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Review article

Retinotomies and retinectomies: A review of indications, techniques, results, and complications

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ABSTRACT

Retinotomy refers to “cutting” or “incising” the retina, whereas retinectomy denotes “excising” the retina. Retinotomies and retinectomies aid in tackling traction and retinal shortening that persist following membrane dissection and scleral buckling. We performed a literature search using Google Scholar and PubMed, followed by a review of the references procured. All relevant literature was studied in detail and summarized. We discuss the indications of retinotomies and retinectomies for relaxing retinal stiffness, accessing the subretinal space for choroidal neovascular membrane, hemorrhage and abscess clearance, drainage retinotomies to allow retinal flattening, radial retinotomies to release

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Proliferative vitreoretinopathy
Review
Retinal detachment
Circumferential traction
Intrinsic contraction

circumferential traction, harvesting free retinal grafts, and prophylactic chorioretinectomies in trauma.

1. Introduction

Complex forms of retinal detachment (RD) with advanced proliferative vitreoretinopathy (PVR) in the setting of chronicity or recurrence, traumatic RDs with retinal incarceration, and RD in proliferative vasculopathies remain challenging surgical scenarios despite advances in modern vitreoretinal surgery. Approximately 5%–10% of repairs of primary rhegmatogenous detachments are complicated by PVR. The incidence of PVR remains largely unchanged over the years, even in the presence of improved surgical instrumentation.[16,17,44,49] Retinotomies and retinectomies aid in tackling traction and retinal shortening that persist after membrane dissection or scleral buckling.[67,69]

Retinotomy refers to "cutting" or "incising" the retina, and retinectomy refers to "excising" the retina.[1] Retinotomy, first introduced by Machemer in 1979, was utilized in complex cases where the detached retina is too short to be reattached to the concavity of the eye wall.[68] Subsequently, Haut and coworkers introduced the concept of 360° retinotomy.[36] The indications of retinotomy and retinectomy have expanded to include multiple challenging scenarios, serving as a solution in cases that seemed inoperable. We shall enumerate the indications, surgical techniques, modifications in the techniques, functional and anatomical outcomes, and the complications of retinotomies and retinectomies.

2. Indications

Retinotomies and retinectomies can be used for various indications (Table 1). Certain surgical principles remain uniform in all cases. The advent of smaller gauge vitrectomy systems allows for less traumatic surgery. This, in turn, incites less inflammation, thereby potentially reducing the development of PVR. Wide-angled viewing systems and the usage of intraoperative stains, such as triamcinolone acetonide for visualization and completion of difficult posterior vitreous detachment, are recommended for enhancing surgical outcomes. Complete vitrectomy including vitreous base shaving with the aid of scleral indentation helps in debulking inflammatory and cellular debris. Intraoperative use of perfluorocarbon liquids (PFCLs) aids in flattening bullous RDs, facilitates safer vitrectomy and drainage of subretinal fluid (SRF) through anterior breaks, and stabilizes the posterior retina while performing retinectomies. Laser retinopexy, whenever possible, is preferred over cryotherapy. Judicious retinopexy is important as excessive and aggressive use increases the risk of PVR. Postoperative tamponade with gas or silicone oil improves anatomic success. Adjuvant scleral bucking procedure supports the vitreous base. This is particularly useful in cases with extensive peripheral vitreoretinal pathology, multiple breaks, and pediatric and phakic eyes where aggressive vitreous base shaving is not recommended.[58,85]

2.1. *Relaxing retinotomies and retinectomies in the management of PVR*

The role of retinotomies and retinectomies cannot be overemphasized in the management of PVR. Preoperative risk factors for PVR include trauma, uveitis, giant retinal tears, multiple breaks, associated vitreous hemorrhage, choroidal detachment, and aphakia. Syndromes such as Marfan, Wagner, Stickler, and familial exudative vitreoretinopathy are inherently associated with an increased predilection for PVR formation. Multiple surgical interventions, intraoperative hemorrhage, and excessive cryotherapy increase the risk of PVR.[9] These risk factors result in the dispersion of the retinal pigment epithelium (RPE) and the breakdown of the outer blood-retinal barrier. Moreover, the outer retina becomes ischemic, and the photoreceptors undergo cell death, predominantly by apoptosis. The influx of numerous chemotactic and mitogenic factors activates an inflammatory cascade. RPE and glial cells migrate onto the surface of the retina, forming the PVR membranes and causing intraretinal glial changes. This leads to the transformation of epithelial cells to mesenchymal cells.[18,44] Histopathologically, epiretinal PVR is

Table 1 – Indications of retinotomies and retinectomies

1) Management of PVR
2) Retinotomies to gain access to the subretinal space
  a) Internal drainage of SRF
  b) Removal of subretinal PFCL
  c) Removal of subretinal membranes
  d) Management of subretinal hemorrhage and CNVM
  e) Removal of subretinal foreign body
  f) Retinal and chorioretinal biopsy
3) Retinal incarceration following trauma
4) Prophylactic chorioretinectomy following severe open globe injury
5) Proliferative vasculopathies
6) Removal of anterior horn of GRT
7) Macular translocation/choroidal RPE patch graft surgery
8) Inner wall retinectomy in congenital retinoschisis
9) Intraretinal/Subretinal mass
10) Intractable glaucoma
11) Optic disc maculopathy
12) Arcuate retinotomy for macular hole
13) Autologous retinal graft for macular hole

