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An Overview on Surgical management of Tractional Retinal Detachment

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Abstract:

Tractional retinal detachment (TRD) is a serious ophthalmic condition characterized by the separation of the neurosensory retina from the underlying retinal pigment epithelium due to vitreoretinal traction, often caused by fibrovascular proliferations. It is most commonly associated with proliferative diabetic retinopathy (PDR), retinopathy of prematurity, sickle cell retinopathy, and ocular trauma. The primary goal of surgical intervention in TRD is to relieve the pathological traction and reattach the retina to restore or preserve visual function. Pars plana vitrectomy (PPV) is the standard surgical approach for managing TRD. This procedure involves the removal of the vitreous gel and fibrovascular membranes, allowing the retina to relax and reattach. The surgery may also include membranectomy, endolaser photocoagulation, and the use of tamponade agents such as gas (SF6 or C3F8) or silicone oil, depending on the complexity of the detachment and the risk of reproliferation. Advances in microsurgical techniques and instrumentation, such as small-gauge vitrectomy (25- or 27-gauge systems), wide-angle viewing systems, and intraoperative optical coherence tomography (OCT), have significantly improved the safety and anatomical success rates of TRD repair. Despite these advancements, visual outcomes remain variable and are often limited by the chronicity of the detachment, macular involvement, and the presence of ischemia or neovascular complications. Early diagnosis and timely surgical intervention are critical in improving prognostic outcomes, particularly in diabetic patients where TRD is a common and vision-threatening complication.

Keywords: Tractional Retinal Detachment, PDR, DR.

Introduction:

Tractional retinal detachment (TRD) is a vision-threatening condition characterized by the separation of the neurosensory retina from the retinal pigment epithelium due to vitreoretinal traction, commonly caused by fibrovascular proliferation in diseases such as proliferative diabetic retinopathy (PDR) (1). The pathophysiology involves contraction of epiretinal membranes, leading to progressive traction and detachment, often without retinal breaks.

The mainstay of treatment for TRD is pars plana vitrectomy (PPV), which allows for the removal of vitreous and fibrovascular tissue, membrane dissection, and retinal reattachment. Adjunctive procedures such as panretinal photocoagulation, tamponade with gas or silicone oil, and internal limiting membrane (ILM) peeling may be employed depending on case complexity (2). Technological advancements, including small-gauge vitrectomy systems and wide-angle viewing platforms, have significantly improved anatomical success rates and reduced surgical morbidity.

Despite these surgical innovations, visual recovery remains variable and is largely dependent on preoperative factors such as macular involvement, the chronicity of detachment, and the extent of retinal ischemia (3). Therefore, early diagnosis and timely surgical intervention are crucial for preserving vision and preventing irreversible retinal damage.

Surgical Indications

The indications for surgical management of the late complications of PDR have steadily evolved since the DRVS reports (4). The primary goals of vitrectomy for DR include eliminating any media opacities, alleviating any anteroposterior or tangential traction, reducing the vascular endothelial growth factor (VEGF) load within the vitreous cavity, enhancing oxygen supply to the retinal tissue, and impeding the further progression of PDR (5).

[I] Nonresolving Vitreous Hemorrhage(NRVH)

VH can arise from either the anteroposterior force exerted by the posterior cortical vitreous or the tangential force exerted by the ERM or ILM on the angiogenetic vessels. NRVH is defined by Diabetic Retinopathy Vitrectomy Study (DRVS) as VH that reduced visual acuity to less than 5/200 on two visits at least 1 month apart (6). DRVS concluded that early vitrectomy (1–6 months) was beneficial as compared to delayed vitrectomy (>1 year) in type 1 DM but not in type 2 DM (7). While the eventual visual outcome did not change between early and delayed vitrectomy in type 2 DM, patients with type 2 DM still had to deal with poor vision for 1 year. In today's MIVS era, the DRVS recommendations are obsolete. With better instrumentation and small gauge vitrectomy, the general recommendation is to operate after 4–6 weeks of onset of hemorrhage irrespective of the type of diabetes, especially if the eye is not pretreated for PDR (6).

