclera with either mattress sutures or through scleral tunnels to prevent migration of the band once it is shortened. It is not necessary to place the band around the greatest curvature of the eye. The ends of the band can be secured with a tantalum clip,11 clove hitch nonabsorbable suture31 or a silicone sleeve30 (Watzke sleeve). The later allows easy adjustment of the band throughout the procedure.

Disadvantages of encircling element include the following:
- Circumferential shortening of the sclera in relation to the retina, causing retinal fold formation in the retina, that may predispose retinal breaks to the fish-mouth phenomenon19,30
- Axial elongation or myopic shift even with mild to moderate buckle height
- Increased risk of muscle imbalance, diplopia and strabismus
- Excessive tightening may cause reduced ocular blood flow, anterior segment ischemia121,122 and transscleral erosion
- It may necessitate SRF drainage in most of the cases
- Requires extensive surgery and is associated with higher morbidity.

Persistent patency of the retinal break resulting from the fish-mouth phenomenon can result in surgical failure and therefore needs to be addressed. Techniques in the management of retinal tears with fish-mouth phenomenon include:
- Decreasing the height of the circumferential buckle if the buckle height is more. This can be accompanied by taking an extra mattress suture near the primary suture at the break.
- Placement of a radial element beneath the circumferential element. Radial scleral buckles provide focal support for the retinal tear and minimize adverse effects due to radial folding of the retina from the circumferential scleral buckle.123
- Injection of an intravitreal gas bubble and appropriate positioning functionally closes the break and brings about approximation of the retina to the RPE due to the RPE pump. The effect of previously applied retinopexy then permanently closes the break. Care should be taken to avoid formation of multiple small bubbles or fish-eggs, as these may pass through the tear into the subretinal space.

For encircling elements, buckle height can be obtained in the following ways:
- The first method of obtaining buckle height is by adjustment with suture configuration. This technique is used with wider and thicker explants such as tires and sponges. The farther apart the bites of the mattress suture are placed, the greater the height of the buckle when the sutures are tightened. With this technique, axial length may actually decrease.125
- Lowering the IOP through paracentesis also augments the height of the buckle.
- Tightening or shortening of the circumferential explant. The best method of determining how much to shorten the band is a visual assessment of the buckle height created by the band.31,123 An ideal height of about 2 mm is achieved by shortening the circumference of the 240 band by about 10–12 mm. However, excessive tightening should be avoided as it leads to circumferential shortening of the globe in relation to the retina, causing fish-mouthing and increased axial elongation of the globe.

10.2. Implant Techniques

Schepens and colleagues37 described implants in 1960. Modifications and refinement of the technique subsequently have been described. The procedure is performed infrequently nowadays. A short description is given here.

10.2.1. Preparation of the Scleral Bed

A lamellar scleral dissection is done to create a bed extending 3 mm posteriorly, 2 mm anteriorly and 3 mm circumferentially beyond the retinal break.16 The initial incision is created parallel to the limbus along the posterior edge of the retinal break. The dissection is continued using a blunt dissector while the scleral flaps are kept stretched. Damage to the vortex veins must be avoided. The depth of the incision is considered appropriate if a thin gray layer of sclera remains over the choroid.

10.2.2. Diathermy

After making lamellar scleral dissection, diathermy is applied to treat the break. When diathermy is applied to full thickness sclera, energy transmission is irregular and unpredictable and induces scleral necrosis and shrinkage.64,66 Hence, it is applied after the lamellar scleral dissection. Diathermy is applied to the dried scleral surface with a blunt-tipped electrode,
placing medium intensity burns approximately 2 mm apart in staggered rows parallel to the limbus under ophthalmoscopic control. Treatment is started posteriorly and then proceeds anteriorly so that even if an excessively intense application causes a tiny defect posteriorly, anterior dry areas can still be treated. The long posterior ciliary arteries, nerves and vortex veins should be avoided.

10.2.3. Buckle Implantation
The silicone implant is trimmed to fit beneath the scleral flaps. An encircling band may be placed in cases of large or multiple retinal breaks. The edges of the scleral flaps are closed with mattress sutures over the buckle. Drainage of SRF usually is required.

10.2.4. Advantages and Disadvantages
Advantages of this procedure include decreased chance of infection or extrusion of the implant, less inflammation compared to cryotherapy, and less dispersion of viable RPE cells. Drainage is safer as it is performed in an area already treated with diathermy. However, the popularity of implants has declined over the past 2 decades because of the following disadvantages:
• The need for scleral dissection
• Permanent scarring damage from diathermy and dissection, making reoperations difficult
• Elevated IOP caused by scleral shrinkage from diathermy, necessitating drainage of SRF
• Increased risk of intrusion of the implant
• Difficulty in modification in the shape or location of the scleral buckle in relation to the retinal break. These are made most easily if an episcleral explant is used.