PVR = proliferative vitreoretinopathy; SRF = subretinal fluid; PFCL = perfluorocarbon liquid; CNVM = choroidal neovascular membrane; RPE = retinal pigment epithelium.

composed of transdifferentiated RPE cells and myofibroblasts that contribute to the contractility of the membranes. Subretinal bands are similarly composed of basement membrane-type material along with RPE cells, myofibroblasts, and macrophages.[74,75] Alkatan and coworkers performed histochemical analysis on subretinal membranes confirming its composition to be predominantly RPE cells and abundant macrophages, with less glial component.[4] Mueller cells undergo hypertrophy to replace retinal neurons and contribute to the formation of intraretinal PVR, which comprises of intrinsic retinal shortening and gliosis.[84] This intraretinal PVR component precludes retinal flattening and cannot be managed with membrane peeling and scleral buckling. Therefore, it requires relaxing retinotomies and retinectomies (Video 1).[94]

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The timing of intervention in cases with PVR remains a matter of debate. Proponents of delayed intervention believe that, in the setting of clinical activity, additional surgical trauma could potentiate cellular proliferation and aggravate PVR. Epiretinal proliferation develops over a period of 6–12 weeks, after which membrane peeling could be easier; however, Feng and coworkers noted that a delay in surgery of more than 28 days was a risk factor for PVR formation. The ideal timing of surgical intervention, therefore, remains subjective and requires a tailored approach based on individual case presentation and surgeon discretion.[19,25,83,84]

2.2. Retinotomies and retinectomies to access to the subretinal space

Retinotomy is required to gain access to the subretinal space in the pathologies listed in the following section.

2.2.1. *Internal drainage of subretinal fluid*

Drainage retinotomy is indicated when there is difficulty in visualizing or accessing a preexisting retinal tear because of SRF drainage from the break.[1] In such situations an area of the retina bereft of large vessels and posterior to the equator is endodiathermized to create a small opening. The SRF is cleared via this opening by a fluid–fluid exchange to reduce the height of the RD. Finally, the retina is settled via a fluid–air exchange. Directly performing fluid–air exchange is an alternative approach (Video 2).

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2.2.2. *Removal of subretinal perfluorocarbon liquid*

Insufficient release of vitreoretinal traction might result in a subretinal passage of PFCL. Large retinectomies have been associated with a higher risk of subretinal PFCL retention. Garcia-Valenzuela and coworkers in their retrospective case series of 72 cases found that 40% of eyes with 360° retinotomy had subretinal PFCL postoperatively. Cases with small/medium-sized breaks seemed to be devoid of the risk, with subretinal PFCL noted only in cases with retinotomy > 120°. Slow injection of PFCL, keeping the cannula submerged within the PFCL bubble, reduces the risk of fish egg formation. Smaller PFCL bubbles are more likely to pass subretinally and should be avoided. Intraoperative detection and removal of subretinal PFCL are ideal. In approximately 1%–11% of cases, however, subretinal PFCL is detected postoperatively.[27] Small amounts of PFCL might be tolerable and visually insignificant; however, a submacular passage of PFCL can result in a dense scotoma.[99] Submacular migration of PFCL is more likely to occur in the presence of a bubble trapped superior to the macula and in cases with epiretinal membrane. Extrafoveal retinotomy is a technique that can be used to remove PFCL. The retinotomy is ideally made at the edge of the submacular PFCL bubble. Using smaller gauge cannulas (39-G, 41-G) coupled with active suction for subretinal PFCL aspiration has been found to lower the risk of iatrogenic complications, such as subretinal hemorrhage, nerve fiber layer and RPE damage, and epiretinal membrane formation.[26,91] In extrafoveal retinotomy balanced salt solution is infused beneath the fovea, displacing the PFCL bubble to an extrafoveal location from where it may be safely removed using suction.[65]

2.2.3. *Subretinal membranes*

Extensive PVR may result in the formation of a subretinal band that prevents retinal reattachment. Subretinal bands can be broadly grouped into 2 types. Diffuse cell sheets in the absence of contractile epiretinal proliferation, in which the retina is likely to settle without actively tackling such subretinal bands. The second type is taut membranes that sometimes form in an annular configuration or “napkin ring constriction” at the disc. Such membranes are problematic and impede conventional retinal reattachment techniques.[41] For subretinal band removal, a small retinotomy is made adjacent to the band, and the membrane is grasped through it with forceps and removed into the vitreous cavity (Video 3).[62,70] Subretinal bands are best removed by grasping them from the center and rotating the forceps around in a spaghetti maneuver. Bands that are thinner in the center become difficult to remove as they are more prone to breakage during manipulation. Such thin subretinal bands may sometimes be adequately dealt with by a retinotomy over the site of the band, through which the subretinal band is transected, relieving traction on the retina. Another subset that is difficult to remove is the one with an extremely thin overlying retina. Here, there is a risk of extension of the retinal break or the retinotomy during the spaghetti maneuver. In such situations and in cases with extensive subretinal bands in the form of sheets, the band is best removed under direct visualization via a peripheral large retinotomy to access the undersurface of the retina (Video 4).