Persistent or recurrent vitreous haemorrhage remains a common indication for surgery with flexible criteria generally being applied now regarding the decision and timing of vitrectomy surgery (8).

Various factors should be considered including the degree of visual impairment (with consideration of the visual status of the fellow eye), predicted time course for spontaneous resolution, predicted risk of developing further vitreous hemorrhages, adequacy of previous laser treatment to control retinal ischemia, presence of underlying tractional retinal detachment involving or threatening the macula, and presence of untreated diabetic maculopathy. It is particularly important not to underestimate the impact of unpredictable visual impairment experienced by patients with frequent recurrent vitreous hemorrhages (8).

In performing the surgery, surgeon's individual expertise, the condition of the other eye, past retinal laser treatment, the likelihood of VH recurrence, and overall management of glycemic levels should be considered. Cases of nonclearing VH with complete separation of the posterior hyaloid are not very common. Patients with simple nonclearing VH, especially in old age, usually have PVD or minor vitreo-retinal (VR) attachment . Removing the vitreous can greatly improve vision in most eyes. Retinal laser treatment before vitrectomy surgery can significantly increase the chances of a successful procedure by decreasing retinopathy activity and addressing retinal ischemia. In addition, RD may be prevented if breaks are induced during surgery within the area of the laser scar. Sometimes, VH can be associated with more severe proliferative retinal disease, such as a macula-involved TRD. In this situation, surgery is more difficult, and the final visual outcome will be impacted by the presence of TRD. Utilizing a preoperative B scan ultrasound is imperative for identifying VR adhesion and TRD. Vitrectomy is usually considered for patients with dense or recurrent VH (9).

The importance of early vitrectomy was emphasized, particularly for type 1 diabetics with more advanced diseases; the advantages of the surgery were sustained for up to 4 years (9). the study was done at a time when vitreoretinal specialists didn't have access to the latest technological advancements, and intravitreal anti-VEGFs were not available at that time. The surgical indication for nonclearing VH has become less stringent. Patients with diabetic VH, but no retinal detachment should be closely observed for at least 4 weeks. If there is no improvement in visual acuity or symptoms, and the vitreous does not clear up, then a vitrectomy is necessary to restore vision (10). Unlike the effect on progressive FVP, there is limited evidence to support the use of anti-VEGFs as an adjuvant therapy before diabetic vitrectomy in cases of VH.

[II] Tractional Retinal Detachment Threatening the Macula

A TRD that has recently involved the macula continues to be the most common indication for vitrectomy (6). TRD is a major indication for vitrectomy in diabetic patients (11, 12). It is characterized by FVP-induced RD with a rigid, concave-shaped configuration that does not move and has no breaks. In DR, the detachment of the retina is due to the gradual contraction of abnormal fibrovascular tissue that pulls the neurosensory retina away from the retinal pigment epithelium. When the macula is involved, a significant reduction in vision clarity results (9).

Eyes with TRD may be associated with a rhegmatogenous component to become a combined rhegmatogenous and tractional RD (CRTRD). Retinal breaks are usually located adjacent to FVP patches in the thin, ischemic retina. In CRTRD, patients experience a quick and severe decline in their vision, and it is crucial to undergo an early pars plana vitrectomy (PPV) (13, 14). It is important to closely monitor the fundus to ensure proper detection of RD progression.

To determine the potential and extent of macula and fovea involvement, it is advisable to undergo OCT. Furthermore, it would be beneficial to investigate the presence of epiretinal membranes (ERMs) and their impact on prognosis (9).