11. SUBRETINAL FLUID DRAINAGE
The external drainage of SRF is a critical and the most controversial step in the scleral buckling procedure. Drainage is considered to be the only intraocular step of the extraocular buckling procedure and may be associated with possible serious complications. Though a nondrainage procedure may slightly increase the chance of primary failure, the eye will survive the surgery almost intact. Though drainage can flatten the retina on the table, complications (blood under the macula, etc.) may forever preclude visual recovery. From a pathologist's viewpoint, drainage is a penetrating injury to a vascular tissue in an inflammatory and hypoprotic setting. Drainage with confirmed retinal flattening at the surgery reassures the surgeon and the patient, leading to its popularity. Nondrainage surgery is discussed in detail in the subsequent chapter.

11.1. Rationale
The rationale for drainage of SRF is to diminish intraocular volume so as to achieve good buckle height without causing elevated IOP and to reduce SRF, enabling approximation of the retinal breaks to the RPE over the buckle, facilitating closure of the breaks.

In most cases, the decision regarding drainage depends upon the size and configuration of retinal tears, the amount of traction, the appearance after the scleral buckle has been elevated beneath the retinal break(s), and the experience of the surgeon regarding the amount of SRF that can be allowed to remain between the crest of the buckle and the break(s). External drainage is ineffective in eyes that have undergone prior vitrectomy, because fluid inside the eye readily gains access to the subretinal space through the retinal break.

We prefer to drain for the following indications:
• Bullous detachments: Drainage promotes settling of the break on the buckle and if performed initially during the operation, may aid in accurate localization of the break and allow more effective cryotherapy.
• Chronic detachments: SRF in these eyes has a high concentration of protein. The high osmolarity of this fluid may impede resorption by the RPE.
• Proliferative vitreoretinopathy: PVR may cause the break to remain open. Drainage in cases with PVR grade B or more may indicate adequacy of support to areas with membranes or folds and apposition of the break onto the buckle.
• Poor retinal pigment epithelium function: Patients with age-related macular degeneration, high myopia or other causes with compromised RPE function may have protracted resorption of SRF and retinal reattachment. This may be hastened with drainage.
• Highly myopic and aphakic or pseudophakic detachments: Fluid or synergetic vitreous can persistently pass into the subretinal space the vitreous cavity in these eyes. This may prevent break-buckle apposition. Intraoperative achievement of this apposition may give more peace of mind.
• Inferior breaks: In eyes with inferior breaks and significant separation between retina and RPE at the break site after placing the buckle, drainage is preferred. SRF gravitates inferiorly. This may prevent inferior retina from settling on the buckle as readily as superior retina.
• Eyes with known glaucoma, where raised IOP from buckling or gas injection may prove deleterious.
• Eyes in which no apparent retinal break is found. Here, if buckle is planned, it may be preferable to achieve flattening of the retina intraoperatively.
• Eyes needing more extensive buckling of multiple breaks and hence, larger elements. Drainage helps reduce pressure rise and accommodates larger buckles.

11.2. Selection of the Drainage Site

A number of factors are considered in selecting the location for drainage of SRF:

• Drainage should be performed in an area where there is sufficient SRF to enter the subretinal space safely. Indirect ophthalmoscopy should always be performed just before drainage, after placement of buckle with loose temporary sutures, to make sure that SRF has not shifted and that there are no vortex veins near the proposed site of drainage.

• It should be avoided in areas treated with cryotherapy, because choroidal congestion induced by cryotherapy may predispose to hemorrhage.66

• Draining just above or below the horizontal meridian at or slightly anterior to the equator is preferable because the choroid is less vascular in these areas.

• Where feasible, nasal quadrants are preferred because if subretinal bleeding complicates drainage, it would be less likely to track under the macula.

• It is best to drain in the bed of the buckle because any inadvertent retinal perforation or incarceration will automatically be supported without the need for additional buckling or revision of the buckle.

• An especially good location for drainage of SRF is beneath an area of peripheral vitreoretinal traction or epiretinal membrane formation. The traction tends to keep the retina elevated in that area so that the retina first flattens elsewhere, allowing more complete removal of the SRF with a lesser risk of retinal incarceration in the wound.

• The site for drainage is usually selected as far away from the retinal break(s) as possible, to minimize the chance of liquid vitreous passing from the vitreous cavity through the break and into the subretinal space.

11.3. Drainage Technique

Once a proper drainage site has been selected, the globe should be positioned such that the proposed drainage site is easily accessible externally and can be viewed by indirect ophthalmoscopy without significant manipulation. All sources of external pressure should be removed before drainage. The proposed drainage location is viewed by indirect ophthalmoscopy with the eye in the same position that will be used during drainage. Prior to draining, have a syringe with gas or filtered air ready in case of hemorrhage or hypotony. Drainage can be performed via one of the following:

11.3.1. Radial Sclerotomy and External Observation of the Drainage Site

A radial incision 3–4 mm in size is made with a rounded scleral blade, keeping the blade perpendicular to the sclera to prevent sheathing of the edges. Light diathermy is applied with a blunt-tipped electrode to cause the edges of the wound to gape and for perfect hemostasis. All scleral fibers are carefully divided or separated until subtle prolapse of uveal tissue is observed. Magnification helps in the identification of residual scleral fibers, which must be cut; otherwise, they may swell during drainage, prematurely closing the drainage site. Once the choroid is exposed, it is inspected under magnification to identify major vessels, which should be avoided during choroidotomy. A fiber optic light source placed against the sclera across from the drainage site helps in the identification of choroidal vessels. Diathermy is then applied to the choroid to close vessels and to cause shrinkage. The tip should be moved gently to prevent it from sticking to the choroid. A preplaced 5-0 polyester suture is passed in mattress configuration if a sclerotomy is not under the buckle. Entry through the choroid and into the subretinal space can be performed by a variety of techniques using:

• Needles: Suture needle144 or bent 27–30 gauge needle. This necessitates entry into the subretinal space with the potential of causing retinal injury and hole in shallow detachments.

• Diathermy electrodes: An insulated diathermy132 electrode may be used to vaporize the choroid to create an opening. This technique was reported to have a lower complication rate than needles as there is no need to enter the subretinal space.

• Lasers: Using an endolaser probe or an indirect ophthalmoscope laser delivery system to deliver laser energy in the bed of the sclerotomy can create an opening in the choroid. Argon laser135 and a power setting of 800 mW to 2W at 0.2–0.5 seconds is used to perform choroidotomy. The endolaser probe is held close to, but not touching, the choroid. Usually only a single burn is needed to enter the subretinal space. This technique avoids retinal injury from a sharp needle tip. Occasionally, it may result in a large hole in the choroid and is difficult to control.134

All the above techniques are effective and each may have some advantages in selected detachments. For example, laser or diathermy choroidotomy may be preferable in
shallow detachments, since they do not require entry into the subretinal space. Entry into the subretinal space can be either perpendicular or tangential to the choroid, depending on the amount and location of the SRF. Usually a single stab incision of the choroid is made; however, when highly viscous SRF is expected, a large needle or cutting entry may be used.

11.3.2. External Needle Drainage

As originally described, this method is performed under direct visualization. A needle mounted on a syringe with plunger removed is held tangentially against and with bevel away from the sclera. With the indirect ophthalmoscope, area depressed by this needle is assessed. When the needle is in an adequate area for drainage, the needle is angled toward the sclera and entry is made into the subretinal space. The needle tip is seen in the subretinal space with bevel away from the retina. A rippling effect is seen on the retina as the drainage starts. Care is taken to withdraw the needle slowly as the SRF drains sufficiently and the retina approaches the subretinal needle. The procedure may be performed either with the scleral buckle left loose (S Charles) or tightened to an appropriate height with sutures permanently tied. Raising the IOP to supranormal levels by tightening the scleral buckle is thought to ameliorate intraocular bleeding. We prefer the larger gauge needles (24-gauge) since these do not bend easily while angling the needle to enter the eye.

Another modification of needle drainage involves identifying the site of drainage with indirect ophthalmoscopy. This is followed by external diathermy to this site and passage of a needle is perpendicular to the ocular surface through the sclera and choroid into the subretinal space. The needle is gradually advanced perpendicular to the sclera until the SRF is seen in the hub. At this point the needle is immediately withdrawn to permit spontaneous SRF drainage. Observing the SRF in the hub of the needle allows the needle entry in a controlled manner to a desired depth. This also decreases the risk of retinal perforation, subretinal hemorrhage and vitreous loss and the drainage is more controlled.

Whatever method is used for drainage of SRF, as the fluid drains, it is important to maintain a relatively normal and constant IOP to prevent retinal incarceration and choroidal hemorrhage. Indentation of globe at the ora serrata in the meridian of the drainage site facilitates elevation of the retina over the site and allows movement of SRF to the drainage site. A cotton-tipped applicator can be used to displace SRF from other locations toward the drainage area if the retina remains elevated elsewhere. Pressure with cotton-tipped applicator may be applied to the break location to close the same during drainage. This helps prevent vitreous fluid from draining through the break into the subretinal space and outside. As the SRF drainage slows, pigment particles may be seen in the fluid. This usually means that the drainage is nearing completion. If the drainage slows or stops prematurely, the drainage site may be manipulated with a blunt end of the forceps or applicator. This will often reopen the site and reestablish flow.

Total drainage of SRF is not necessary and, in some cases, may not be desired. Some believe the residual SRF to be beneficial by permitting a slower settling of the delicate outer segments of the photoreceptor elements against the pigment epithelium so that there is better visual recovery. The goal is for enough drainage to allow the scleral buckle to close the retinal breaks effectively without excessive elevation of IOP. Fluid is allowed to persist if the optimal amount of buckling nearly closes the retinal break(s). Immediately after drainage, the drainage site is evaluated for signs of subretinal bleeding, retinal incarceration, and iatrogenic hole formation. The amount of persistent SRF is then determined, and the need for further drainage is considered. However, every effort is made to achieve satisfactory drainage through the initial sclerotomies because it has been made in the best location for drainage.