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2.2.4. *Subretinal hemorrhage and choroidal neovascular membrane (CNVM)*

Numerous techniques have been described for the management of subretinal hemorrhage. Subretinal t-PA injection (25–50 μg t-PA in 0.05–0.1 ml saline) using a small gauge (41-G) cannula or through a small retinotomy, followed by air or gas tamponade for clot lysis. Displacement has been demonstrated to be an effective treatment option.[33,39,40] Retinotomy for removing CNVM is rarely indicated in the current anti-vascular endothelial growth factor (VEGF) era, as the complications outweigh the benefits. Hawkins and coworkers conducted a prospective randomized controlled trial in which they compared outcomes of surgical removal of subfoveal choroidal neovascularization with observation. Visual acuity was maintained or improved from baseline in about 40% in both groups. Median visual acuity declined from 20/100 to 20/400 at 2 years follow-up in both arms of the study. Rhegmatogenous RD complicated 5% of eyes in the intervention group.[37]

Certain CNVM cases are refractory to anti-VEGF treatment. They are usually associated with massive subretinal hemorrhage or RPE tears and can benefit from autologous RPE-choroid transplantation. The technique described involves a complete vitrectomy, followed by the induction of the RD using a balanced salt solution injected into the subretinal space with a 41-G needle. The peripheral 200° retinotomy was done, and the retina is reflected on itself, enabling excision of the CNVM tissue with forceps. Endodiathermy is applied to the area, causing microtraumas to the choriocapillaris and aiding revascularization of the graft. An autologous, healthy RPE choroid is subsequently harvested and transplanted into the submacular space. PFCL can be injected subretinally prior to positioning the graft in the subfoveal area. This is followed by slow aspiration of PFCL from the subretinal space to avoid flap displacement. Then, the retina is flattened under PFCL, and the retinotomy is sealed using multiple rows of lasers. Long-term outcomes of autologous transplant have been studied and showed that 40% of eyes (n = 88) showed a 3-line improvement in visual acuity. Mean preoperative visual acuity was 20/320, and mean postoperative visual acuity was about 20/200, a statistically significant difference. Presenting visual acuity and intact external limiting membrane on OCT were found to impact final outcomes. The potential complications of this technique include graft dislocation, atrophy, RD, PVR, recurrent CNVM, and macular hole formation.[13,81]

2.2.5. *Removal of subretinal foreign bodies*

Posteriorly located subretinal foreign bodies may rarely warrant a localized retinotomy over the object to aid in removal. This is more likely in cases with associated RD and mobile posteriorly located subretinal foreign bodies precluding external transscleral extraction. Forceps, intraocular foreign magnet, or soft-tip extrusion cannula may be utilized to retrieve the foreign body through the retinotomy, following which it is removed through an adequately sized sclerotomy.[50]

2.2.6. *Retinal and chorioretinal biopsy*

Retinal and chorioretinal biopsies are indicated in certain neoplastic diseases and infectious/inflammatory retinitis or chorioretinitis. A transvitreal approach is warranted in lesions posterior to the equator. Complete pars plana vitrectomy (PPV) is to be done prior to obtaining a biopsy specimen. The height of the infusion bottle is raised to prevent bleeding during the procedure. A retinotomy over the region of interest (measuring 2 *2 mm) is made to gain access. Vertical intraocular scissors may be utilized in the bimanual technique to obtain a sample. Alternatively, a cutter can be used to impale retinal/chorioretinal tissue, and the sample is obtained using low cut rates. The tissue material is aspirated into a 5-ml syringe for cytopathological examination. Endolaser surrounding the area of biopsy followed by fluid–air or fluid–gas exchange is done.[89,105]

2.3. *Retinal incarceration following trauma*

After acute trauma, the vitreous and retina might be extruded through a scleral perforation. Retinal incarceration might occur while healing from a penetrating injury, where the retina is gradually drawn toward the wound. Retinotomy and retinectomy are indicated in these settings to relieve traction from the site of incarceration to allow retinal reattachment (Video 5).[35]

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2.4. *Prophylactic chorioretinectomy following severe open globe injury*

The incidence of PVR after severe open globe trauma is reported as 60%. Kuhn and coworkers reported that performing prophylactic chorioretinectomy within the first 100 h of trauma might prevent PVR. Additionally, visual acuity was found to improve in 93% of eyes (n = 40) that underwent intervention.[55] The area surrounding the site of incarceration or foreign body impact was treated with high-power endodiathermy. The appearance of gas bubbles from the site of application denoted vaporization of the retina and choroid. The emanating debris was cleared with the vitrectomy probe.[56] Complete excision of the incarcerated retina and the underlying choroid till the bare sclera with the cutter has been subsequently described.[79,104] Chorioretinectomy reduced the nidus for PVR formation, decreasing its occurrence and improving anatomic success in eyes with severe trauma.