The timing for vitrectomy depends on whether the fovea is involved. If the fovea is detached, it is important to perform a PPV as soon as possible to prevent serious and permanent vision loss . However, if there's nonprogressive localized TRD without fovea involvement, monitoring the situation closely without vitrectomy may be an option (14, 15). On the other hand, it is imperative to undergo a vitrectomy as soon as possible if afflicted with a combined TRD and RRD. This condition has the potential to exacerbate rapidly and culminate in proliferative vitreoretinopathy (16-18). Prompt surgical intervention is indicated for a recent macular detachment, whereas surgery is not routinely performed for a peripheral RD or a chronic macular RD. Older studies showed that chronic TRDs had worse visual outcomes than acute macula-involving TRDs (19). Patients with a macula-involving TRD usually experience rapid loss of vision when the photoreceptors are pulled away from the RPE. In early surgical series, TRD constituted 20% of diabetic vitrectomies (20) but this proportion has risen to 40% in more recent studies (21). In eyes with chronic macular detachments, the retina is frequently atrophic and the fibrous membranes are often strongly adherent. Detachments of >6 months duration may be accompanied by photoreceptor degeneration, which often prevents return of useful vision (22).

It is important, however, to note that extramacular tractional retinal detachments can generally be safely observed as they tend to remain stable over prolonged periods of time (8). Laser photocoagulation as a treatment for small extrafoveal TRD is a viable option as it can remain stable for years, eliminating the5 need for vitrectomy. It is important to be careful when performing laser photocoagulation or intravitreal anti-VEGF injections, as they may result in changes to preexisting fibrovascular tissue that could quickly worsen retinal tractions and lead to retinal detachment(Crunch syndrome) (6).

[III] Progressive Fibrovascular Proliferation and Anterior Hyaloid Fibrovascular Proliferation

PFP is a major contributor to recurring or persistent VHs, vitreoretinal tractions affecting the macula and disc, recurrent DME, ERMs, macular holes, and TRD in cases of PDR (23). PFP may develop on the outer edges of the retina, leading to the growth of lesions from the sclerotomy sites. This was particularly prevalent during the period of large sclerotomies when using 20G vitrectomy system. Anterior hyaloid fibrovascular proliferation (AHFVP) is a condition that occurs due to the persistence of peripheral vitreous after surgery and untreated ischemia in the peripheral region. The occurrence of this issue is a well-known possibility that may arise from delayed vitreous cavity hemorrhage after diabetic vitrectomy. Furthermore, it has been noted in diabetic patients with poor control after undergoing cataract surgery. Delayed vitreous cavity hemorrhage affects 10%–20% of patients after surgery, occurring 3 or more months later (24). The primary causes are residual fibrovascular membranes, reproliferative neovascularization of the retina, and neovascularization at the site of sclerotomy (fibrovascular ingrowth) (25). An enlarged episcleral vein can indicate AHFVP. Ultrasound biomicroscopy can confirm diagnosis. An effective preventive strategy is to perform laser photocoagulation to eliminate any postoperative neovascular stimulus, especially if the existing pan-retinal photocoagulation is inadequate, which includes treating the peripheral retina. Cryotherapy is a highly recommended method for treating the peripheral retina and sclerotomy entry points (26). Delayed vitreous cavity hemorrhages can be a significant problem for some patients, and may require further vitreous lavage if they fail to clear spontaneously. Treatment involves vitreous cavity lavage, fine dissection of fibrovascular membranes, and additional laser photocoagulation and cryotherapy to entry sites of sclerotomy (27). Occasionally, silicone oil tamponade may be necessary to ensure clear media.

Severe fibrovascular proliferation is a less common indication for vitrectomy surgery comprising macular distortion or dragging, tractional macular oedema, and media opacity due to fibrovascular tissue. The indications for vitrectomy surgery for this group of patients have also steadily evolved with increasing clinical experience since the era of the DRVS study (8).