11.4. Adjusting Intraocular Volume

Occasionally, excessive drainage results in eyes with liquefied vitreous and large retinal breaks. If excessive drainage results in hypotony, IOP may be restored by tightening the buckle or by injection of air, gas or balanced salt solution (BSS) through the pars plana. BSS is used for intraocular injection if the retina has settled well and the retinal breaks are flat or nearly flat on the scleral buckle. In other cases, gas is injected for the dual purpose of raising the IOP and providing temporary intraocular tamponade. However, visualization of the fundus may be impaired after gas injection unless a single bubble is obtained. Therefore, other decisions requiring visualization of the fundus are made before injection of gas. BSS is injected slowly while IOP is monitored with a finger. Gas is injected with moderate rapidity in one movement to obtain a single large bubble, and prevent many small bubbles that would interfere with visualization of the fundus.

Air is used most commonly for intraocular injection, although expandable longer acting gases are sometimes used, such as sulfur hexafluoride (SF₆) or a perfluorocarbon gas such as C₃F₇. The intraocular tamponade effect of the bubble is usually needed for only 24–48 hours to temporarily flatten the retinal break against the scleral buckle and/or to functionally close the retinal break by physically obstructing the break while the SRF is absorbed. Therefore, the breaks remain flat and the helpful effect of the bubble is no longer
necessary. Therefore, air is preferred when the eye is soft enough to permit injection of a larger volume. When a volume of 0.5 mL or less can be injected or in cases where a longer tamponade is desired, a bubble that expands postoperatively is used (SF₆ or C₃F₇). The optic nerve is then inspected to document perfusion of the retinal artery.

12. ADJUSTMENT OF THE SCLERAL BUCKLE

After SRF is drained or the eye is softened by other means, scleral sutures are temporarily tightened to enhance the scleral buckling effect. First, the suture overlying the break is tightened. The fundus is examined by indirect ophthalmoscopy to determine whether the retinal break is now closed or nearly closed by the buckling effect. The temporary ties allow easy adjustment of the buckle height or position if necessary. This flexibility is a primary advantage of explant techniques.

If the retina flattens well against the pigmented epithelium during drainage of SRF, the height of the scleral buckle can be reduced, unless prominent vitreoretinal traction is present. If a circumferentially oriented scleral buckle causes excessive radial folding of the retina, the radial folding can also be reduced by lowering the buckle height. To lower the height of the scleral buckle, the scleral sutures and/or encircling band are loosened somewhat, and gas or saline is injected through the pars plana into the vitreous cavity. Conversely, if the retinal break(s) are still elevated above the scleral buckle, the buckle height can be increased by further tightening of the sutures. If the scleral buckle is not sufficiently wide or properly located to support all edges of each retinal break, the sutures and the buckle are repositioned or modified by adding additional pieces of silicone rubber as necessary. If IOP remains low and the breaks are in optimal position, the sutures are permanently tied. If an encircling band has been used, it is secured, and redundant portions of silicone are cut off and discarded.

The final elevation of the buckling effect should be sufficient to position the treated pigment epithelium near the retinal break and to relieve any clinically significant vitreoretinal traction. The height chosen for the scleral buckle also depends on whether SRF will be drained. We prefer to use the minimal buckle height necessary to relieve the vitreous traction and to close the retinal breaks, although the amount varies considerably from case to case. Once the buckle is positioned and the band adjusted, the fundus is again inspected to determine the status of the retinal breaks in relation to the position and height of the buckle. If everything looks alright, the temporary suture ties are converted to permanent knots and rotated posteriorly to minimize the risk of erosion through the conjunctiva.

13. ASSURING PERFUSION OF CENTRAL RETINAL ARTERY

Unless fluid has been removed from the eye, tightening of the sutures around the explants causes the IOP to rise because of displacement of intraocular volume as the sclera is indented. This is temporarily tolerable, but pressure must be lowered and at least pulsating perfusion restored within 5–10 minutes. Whether or not SRF is drained, perfusion of the central retinal artery must be confirmed by the end of the case.

It can be difficult to tell whether the central retinal artery is patent. If pulsations of the central retinal artery are observed, perfusion is marginally sufficient. If pulsations are not visualized and perfusion is questioned, additional digital pressure should be applied to the globe to elicit pulsations. If these do not occur, the arterial flow into the eye has probably ceased, and IOP must be reduced if pulsations do not begin soon. IOP can be reduced by drainage of SRF, paracentesis, aspiration of fluid vitreous, reduction in circumferential contraction of the buckle, or relaxation of sutures causing indentation of the buckle.

14. NONDRAINAGE PROCEDURE

The concept was originated by Custodis80 and popularized by Lincoff and Kreissig.81 The primary advantage of a nondrainage procedure is avoidance of the possible complications associated with drainage. Nondrainage procedures have been shown to reattach the retina with success rates comparable with those of drainage procedure.129,131,134 The selection of patients for drainage or nondrainage is usually a matter of surgeon’s preference. Most retinal surgeons drain most retinal detachments most of the time.126,149 while on the other hand some surgeons perform nondrainage operations in 70–80% of their cases.130,152 Experience is required to determine whether an operation can be terminated without drainage of SRF.