2.5. *Retinectomy in proliferative vasculopathies*

In the case of long-standing RDs or redetachments following surgery for tractional or combined RD in vasculopathy, such as diabetic retinopathy and branch vein occlusion, retinectomy may be attempted as a last resort to achieve retinal reattachment (Video 6).[46,48]

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2.6. *Removal of anterior horn of retinal tears*

The anterior flap of the horseshoe and giant retinal tears have strong vitreous adhesion and are associated with a risk of cellular proliferation, progressive contraction, and redetachment. Retained anterior flap increases the risk of anterior PVR with the formation of epiciliary scar tissue. This contracts the ciliary processes, and the traction exerted may also lead to ciliary body detachment. These mechanisms contribute to aqueous hyposecretion and hypotony. The retained anterior flap is ischemic and associated with VEGF release, which causes anterior retinal neovascularization and late postoperative hemorrhage. Prophylactic retinectomy of the anterior flap is indicated to avoid these postoperative complications.[1,54,94]

2.7. Submacular surgery

Submacular surgeries largely comprise macular translocation, submacular hematoma excision, and choroidal patch grafting. Retinotomy or peripheral retinectomy is needed to clear the subretinal hematoma/fibrovascular membrane complex and perform either a macular translocation or a choroidal patch grafting to restore the damaged RPE (Video 7).[61,81,106] A macular translocation involves displacing the fovea from the underlying afflicted subretinal bed to a new healthier location in an attempt to restore useful central vision.[71] The surgical technique described involves induction of RD using SRF injection through a peripheral retinotomy, which is then extended 360°. A subretinal lesion might be removed from the reflected retina. The retina is then manipulated and rotated by 40°–45°, displacing the fovea to its new position. For a choroidal patch graft, approximately 200°–240° of retinotomy would suffice. Currently, the evidence is insufficient to justify the role of macular translocation in the management of CNVM, given the complex surgical technique and associated risk of complications.[24,61]

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2.8. Inner wall retinectomy in retinoschisis-associated RD

Limited inner wall retinectomy has been used as an adjunct for managing schisis detachment in retinoschisis. The separation of the posterior hyaloid from the inner leaflet of the schisis cavity is near impossible owing to the strong vitreous adhesion with the thin inner wall. Limited removal of the inner wall followed by low-intensity laser photocoagulation to the retinectomy and outer wall break is a technique described to achieve retinal attachment.[47,100]

2.9. Intraretinal/subretinal mass

Retinectomy is utilized in the endoresection of intraretinal and subretinal mass lesions. It is described in cases of retinal capillary hemangioma, vasoproliferative tumors, and uveal melanomas (Video 8).[109]

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2.10. Retinectomy for management of intractable glaucoma

Hypotony following retinectomy is caused by an increase in fluid absorption through the large, exposed area of bare RPE. Joussen and coworkers demonstrated the efficacy of intraocular pressure lowering using retinectomy, performed to manage intractable glaucoma, in 44 eyes.[48] Retinectomy is not indicated in routine clinical practice for intraocular pressure lowering because of the high risk of complications and the availability of less invasive alternatives, such as cyclophotocoagulation. Moreover, the mechanism of hypotony after retinectomy is questionable. Anterior PVR caused by a residual anterior flap of retinectomy may form epiciliary membranes, which result in traction on the pars plicata. Additionally, ciliary body inflammation and edema occur secondary to anterior PVR and subsequently ciliary body detachment. Blood-aqueous barrier breakdown, aqueous hyposecretion, and hypotony occur due to these mechanisms.[63,66] A study on risk factors for intraocular pressure fluctuations following complex RD repair found that eyes with CMV retinitis had lower rates of postoperative hypotony. Necrotic retina with a lower risk of anterior PVR contributed to less intraocular pressure fluctuation compared to non-CMV retinitis eyes. This further emphasizes the role of anterior PVR in the pathogenesis of chronic hypotony.[38]

2.11. Optic disc pit maculopathy

Surgical techniques commonly described in the management of optic disc pit maculopathy include vitrectomy with gas tamponade, additional juxtapapillary laser, and ILM peeling with or without plugging of the disc pit with the flap.[5,6,82,87] Other options described include plugging the optic disc pit with a human amniotic membrane, autologous scleral patch graft, and fibrin glue.[90,93,97] Partial thickness inner retinotomy radial to the optic pit has also been described to facilitate the egress of fluid into the vitreous cavity, achieving long-term resolution of optic disc pit maculopathy. Ooto and coworkers performed PPV with inner retinal fenestration in 18 eyes. Postoperatively, complete resolution of fluid (over a period of 6 $\pm$ 3.9 months) was found to occur in 17 eyes (94%), with 3-line improvement of visual acuity noted in 61%[78,107]; however, PPV with induction of posterior vitreous detachment remains the most important steps that result in relief of vitreous traction. PPV plus posterior vitreous detachment in isolation has been reported to result in fluid resolution with improvement in visual acuity in 88% of cases in a series of 8 eyes by Hirakata and coworkers.[37]