[IV] Diabetic Macular Edema with or without Vitreomacular Traction

The leading cause of vision loss in DR is DME. Currently, the most effective treatment for DME affecting the central area is the use of intravitreal anti-VEGF therapy, which is considered the gold standard (28, 29). However, VMT and ERM can be present in eyes with DME and may potentially restrict the visual advantages of anti-VEGF therapy. For patients with DME associated with OCT-evident VMT and ERM, vitreoretinal surgery with membrane removal is strongly recommended. In certain cases of diffuse DME without VMT, laser treatment or medication with intravitreal anti-VEGF agents and corticosteroids may be ineffective. In such cases, vitrectomy with or without internal limiting membrane (ILM) peeling could be beneficial as it has the potential to increase oxygen flow to the retina and improve nutrient diffusion between the vitreous and retina (9). For cases of DME with massive hard exudate, vitrectomy with ILM peeling may facilitate the resolution of hard exudate and edema.

[V] Macular Tractional Retinoschisis

Tractional retinoschisis is characterized by fibrous proliferation, indicating a more chronic process than TRD. Bridging columnar tissue is visible on OCT between the outer and inner layers, with the inner layers appearing reflective and the outer layers less so (30). A study by Faulborn and Ardjomand found that the posterior hyaloid membrane adhering to the retina and vitreous body shrinkage could cause retinal elevation and splitting of the outer plexiform layer, leading to retinoschisis (31). Preoperative intravitreal injections of anti-VEGFs may not be necessary since schisis cases predominantly have fibrous tissue rather than active FVP (32). When manipulating a chronically elevated retina, it is imperative to use careful scissor delamination to reduce traction and prevent tissue avulsion and retinal vascular injuries. The retina often has more fibrous tissue than proliferation.

Vitrectomy with careful membrane removal usually yields good results, with complete resolution in 60% of cases (33).

[VI] Neovascular and Ghost Cell Glaucoma with Acute Vitreous Hemorrghes

The ischemic component of DR causes the development of new blood vessels in the posterior segment of the eye, as well as in the iris and the anterior chamber angle, ultimately leading to the onset of neovascular glaucoma (NVG). This issue is commonly seen in eyes that have had cataract surgery or have an artificial lens and have a defect in the posterior lens capsule. To manage intraocular pressure effectively, anti-glaucoma agents must be administered either topically or orally. The primary objective for treating these patients is to eliminate the ischaemic retina areas to reduce the release of pro-angiogenic factors. To achieve this goal typically requires intravitreal anti-VEGF, pan-retinal photocoagulation, and anterior retinal cryotherapy. It is strongly advised that individuals with a dense VH in conjunction with anti-VEGF injections proceed with a vitrectomy. Individuals with persistent VH are at risk of developing ghost cell glaucoma. This is because red blood cells can break down and form inflexible ghost cells that block the trabecular meshwork, leading to a significant increase in intraocular pressure. Early vitrectomy is necessary to remove ghost cells from ghost-cell glaucoma (34).

The primary goals of vitrectomy are to clear medial opacities and stabilize the proliferative process (35).

Vitrectomy is also thought to increase retinal blood flow by decreasing the resistive index [resistive index = (systolic red blood cell velocity − diastolic red blood cell velocity)/systolic red blood cell velocity] (36). The primary indications for diabetic vitrectomy were established in the 1980s and remain equally valid today (removal of non-clearing media opacities and relief of vitreoretinal traction) (37).

[VI]Macular Hole

The development of full-thickness macular holes in a TRD due to tangential traction by the posterior vitreous and ILM complex is a rare occurrence (38, 39). However, it is important to note that fibrovascular contraction post bevacizumab can worsen the condition. The incidence of macular holes in TRD is 1% in the absence of anti-VEGF treatment (38). In contrast to idiopathic macular holes, these holes have a larger detached area surrounding the hole instead of just a simple cuff. A broad or multiple focal vitreomacular adhesion near or at the edge of the hole may exist. Holes parallel to tractional forces may appear oval (40). TRDs with macular holes do not exhibit different outcomes compared to combined RRD/TRD with holes in nonmacular locations. When inducing a PVD, care must be taken to avoid excessive traction as it can potentially enlarge the hole (41). Holes can be closed by relieving tractional forces, and the TRD can be repaired without ILM peeling (42). However, ILM peeling may be necessary for complete membrane removal, especially if vitreoschisis is suspected (40). Real-time intraoperative OCT has been found to be useful in these cases (43). Tamponade must always be used, with identical outcomes between oil and gas, as well as between short or long-acting gas (41). Draining subretinal fluid through the macular hole is highly likely to cause damage to the sub-foveal RPE (38). It is important to keep in mind that even if the hole is successfully closed, the final visual acuity may not improve iatrogenic macular holes may occur while the removal of the membrane from the macula.