If the edges of the retinal break(s) are supported by the scleral buckle, drainage of SRF is unnecessary, even though the retinal breaks may not be entirely flat on the buckle and even though considerable SRF is present.135,139,151,152 Most nondrainage procedures are effective if the crest of the buckle is within 3 mm of the respective retinal break.81 The SRF rapidly absorbs within 2 weeks postoperative time in most cases,150 although in some eyes several weeks or months may be required before all the fluid is absorbed.151,152,153 In our experience, it is not necessary to drain SRF in young patients with:

- Superior retinal breaks when the surrounding retina was close enough to the pigment epithelium to be frozen by the cryo applications
• Retinal breaks located anterior to the equator associated with low retinal detachment
• Significant preoperative absorption of SRF after bed rest and bilateral patching.

Nondrainage procedure often requires lowering the IOP by either medical or surgical means. A 27–30-gauge needle can be used to remove 0.3–0.4 mL of aqueous at one time intraoperatively. Nondrainage minimal buckling procedure is described in more detail in the subsequent chapter.

15. CLOSURE OF INCISIONS

Irrigation of the operative field with an antibiotic solution is usually performed. The irrigation should be deep in the plane between Tenon's capsule and the sclera in all opened quadrants. A layered closure is done, first closing Tenon's capsule to the muscle insertions in all quadrants. This ensures that the explants and nonabsorbable sutures are covered by the thick Tenon's capsule and also removes tension on the conjunctival closure, thereby minimizing the possibility of buckle erosion. The relaxing incisions are closed with one or two interrupted sutures or a running absorbable suture. If a posterior conjunctival peritomy is done, it is closed 360º with running suture. After closing the conjunctiva, solutions containing corticosteroids and antibiotics are injected subconjunctivally and the eye is covered with sterile gauze.

16. POSTOPERATIVE MANAGEMENT

16.1. Medications

Systemic analgesic and anti-inflammatory medication (NSAIDs) is given to reduce pain and inflammation. Frequent applications of steroid and antibiotic eye drops are used postoperatively. A topical mydriatic/cycloplegic medication is used routinely to dilate the pupil. This regimen reduces inflammation and lowers the chance of developing posterior synechiae. It also allows examination of the retina without the need to dilate the pupil before each examination.

16.2. Patching

Bilateral patching may be used in cases in which retinal breaks remain elevated over the scleral buckle.

16.3. Examination

Most patients now undergo buckling surgery as an outpatient procedure without hospital admission unless a postoperative condition necessitates it. All patients are examined the first day after surgery. Early postoperative examination is usually brief, but it must be complete enough to determine the status of the retina and to detect significant complications.

Cornea is examined for epithelial defects. The anterior chamber is examined for cells and protein flare. A few cells and mild flare are common as a result of postoperative iritis. A severe cell and flare reaction may indicate endophthalmitis or anterior segment ischemia. IOP is measured daily until it is normal and stable. Applanation tonometry is preferred because indentation tonometry gives a falsely low reading due to altered ocular rigidity after scleral buckling operations. The optic nerve head is examined to be certain that the central retinal artery is open and that retinal perfusion is adequate. The macula is examined to determine whether it is reattached and whether there are visible abnormalities such as subretinal hemorrhage or pigment. The retinal breaks are examined to determine whether they are flat against the pigment epithelium. Changes in the status of the retina are recorded, particularly changes in the amount of SRF. The patient is told to return promptly if new symptoms occur after discharge from the hospital. A significant increase in pain and further reduction in vision are the main causes for emergency examination. In uncomplicated cases, the patient is scheduled to return for additional follow-up about 1 week. If there are no problems, subsequent follow-up examinations are completed at 4 weeks, 3 months, 6 months and yearly thereafter. When the refraction is stable, a change in eyeglasses is made. The refractive usually does not stabilize until at least 4–6 weeks after surgery.

16.4. Activity

If gas has been injected, the patient will require specific instructions regarding head position and restriction from air travel. Air travel or ascent to high altitude may cause rapid expansion of the bubble and dangerously high elevation of IOP. Some surgeons recommend that patients not fly if a gas bubble occupies more than 20% of the vitreous cavity or is larger than 0.6 mL, which corresponds to about 20% of the height of the vitreous cavity.

Patients are often told not to engage in exertional manual labor or heavy lifting for at least 4 weeks, but this limitation may be unnecessary. A randomized prospective trial comparing retinal detachment patients restricted postoperatively to limited activity with another group under no restriction showed no difference in the surgical success rate. However, patients are instructed not to work in a dirty or dusty environment for 2–3 weeks, until the conjunctival incision has fully healed.