2.12. Arcuate retinotomy for macular hole

Relaxing retinotomy has been described to achieve the closure of recurrent and large macular holes. The arcuate relaxing retinotomy is proposed to relieve tangential traction, resulting in hole closure.[15,51-53] Tsipursky and coworkers studied outcomes of relaxing parafoveal nasal retinotomy for persistent or recurrent macular holes. Of the 13 cases included, anatomical closure was achieved in 92.3%, with statistically significant improvement in overall visual acuity.[102]

2.13. Autologous retinal graft for macular hole

Anatomical and functional success has been demonstrated in closing large refractory macular holes using autologous retinal grafts. Harvest sites for neurosensory grafts are selected in the mid-periphery and usually in the superior quadrant. A circular area of two-disc diameters (or a customized graft size based on the size of the macular hole) is marked with the endolaser. Endodiathermy is applied around the proposed graft site, and vessels are cauterized. A localized retinectomy is done using the bimanual technique with forceps and curved or vertical scissors, and the graft is carefully positioned over the macular hole. The maneuvers can be performed under PFCL to ensure greater stability. Postoperative medium-term PFCL tamponade, gas, and silicone oil tamponade are viable options.[31]

A multicenter retrospective series in which autologous retinal transplantation was done in 130 cases showed closure rates of 89% for macular holes and 95% in the case of macular hole-rhegmatogenous RD with significant improvement in visual acuity. Dislocation of the graft was found to occur in 3.8% of cases.[73]

3. Surgical techniques

3.1. *Drainage retinotomy*

Posterior drainage retinotomy is indicated when there is difficulty in accessing the primary break for SRF drainage. Bipolar diathermy is utilized in making the drainage retinotomy. The retinotomy is made along the direction of retinal nerve fibers to minimize visual field defects. Bourke and coworkers studied the perimetric effects of retinotomy and found that retinotomy within five disc diameters of fixation was associated with significant visual field defects. Retinotomies located more posteriorly had a greater extent of central 30° field loss. Retinotomies located in the superonasal quadrant were found to reduce the inferotemporal visual field area to half vis-à-vis a superotemporal retinotomy. The preferred site of retinotomy is the superotemporal quadrant, made at least five disc diameters from fixation, avoiding the macula and large retinal vessels.[12] Fluid–air exchange is performed by aspirating the fluid using a soft-tip flute needle. It is performed through the drainage retinotomy and over the disc several times to ensure complete fluid removal. Placing the retinotomy in the most dependent position and tilting the eye to ensure that the fluid accumulates near the retinotomy site will enhance SRF drainage. The drainage retinotomy is subsequently treated with a single encircling row of laser burns.[1,14]

4. Relaxing retinotomies and retinectomies

4.1. *General principles*

Circumferential relaxing retinectomy is often indicated in the management of PVR. It is effective in relieving anteroposterior retinal shortening. Radial retinotomy has the potential to relieve intrinsic circumferential retinal shortening associated with advanced PVR (Video 9).[64] Circumferential retinectomies are preferred over radial because radial retinectomies might extend posteriorly, compromising visual function.

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5. Technique

5.1. *Membrane peeling*

Complete removal of all epiretinal and subretinal membranes causes significant traction, which is essential prior to retinectomy.[1,60] Inadequate membrane dissection can lead to persistent traction and results in redetachment, warranting subsequent larger retinectomies. Any residual epiretinal proliferation or membranes not amenable to peeling should be anterior to the site of retinectomy. After the complete removal of epiretinal membranes, subretinal proliferations should be meticulously examined at the site with persistent retinal traction. If subretinal proliferations are causing significant traction, a retinotomy should be performed to grasp and retrieve the membrane into the vitreous cavity using forceps. Alternatively, certain subretinal membranes may be transected through the retinotomy, effectively relieving the traction.[76,96] A novel transscleral approach using a posteriorly placed fourth 25-G valved cannula has also been described for the access and removal of subretinal bands.[92]

6. Steps of retinectomy

Peripheral large retinectomies are preferred over smaller posterior retinectomies, which hampers functional vision. Circumferential retinectomies are generally made parallel to the ora serrata. Diathermy is applied over the retina to be cut. Bleeders are cauterized to ensure hemostasis during the procedure. Scissors were originally used for the controlled cutting required in retinotomies; however, the procedure is time-consuming. With the advent of smaller gauge instrumentation, vitreous cutters are utilized to achieve precise retinectomies.[1,14,57,60]

Smaller and inadequate retinectomies are ineffective, and the resultant residual traction increases the risk of postoperative redetachment.[57] The retinectomy should extend beyond the area of contraction to the normal retina on either side and posteriorly. In the case of large retinectomies, up to a 30° extension into the normal retina at the ends may be indicated. PFCL may be utilized as a ‘third hand’ to stabilize the posterior retina during retinectomy. Special care should be taken to avoid filling the eye with PFCL till the area of traction of the open retinal break to avoid the subretinal leak of PFCL.