Surgical steps

The surgical objectives of a diabetic vitrectomy comprise: (1) removal of vitreous opacities, (2) dissection and excision of fibrovascular membranes with elimination of vitreoretinal traction, (3) retinal reattachment using intraocular tamponade, if necessary, and (4) prevention of reproliferative neovascularization by laser photocoagulation.

The precise surgical procedure required is highly variable because it is dependent upon the surgical anatomy presented by each individual case. In addition, a patient's general medical status requires consideration when planning vitrectomy surgery (including control of risk factors for diabetic retinopathy progression). The complexity of a diabetic vitrectomy is largely determined by the configuration of the vitreoretinal attachments. Minor complexity procedures comprise cases with vitreous haemorrhage and a complete posterior vitreous detachment, in which no fibrovascular membrane dissection is required. Medium complexity procedures comprise cases with focal vitreoretinal attachments (single or multiple) or broad vitreoretinal attachments without underlying retinal folds, in which there are multiple small neovascular pegs. Major complexity procedures generally comprise cases with broad vitreoretinal attachments with underlying retinal folds, in which the surgical plane is less clearly defined because of diffuse fibrovascular membrane attachment.

A variety of surgical techniques has been developed for dissection of diabetic fibrovascular membranes which broadly comprise segmentation, delamination, and en bloc delamination. It is also mportant to recognise the presence of vitreoschisis when identifying the correct surgical plane for delamination. A flexible approach is often required during vitrectomy surgery because several dissection techniques may be required in a single case. The creation of iatrogenic retinal breaks can, in particular, convert a 'simple' case into a much more complex procedure (8).

[I]Sclerotomies

In the trocar-cannula system, three sclerotomies are typically made around 3.5–4.00 mm from the limbus, depending on the lens status. The lower temporal quadrant is used for infusion, while the upper right is for active instrumentation like cutters or scissors, and the upper left is for endoilluminator. In certain cases, a chandelier light may require an extra opening in the sclera to allow for bimanual surgery (9). This opening can be located between the two upper sclerotomies or in the lower nasal quadrant, depending on the surgeon's preference and the area requiring complicated tissue dissection.

[II]Use of Chromo-assisted Vitrectomy

The use of intravitreal triamcinolone and dyes such as indocyanine green, trypan blue, brilliant blue G, membrane dual and brilliant peel can improve the visibility of cortical gel ERM and ILM (44). The decision to use chromo dissection during diabetic vitrectomy is up to the surgeon's discretion. However, if the vitrectomy is being done for VMT, staining the vitreous gel, ERM, and ILM can improve surgical precision in achieving the desired outcome (44).

[IV]Posterior Vitreous Detachment Induction and the Concept of Vitreoschisis

During diabetic vitrectomy, a total PVD is rarely seen. However, if it does occur, it is often incomplete and characterized by multiple-point attachments, primarily located in the posterior pole, and connected with FVP tissues. When approaching the arcades or optic nerve head, the attachment will become thicker and have more blood vessels. A multi-layered posterior hyaloid is not infrequently seen. The process of posterior vitreoschisis, which refers to the splitting of the posterior cortical gel, is a commonly observed occurrence in advanced PDR and has been extensively studied (45) and, probably, contributes to a second or more layers of posterior hyaloid with tangential or oblique traction. To ensure successful surgery, it is important for the surgeon to understand the presence and variability of multi-layered posterior hyaloid in the eye, which may range from the false cleavage point to the outer edge of the retina. This knowledge will aid in identifying and dissecting any nails or pegs using appropriate tools such as cutters or scissors (45). Dye-assistant peeling of ILM and ERM may facilitate the complete removal of the posterior hyaloid.