17. OUTCOMES

17.1. Anatomic Results

The objectives of retinal detachment surgery are to permanently reattach the retina to the pigment epithelium
and to restore or maintain maximal visual acuity and visual field function. Most contemporary reports of large consecutive case series indicate that an overall anatomic reattachment is now achieved in at least 90% of cases, and few eyes are considered inoperable because of preoperative findings (Table 29.1). Around 75–90% of eyes are successfully treated with one operation. About 10–20% of eyes require more than one operation to reattach the retina.  

Multiple preoperative and intraoperative risk factors have been correlated with the anatomic prognosis after scleral buckling. These include the presence of PVR, vitreous hemorrhage, choroidal detachment, greater extent of detachment, large tears, hypotony, failure to identify a retinal break, or injection of air, gas or fluid.  

Over the past 5 decades, the materials and techniques of scleral buckling surgery have undergone continued refinement, resulting in a high rate of retinal reattachment.

17.2. Visual Results

Although anatomic success rates have continued to improve, improvement in visual results has been limited because permanent visual acuity damage occurs when there is detachment of the macula. Some improvement in visual results may be due to an increasing number of ophthalmologists and trained retinal surgeons and increased sophistication of patient population leading to a shorter average time between onset of symptoms, diagnosis and therapy for retinal detachment compared with several decades ago. This should result in both a lower incidence of macular involvement and a shorter interval between onset of macular detachment and surgery. Advances in surgical techniques may also have resulted in improved visual results by minimizing intra- and postoperative complications. Nonetheless, improvement in the visual outcome remains disappointing compared with improvements in anatomic results, especially in eyes with detachment of the macula.

Postoperative visual acuity depends on several factors. The strongest predictor of both postoperative reattachment and vision is the preoperative status of the macula. Detachments without macular involvement have a better anatomic prognosis than those with SRF beneath the macula. In eyes with successful reattachment of macula off detachment, approximately 50% of eyes have final visual acuity of 20/50 or better. In eyes with macula on detachment and excellent preoperative visual acuity, 90% achieved an acuity of 20/30 or better at 6 months but 10% suffered decreased visual acuity despite an anatomically successful operation. Histologic studies suggest that visual recovery is limited by permanent photoreceptor damage, CME, and epiretinal membrane.  

The duration of preoperative macular elevation correlates with visual outcome. Decreasing visual acuity occurs with increasing duration of detachment. Hassan and colleagues reported that in eyes with a macula off retinal detachment and preoperative vision of 20/200 or worse, a final vision of 20/40 or better was achieved in 71% of eyes with a duration of macular detachment of 10 days or less; 27% of eyes with a duration of macular detachment of 11 days to 6 weeks; and 14% of eyes with a duration of macular detachment greater than 6 weeks. Other studies demonstrate a similar correlation between duration of macular detachment and final visual acuity suggesting that macula off retinal detachments should be repaired within 7-14 days when possible.

These results are consistent with the anatomic changes associated with experimental retinal detachment. As the duration of detachment increases beyond 2 weeks, cystoid spaces extend through the retina. These spaces decrease in size as the retina becomes increasingly atrophic as the detachment persists. Photoreceptor damage is also related to the duration of detachment. Reattachment of the retina does result in some

<table>
<thead>
<tr>
<th>Authors</th>
<th>No. of eyes</th>
<th>% success first operation</th>
<th>% final success</th>
<th>% final failures due to severe PVR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chignell et al. 176</td>
<td>452</td>
<td>75</td>
<td>88</td>
<td>77</td>
</tr>
<tr>
<td>Lincoln H 180</td>
<td>752</td>
<td>88</td>
<td>97</td>
<td>86</td>
</tr>
<tr>
<td>Rachal &amp; Burton 189</td>
<td>865</td>
<td>76</td>
<td>89</td>
<td>Nearly all</td>
</tr>
<tr>
<td>Hilton et al. 177</td>
<td>600</td>
<td>84</td>
<td>92</td>
<td>94</td>
</tr>
<tr>
<td>Wilkinson &amp; Bradford 182</td>
<td>662</td>
<td>91</td>
<td>94</td>
<td>97</td>
</tr>
<tr>
<td>Sharma et al. 191</td>
<td>601</td>
<td>86</td>
<td>90</td>
<td>Most important cause</td>
</tr>
<tr>
<td>Grizzard et al. 23</td>
<td>1008</td>
<td>-</td>
<td>92</td>
<td>Major cause</td>
</tr>
<tr>
<td>Kreissig I et al.</td>
<td>107</td>
<td>92.6</td>
<td>97</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Abbreviation: PVR, proliferative vitreoretinopathy.
reversal of the histologic changes seen during detachment, but the extent of recovery depends on the duration of detachment. This work in animals is supported by human autopsy studies that demonstrate permanent photoreceptor damage in eyes after retinal reattachment. 201-203 Experimental work suggests that hypoxia is the primary cause of photoreceptor damage. 204 Visual acuity also correlates with the extent of retinal elevation. When the macula has bullous elevation, postoperative visual recovery is less. 205 This is probably caused by permanent photoreceptor degeneration, which in experimental retinal detachment increases as the distance between the pigment epithelium and the photoreceptors increases. 206

Another very important factor affecting postoperative visual acuity is the preoperative visual acuity and this is true whether or not the macula is detached. 207-209

Optical coherence tomography (OCT) can play an important role in the follow up of patients with unexplained visual impairment after retinal detachment surgery. It can detect clinically unapparent subfoveal shallow retinal detachments persistent for months after surgery, cystoid changes and outer layer defects (e.g., disintegrated photoreceptor IS/OS junction 209-210). We feel OCT should be routinely considered in the follow-up of these patients. Preoperatively elevation of the retina and intraretinal fluid with outer retinal changes as evidenced by OCT are associated with poor postoperative vision.