In the case of partial circumferential retinectomy, the ends of the retinotomy should be extended to join the ora serrata in an oblique direction, creating an acute angle at the edges. This relieves the residual traction and prevents lifting of the edge of the retinectomy that would otherwise occur with time. In the case of retinectomy, extending over 270° is ineffective as the residual uncut retina may undergo progressive contraction with time and might be similar to extending the retinectomy the complete 360°.

7. Postprocedural review

After the completion of retinectomy, a thorough examination for any residual traction is mandatory. Charles S has described the technique of incremental retinectomy under air, which has a higher surface tension.[14] The infusion cannula is connected to air, and SRF is aspirated from the edges of the retinectomy. Any air that passes subretinally during the “reattachment experiment” indicates residual traction that needs to be addressed with either membrane peeling or further retinectomy (Video 10).

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The residual avascular, nonfunctional anterior retinectomy flap is completely excised. The anterior flap is a potent source of ischemia and VEGF.[12] The anterior flap is a nidus for PVR formation when retained with subsequent development of epiciliary membranes that lead to aqueous hyposecretion and hypotony.

After completion of retinectomy, the retina is reattached using PFCL. Endolaser is applied to the edges of the retinectomy. Then, PFCL-air exchange, followed by air-silicone oil exchange or direct PFCL-silicone oil exchange, is done.

8. Modifications of technique

8.1. *Relaxing radial and combined retinectomies*

These are rarely used as they have a higher potential for compromising vision. Radial retinectomies should be made anterior to the major arcades and at least 3-disc diameters from the center of the optic disc and fovea centralis to preserve visual function by avoiding the posterior pole with maximum photoreceptor density. Membrane dissection of a thick circumferential proliferation near the vitreous base may be unfeasible. A radial retinectomy across the circumferential traction might induce relaxation and flattening of the retina.[29] A combination of circumferential and radial retinectomies has been described to tackle intrinsic circumferential shortening in the advanced stage of PVR by Lim and coworkers.[64]

9. Results (Table 2)

9.1. *Anatomical and functional outcomes*

With the advent of better surgical instrumentation and techniques, outcomes of retinectomies have significantly improved. The final anatomical success rates after retinotomies and retinectomies in recently published large studies range between 72% and 96% (Table 2). The final visual outcome (≥20/400) ranges between 27% and 60% in a large published series.[21,32,64,70,86,103]

9.2. *Factors affecting final outcomes*

Many factors influence the final outcomes. Han and coworkers found that preoperative vision ≥ hand motions and the extent of retinectomy confined to 4 superior clock hours of the fundus were associated with better functional outcomes.[35]

Grigoropoulos and coworkers, in their large retrospective series, found that preoperative visual acuity, duration of postoperative silicone oil tamponade, timing of silicone oil removal, and size of retinectomy impacted final functional outcomes. Therefore, less advanced PVR was associated with better outcomes. Hypotony and recurrent PVR formation were important factors for determining final anatomical failure.[32] Hocaoglu and coworkers corroborated the need for timely intervention with retinectomy at an earlier stage of PVR (PVR grade C, limited to one quadrant).[42] Preoperative vision, the number of previous surgeries, and the need for extensive retinectomy/retinotomy significantly predicted poorer visual outcomes. De Silva and coworkers reported a

Table 2 – Comparison of Major Published Series

Study	Number of Eyes	Type of Intervention	Final Anatomical Success (%)	Functional Success (%)	Hypotony (%)
Han et al, 1990[35]	54	Predominantly circumferential retinotomy, radial and combined in select cases	64	> 5/200 in 26%	14.81
Iverson et al, 1990[46]	40	Circumferential retinotomy	52	≥3/200 in 68%, 37% > 20/400	17.5
Tseng et al, 2005[101]	81	Circumferential retinectomy of varying extent + encircling band	80	≥5/200 in 73%	
Quiram et al, 2006[86]	56	Inferior retinectomy 180°	93	≥20/400 in 27%	3.22
De Silva et al, 2008[21]	145	Circumferential retinectomy of varying extent	68	≥20/60 in 16%, < 20/60–20/400 in 33%	7.6
Grigoropoulos et al, 2006[32]	304	Circumferential retinectomy of varying extent	72	≥20/200 in 27%	16.8
Tsui et al, 2009[103]	41	Circumferential retinectomy > 180°	90	≥20/200 in 59%	22
Lim et al, 2009[64]	30	Combined radial retinotomy and circumferential retinectomy	90	≥20/400 in 26.7%	6.7
Tan et al, 2010[98]	123	Circumferential retinectomy of varying extent	95.9	≥CF in 82.9%	4.1
Shalaby et al, 2010[94]	38	Circumferential retinectomy of varying extent + encircling band	76.3	≥20/300 in 60.5%	13
Kolomeyer et al, 2011[54]	41	360° Circumferential retinectomy	83	≥5/200 in 24%	18
Dimitrios et al, 2020[23]	66	Circumferential retinectomy > 180°	80.3	≥20/200 in 33.33%	13.6
Hocaoglu et al, 2021[42]	126	Circumferential retinectomy of varying extent	94	≥20/200 in 80%	8