[V]Relief of Anteroposterior Traction

To relieve anteroposterior traction, certain surgeons opt to remove the anterior vitreous solely using an operating microscope, without the use of panoramic viewing systems. This approach enables the surgeon to prevent damage to the lens in phakic eyes. Next, the surgeon can use a panoramic viewing system to perform a vitrectomy in the vitreous cavity (46). Surgery for PDR faces major challenges due to the fibrovascular process that creates strong adhesions between the back of the eye and the retina, making it difficult to operate on the vitreous cavity. When it comes to diabetic eyes with fibrovascular proliferative membranes, it's rare to see a complete PVD. Instead, there are usually significant areas of adhesion between the posterior vitreous and retina. To ensure a successful vitrectomy procedure for patients with DR, it is crucial to first eliminate any anterior-posterior tractions present between the vitreous and the retina.

During the initial stages of surgery, the vitreous typically takes on either an open funnel shape with adhesion to the disc or a trampoline-like shape with additional points of adhesion to the retina. The surgeon can remove the vitreous body and associated VH without causing tractions on the retina or unnecessary bleeding by using a vitrector to cut traction in the middle of the vitreous chamber for 360 degrees. This will prevent iatrogenic retinal breaks. Thereafter, the surgeon can start to safely approach the more posterior aspects of the proliferative diabetic disease. It is important to identify the presence of posterior hyaloid schisis to achieve a thorough vitreous detachment. This can be done through using a bimanual technique with a cutter or scissors to remove the posterior hyaloid and shave proliferative membranes. It is imperative that you refrain from pulling with the probes, as this action carries a significant risk of iatrogenic retinal break (47).

[VI]Relief of Tangential Traction

One of the challenges in treating diabetic PPV is relieving tangential tractions. This can be achieved through a combination of surgical techniques such as segmentation, delamination, and en-bloc dissection, which are crucial steps.

1-Segmentation

The process involves cutting or severing a big sheet of fibrous tissue into smaller islands. Each island that remains connected to the retina through a few f ibrovascular adhesion points is then removed using curved scissors or a small-gauge cutter (48).

2-Delamination

Delamination is a process where the fibrous growth is completely separated from the retina by detaching all the vascular peduncles that are anchoring it (49). The dissection can start from either the periphery (outside-in) or from the disc side (inside-out) or a combination of both, based on the height of underlying TRD and the availability of the right cleavage (49). Membranes can be removed using a cutter in two ways. The first one is called a "conformal delamination" technique, where the tissue to be removed is fed directly into the cutter. The second one is called a "foldback delamination" technique, used for very thin tissues. In this technique, the cutter is placed on top of the membrane, which is then aspirated into the cutter's mouth (50).

3-En bloc Dissection

This involves removing a large sheet of fibrous tissue in one piece by cutting the adhesion points, using a bimanual approach. In the initial report of this technique, it was suggested to leave the anteroposterior traction on one side. This remaining traction held the lifted FVP membrane, facilitating tissue delamination from the outside-in (51). With the bimanual technique assisted with chandelier illumination, forceps are held in one hand and scissors in the other.

4-Lift and Shave Technique for Diabetic Tractional Retinal Detachment

Modern vitrectomy machines equipped with MIVS and valved trocars, IOP control, high cut rates, and optimized vitrectors have led to the development of new surgical techniques, such as the concept of all-probe vitrectomy (52). A technique called the lift and shave method can be used during surgery for proliferative DR. This method involves using only a vitrector probe from start to finish, without the need for additional instruments such as forceps or scissors. This procedure can be carried out using either a 27G or 25G setting, with a cutting rate of 5000–10,000 c/m and a vacuum controlled by a foot pedal at 400–650 mmHg. During dissection, the IOP in the vitrectomy machine is initially set at 25 mmHg but may be raised to 40–50 mmHg if bleeding occurs. Using a dual-linear foot pedal can be quite beneficial. First, the retina and ERM plane is located. Then, the vitrectomy probe is utilized to remove fibrous tissue through a combination of aspiration and blunt dissection. To remove the epiretinal tissue from the retina, the tissue is f irst lifted and then the pedal is shifted to cutting when resistance is felt. This process is repeated sequentially, resulting in a gradual shaving of the tissue from the surface of the retina. This technique is known as the lift-and-shave technique (52).