18. SCLERAL BUCKLING VERSUS PRIMARY VITRECTOMY

Treatment options for the primary management of RRD have increased in recent years. Traditionally, scleral buckling has been considered the “gold standard”. There are varying approaches and differing surgical techniques in the scleral buckle operation. Controversy regarding surgical aspects, such as encirclement versus localized buckle and drainage of SRF versus non-drainage, persists among surgeons. In the end, the success rates for anatomic retinal reattachment are high, ranging in the 83–95% range after a single operation. Recent times have witnessed an increasing use of vitreous surgery for retinal detachments. “Primary vitrectomy” was introduced by Klotz. 211 The rationale for primary vitrectomy is to remedy vitreoretinal traction and to avoid complications associated with scleral buckling surgery.

The indications for the choice of primary vitrectomy in managing retinal detachments vary among surgeons. Some prefer buckles for almost all detachments, whereas others rely heavily on vitreous surgery.

Consensus does exist on the use of primary vitrectomy with regard to selected types of retinal detachments that are more difficult to manage with scleral buckling alone (Box 29.3). Explant techniques may be inadequate or may fail to achieve success in most of these cases.

**Box 29.3: Indications for primary vitrectomy in retinal detachment**

- Vitreous opacity—hemorrhage, pigment/debris, uveitis, asteroid hyalosis
- Undetected retinal breaks
- Large posterior retinal tears
- Posterior retinal breaks in high myopia, coloboma and staphyloma
- Failed pneumatic retinopexy with PVR or subretinal gas
- Selected cases of retinoschisis
- Giant retinal tears
- Proliferative vitreoretinopathy
- Retinal detachment following open globe injury.

Abbreviation: PVR, proliferative vitreoretinopathy.

18.1. For Uncomplicated Retinal Detachments

The two most important reattachment procedures for uncomplicated RD are scleral buckling and pars plana vitrectomy. 212 Each of these procedures offers distinct advantages and disadvantages. Reasonable disagreement exists as to which approach (or combination of approaches) is the best form of surgical intervention for patients with uncomplicated rhegmatogenous retinal detachments. Pars plana vitrectomy has three distinct advantages over scleral buckling or pneumatic retinopexy:

- Pars plana vitrectomy is the only procedure that directly removes vitreous traction by lysing the vitreous strands adherent to the flap of the horseshoe tear. Scleral buckling only indirectly relieves vitreous traction, and pneumatic retinopexy does not relieve traction at all.
- Vitrectomy removes media opacities (vitreous hemorrhage, pigment), clearing the visual axis. In cases with significant vitreous opacity, this allows for better intraoperative visualization and the potential for faster postoperative visual recovery.
- Vitrectomy can reliably achieve complete, intraoperative retinal reattachment, either by internal drainage of SRF or by use of perfluorocarbon liquids to displace the SRF. In contrast, scleral buckling with SRF drainage typically achieves only partial reattachment, while scleral buckling without drainage and pneumatic retinopexy never achieves immediate reattachment.

The choice of surgery depends upon following factors:
18.1.1. Break Characteristics

Vitrectomy is preferred especially where the breaks are too many or too large to indent with any degree of subtlety, too small or too well-hidden to be identified with certainty, too awkward in location (posterior) to be easily reached, or subject to too much traction. Multiple breaks are found to be a risk factor for failure of scleral buckling. Some studies have found lower primary success rates in eyes without visible retinal breaks. Direct visualization and perfluorocarbon liquids enable a better view of the pathological anatomy and the identification of previously unseen breaks in these cases. A subset of patients with retinal detachment achieves nearly 100% anatomic success after one buckling operation. This includes patients with retinal dialysis, round, atrophic holes associated with lattice degeneration, retinal detachments in which pigment demarcation lines are present, and retinal detachment with single break.

18.1.2. Age and Posterior Vitreous Detachment

Retinal detachment seen in elderly patients generally accompanies posterior vitreous detachment (PVD) and traction is a factor in these eyes. In contrast, retinal detachment caused by atrophic holes seen in younger patients typically does not accompany PVD. Attempting to induce PVD intraoperatively in younger patients often fails, and may sometimes create retinal breaks. Therefore, we believe that scleral buckling should be indicated in these patients.