15% increase in the risk of final visual acuity ≤ 20/40 with a stepwise increase in PVR grade.[21] Prophylactic 360° endolaser before removing the silicone oil was associated with better final anatomic outcomes. Israilevich and coworkers showed that shorter time intervals between redetachment diagnosis and surgery in eyes with PVR requiring retinectomy were associated with better final visual outcomes.[45] These studies underscore the need for more aggressive approaches with retinectomy at an earlier stage of PVR to optimize outcomes.

9.3. *Hypotony after retinectomy*

Hypotony is an important complication after retinectomy that significantly impacts the final outcomes. The rates of hypotony in large published series are between 3% and 22% (Table 2). The proposed mechanism for the occurrence of hypotony is increased fluid absorption through the exposed bare area of RPE. Moreover, the retained anterior flap can cause recurrent PVR by forming epiciliary membranes that exert traction on the ciliary processes and can lead to ciliary body detachment, resulting in hypotony. Kolomeyer and coworkers in their series of 41 eyes with 360° retinectomies for complex RD reported postoperative hypotony in 17% (7 eyes). Silicone oil tamponade was utilized in all cases, and they believed that it may reduce the occurrence of postoperative hypotony and phthisis.[54] Grigoropoulos and coworkers found a significant association between hypotony and silicone oil removal in their retrospective series of 302 cases, however, not the extent of retinectomy. Patients that underwent oil removal were cases that had a lower chance of developing hypotony. (Odds ratio: 0.23 [C1 0.1, 0.53] and $p = 0.001$.)[32] Hocaoglu and coworkers, in their series of 42 eyes with anterior grade C PVR, reported chronic hypotony in 8% of eyes. Silicone oil tamponade was used. The authors concluded, however, that meticulous surgical techniques with dissection of the anterior retinal flap are more likely to lower rates of postoperative hypotony. The effect of oil tamponade is transient and cannot overcome chronic damage to the ciliary body in the setting of long-standing PVR.[42]

9.4. *Combined lensectomy with retinectomy*

Lensectomy or phacoemulsification with posterior chamber intraocular lens may be warranted in managing cases with anterior PVR to allow for better access. Quiram and coworkers achieved an anatomical success rate of 93% in eyes with complex RDs. In the study, advanced PVR was managed with inferior retinectomy by performing combined lensectomy, meticulous anterior vitreous base dissection, and silicone oil tamponade.[86]

9.5. *Role of buckling*

Lai and coworkers compared a combination of vitrectomy and scleral buckle with vitrectomy alone for the management of rhegmatogenous RD with grade C PVR. They found no significant difference in the outcomes between the two groups.[59] The EVRS RD study group found no additional benefits with supplemental buckle in the management of PVR grade B and C1.[3] Abu Eleinen and coworkers compared a combination of PPV and scleral buckling with PPV and inferior retinectomy in 51 eyes with primary rhegmatogenous RD with inferior breaks and PVR.[2] Although initial visual acuity was better in the buckle group, during the longer follow-up, the functional outcomes became similar. Anatomical success rates were also comparable between the two groups. Deaner and coworkers achieved good anatomical success rates with PPV, retinectomy, and silicone oil tamponade without scleral buckling for the management of recurrent RDs secondary to PVR.[22] Adjuvant buckling seems to play a limited role in eyes with advanced PVR, which is managed effectively with vitrectomy and retinectomy.

9.6. *Choice of tamponade*

The Silicone Study Report 5 reported that, among patients with severe PVR, relaxing retinotomy was warranted in eyes that had undergone previous vitrectomy and not had retinectomy in the primary surgery. Among the eyes that underwent retinotomy, silicone oil tamponade was associated with a lower incidence of postoperative hypotony. Long-term outcomes showed a trend towards better functional outcomes in gas-filled eyes.[10] Silicone oil tamponade following retinectomy was preferred in a majority of the large case series.[28,42,43,52,64] Dimitrios and coworkers compared the outcomes of perfluoropropane gas and silicone oil tamponades in eyes that underwent large retinectomies for advanced PVR.[23] The anatomical success rates and occurrence of complications were similar in both groups. Eyes with gas tamponade showed a marginally better final visual acuity. This study was not randomized; therefore, baseline differences might have impacted the choice of tamponade and final results. The medium-term PFCL tamponade (2–3 weeks) shows good anatomical outcomes. Therefore, it is a viable option in the eyes with inferior RDs with advanced PVR, requiring retinectomies.[9,95]