SURGICAL TIPS AND TRICKS

For cases with severe peripheral anterior-posterior traction and rhegmatogenous etiology, an adjuvant scleral buckle should be considered, especially in phakic patients. In select cases, additional internal limiting membrane (ILM) peeling can help release tangential retinal traction to flatten the posterior pole. Large retinotomies and retinectomies are reserved for very severe cases with extensive retinal contraction, especially those combined with proliferative vitreoretinopathy (PVR), where retinal flattening cannot be achieved by membrane peeling alone. In combined cases of tractional and rhegmatogenous detachment, perfluorocarbon liquids (PFCL) can aid in draining subretinal fluid through a peripheral retinotomy or break, stabilizing and flattening the retina. Care should be taken since PFCL can easily slip through existing posterior holes into the subretinal space; and in such cases fluid air exchange would be a better option. Cases with re-proliferation under silicone oil may benefit from additional membrane peeling under oil. This is a much safer approach nowadays with availability of valved cannulas, where oil can be added to keep the pressure up during bimanual dissection under oil.

Bimanual vitrectomy and Techniques

Precise sectioning and removal of fibro-vascular membranes is essential step which considered the most critical and challenging event that may be associated with severe complications (53). These complicated situations encountered intraoperatively can be better mastered using bimanual techniques than with conventional single-handed methods (53).

The use of the chandelier illumination system as the source of endo-illumination for bimanual vitrectomy is an essential part of modern minimal incision vitreoretinal surgery, as it can provide reliable fundus view including peripheral vitreous for bimanual surgery (54).The general concept of bimanual surgery is to decrease the unwanted pull and push-out forces of scissors and pics that are produced on the retina during dissection of the ERMs. It is used in difficult cases of diabetic TRD for the complete and safe removal of ERM as the surgeon can operate with two active hands and apply counteraction (55). (Fig. 1)

The surgeon can apply laser photocoagulation more easily with the use of chandelier and up to the ora serrata with the help of self- indentation, and compatible with the use of wide-angle viewing systems during vitreous surgery (56, 57). Another use of chandelier in diabetic retinal surgery, in providing retro-illumination during phacoemulsification because of insufficient red reflex caused by dense vitreous hemorrhage (53, 58).