18.1.3. Lens Status

Although primary vitrectomy can achieve anatomic and functional success rates comparable with those achieved by scleral buckling in uncomplicated forms of phakic RRD, the major drawback of the procedure is the high incidence of postoperative cataract formation. Pars plana vitrectomy is somewhat more technically difficult in phakic patients, because access to the vitreous base is impeded by the crystalline lens.iatrogenic damage to the lens was noted in 3% of the cases. Moreover, visual rehabilitation takes place earlier with scleral buckling than with vitrectomy. Scleral buckling should thus be used as the primary surgical modality in the treatment of uncomplicated RRD where the media is sufficiently clear.

18.1.4. Pseudophakic and Aphakic Patients

Despite wide pupillary dilation, visualization is frequently imperfect in eyes with an intraocular lens (IOLs). Additional pupillary opacities may be caused by retained peripheral lens cortex and/or clouding of the posterior lens capsule. Partial decentration of posterior chamber IOLs is also common, adding to the aberrations and difficulty with visualization. Retinal breaks cannot be found in 9–20% of pseudophakic detachments, and this may be a risk factor for surgical failure. For eyes where the break cannot be found because the peripheral retina is obscured by a narrow pupil or capsule opacities, a vitrectomy provides better access and may provide a better prognosis than prospective buckling based on the contour of the detachment, or a cerclage.

Vitrectomy is considered particularly successful in pseudophakic/aphakic patients, as demonstrated by the high primary success rates, that seems to be significantly superior to those of scleral buckling. However, some studies show similar anatomical and functional results with scleral buckling or vitrectomy in pseudophakic patients.

18.1.5. Media

Cases with vitreous hemorrhage and presence of vitreous opacities are more amenable to vitrectomy. Less than ideal (for vitrectomy) are those patients with multifocal IOLs.

18.2. Results

Majority of studies have found no statistically significant differences in either anatomical or visual results between scleral buckling and vitrectomy for uncomplicated retinal detachments. Patients with primary RRD that redetach after initial treatment with scleral buckling procedure require fewer number of secondary operations and silicone oil injections, show a trend for better visual outcomes and are less likely to develop dense cataract or to require lensectomy compared to patients that redetach after initial pars plana vitrectomy or pars plana vitrectomy/scleral buckling.

18.3. Surgeon Factor

The surgeon’s preference also plays a key role in the selection of the type of surgery. Contemporary surgeons have become more familiar with primary vitrectomy compared to scleral buckling surgery, since the indications for vitrectomy outside retinal detachment surgery have increased immensely during the past decade. This is particularly true for vitreoretinal surgeons who started their surgical training in 1990s or later. In some centers in the United Kingdom, primary vitrectomy is the method of choice in 30–40% or even 63% of all patients with RRD. Scleral buckling is a straightforward, highly successful procedure in simple cases with good visualization of the retinal situation. However, in more complicated situations of RRD, the surgical procedure becomes more challenging. If primary vitrectomy simplifies the treatment of more complicated retinal detachments and enables surgeons to manage more complex situation of RRD at an earlier stage of their training, one might question the justification of
exposing trainee surgeons and patients to the longer learning curve of mastering scleral buckling in complicated situations of RRD.

18.4. The Fear Factor

The belief that all breaks have been identified and treated at vitrectomy leads to more confidence for the surgeon compared to the worries one might have because of either patent breaks with residual detachment or "blind" encirclements which, depending upon luck, may or may not work. These factors are increasingly often willingly "traded in" for additional cataract surgery in phakic patients, and are even more easily accepted in pseudophakic patients. The choice of surgical technique also depends on various factors including patient compliance, cost of surgery, and availability of appropriate instrumentation.

The most important disadvantage of pars plana vitrectomy is its relatively high morbidity for other intraocular structures. Postoperative positioning requirements are stricter than for scleral buckling and depend on the location of the breaks (generally, head elevated for superior breaks, face down for inferior breaks). Lastly, pars plana vitrectomy requires specialized equipment and support staff, and is by far the most expensive of all reattachment procedures.

Further data will be required to define the role of vitrectomy for the management of uncomplicated retinal detachments. Until then, scleral buckling remains the main treatment modality for most retinal detachments with vitrectomy as an adjunct for more complex cases.

19. SUMMARY

In general, one should do the least amount of surgery necessary to accomplish the surgical goal. Regardless of specific technique, scleral buckling offers several advantages as a procedure to repair retinal detachments. It involves minimal intraocular disturbance. It is the most established procedure with the longest documented follow-up. Scleral buckling is appropriate for most primary rhegmatogenous RDs and remains the best approach, with or without concomitant pars plana vitrectomy, for inferior breaks. In general, postoperative positioning is supine, which is well-tolerated by most patients. As every retinal detachment behaves differently the choice of procedure for any individual patient should be left to the surgeon's best clinical judgment. The success of repair depends on a careful preoperative examination and choice of an appropriate tailored technique. With experience, improvement in surgical techniques continues and leads to better anatomic and functional success with scleral buckling.