9.6.1. *Prophylactic pharmacology of PVR*

Extensive research has been done on agents that could potentially prevent PVR formation, the details of which are beyond the scope of this review. Pharmacological agents studied for their role in prophylaxis against PVR have been broadly classified into anti-inflammatory agents, such as corticosteroids, antiproliferative (5-fluorouracil, methotrexate, daunorubicin, colchicine, taxol, retinoic acid, and ribozymes), antigrowth factor pathway inhibitors (tyrosine kinase inhibitors, TGF-β inhibitors, PDGF-R kinase inhibitors, mitomycin-C, decorin, and fasudil), antioxidants (N-acetylcysteine and polyphenolic agents), and statins. At present, there is a need for further prospective randomized control trials in human participants to evaluate and demonstrate the efficacy of agents that could halt the development and progression of PVR.[20,58,108]

10. Complications

10.1. *Intraoperative complications*

10.1.1. *Hemorrhage*

Adequate hemostasis with the application of diathermy to the area of retinectomy before cutting is essential to prevent significant bleeding. In the event of hemorrhage, temporarily raising the infusion bottle and cauterizing the bleeder is recommended to avoid further intraoperative bleeding. Postoperatively, hemorrhage under silicone oil results in recurrent fibrous proliferation and submacular blood that compromise visual outcomes. In the presence of shallow anterior detachment, the choroid might be damaged during instrumentation, resulting in choroidal hemorrhage.[1]

10.1.2. *Subretinal PFCL*

Subretinal passage of PFCL may occur in the presence of large peripheral retinectomies.[27] Long-standing PVR with the inadequate release of vitreoretinal traction can result in subretinal passage of PFCL. Subretinal PFCL may also result from the fish-eggs phenomenon caused by an inappropriate injection of PFCL, with the eye filled to the level of retinal break. Further membrane dissection or retinectomy is warranted to release the residual traction prior to subsequent retinal flattening under PFCL.

10.2. *Postoperative complications*

10.2.1. *Hypotony*

Hypotony occurring after retinectomy has been discussed in the section on outcomes.

10.2.2. *Anterior retinal neovascularization*

The avascular retained anterior retinal flap is a source of ischemia with VEGF formation. The incomplete removal of the anterior retinal flap leads to an increased risk of anterior retinal neovascularization and late postoperative hemorrhage.[11]

10.2.3. *Recurrent PVR and redetachment*

Beuste and coworkers described in detail the mechanisms resulting in recurrent RD after retinectomy for complex RD. Posterior and anterior PVR or a combination of the two were the main factors resulting in recurrence. Detachment of the posterior retina might occur in the setting of extensive macular pucker formation. Fibrosis and bridging of the edges of the retinectomy are other causes of recurrent detachment.[8] Gupta and coworkers proposed the “severe inferior retinal folding” mechanism for detachment. The mechanism involved the upward scrolling of the inferior retina secondary to severe postoperative fibrosis.[34]

10.2.4. *Macular abnormalities*

Postoperative formation of focal PVR and CNVM has been described from the drainage retinotomy site, particularly in those made superior to the macula.[72,88] The formation of an epiretinal membrane and macular puckering limit visual recovery after retinectomies. Odrobina and coworkers recommended the complete removal of epiretinal membranes with prophylactic ILM peeling in retinectomies for PVR to reduce the occurrence of postoperative macular puckering.[77] The formation of macular folds and inadvertent macular translocation are other complications that hamper final visual outcomes.[7,80] Grassi and coworkers found that functional outcomes following retinectomy were influenced by central foveal thickness, with only 3% of cases showing normal macular profile on optical coherence tomography at the final follow-up.[30]

10.2.5. *Visual field loss*

Smaller posterior retinectomies cause larger visual field defects compared to larger peripheral retinectomies, which are preferred. Avoiding extension of the retinectomies close to the optic disc or macula is recommended to avoid dense scotomas.[12]

11. Conclusion

Retinotomies and retinectomies show utility in a wide array of indications. The timing and extent of retinectomy need judicious planning. Performing a retinectomy in the earlier stages of PVR is associated with better functional and visual outcomes. Hypotony, recurrent proliferation, and redetachment are chief causes of anatomic failure. Retinectomies are an important tool in the armamentarium of a vitreoretinal surgeon, providing an option in the management of eyes that otherwise seem unsavable. Future studies could look at optimizing the quantum of retinectomy needed on a case-to-case basis.

12. Literature search

A literature review was conducted via Google Scholar and PubMed, followed by a review of the references procured. The words and combinations used for the review included retinectomies, retinotomies, relaxing retinectomy, drainage retinotomy, and PVR. Non-English literature was excluded from the search. A total of 60 relevant abstracts were collated. Abstracts and relevant papers were reviewed in detail. The largest series was summarized in a brief table. All relevant literature has been studied in detail and summarized in the study.

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Declaration of Competing Interest

Hung-Da Chou is a consultant for Novartis, Bayer, AbbVie, and Viatris. Sengul Ozdek is a consultant for Roche, Bayer, Novartis, and AbbVie. Andrew Chang is a consultant for Alcon, Novartis, Bayer, Hoffman La Roche, Apellis, and Allergan. Paisan Ruamviboonsuk is a consultant for Roche and Bayer. Rest of the authors report no disclosures.

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