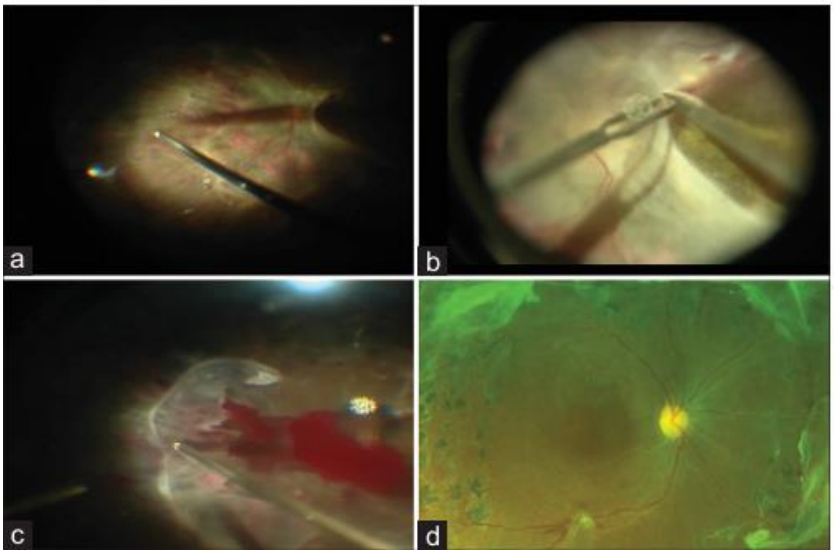

Figure (1): Combination of various steps of diabetic vitrectomy. Use of 25-gauge vitreous cutter to make an opening in the posterior hyaloid (a). Bimanual dissection of posterior fibrous membranes using 25-gauge curved scissors and forceps coupled with chandelier illumination (b). Segmentation of fibrous membranes employing a 25-Gauge Vitreous Cutter (c). Postoperative color photograph showing residual membranes in the periphery with an attached posterior pole (d) (6).

For tightly adherent fibrovascular membranes, bimanual techniques are often necessary to achieve tissue separation. This can best be accomplished by using chandelier lighting systems or illuminating instruments such as the lighted pick (59). Typical bimanual instruments used to dissect fibrovascular membranes include forceps and scissors. However, several combinations depending on the pathology at hand are available, such as forceps with vitrectomy probe, which can be more efficient in many cases. Diabetic dissection is mainly based on scissors use rather than peeling; however, peeling may be needed in combined tractional and rhegmatogenous components with PVR and in cases of premacular hemorrhage with tightly adherent hyaloid where a lighted pick combined with a vitrectomy probe presents the best combination (60).

Membrane delamination can be performed by a bimanual technique, which helps to achieve a more complete removal with fewer complications. The advantage of the bimanual technique is the ability to lift the membrane with one hand, visualize the fine connections to the retina, and dissect them with an instrument in the other hand thereby avoiding in advertent damage to retina. It also helps in identification of the appropriate surgical plane during membrane removal thereby increasing the ease and success of the dissection. An understanding of the process of posterior vitreous separation and posterior vitreoschisis facilitates the identification of the correct surgical plane (61).

The development of self-retaining endoillumination (chandelier) has revolutionized the safety and efficacy of bimanual surgery. The chandelier system pro vides widefield illumination with a low risk of macular phototoxicity because of the significant distance between the light source and the posterior pole (62).

Illuminated instruments and chandelier lighting permit bimanual techniques when needed and most recently, intraoperative OCT was introduced for live tomographic rendering of the vitreoretinal microarchitecture (60). (Fig. 2)

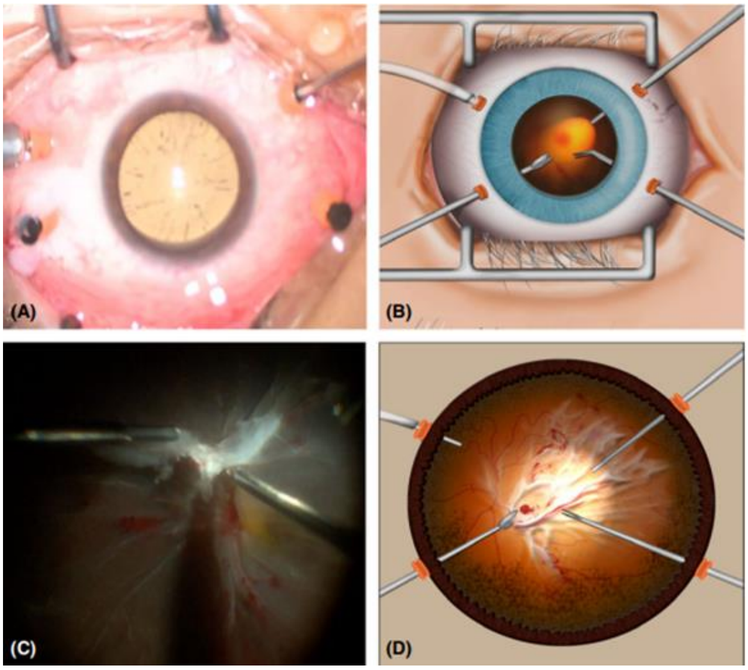

Figure 2: Intraoperative view of the four-Port 23-gauge transconjunctival sutureless vitrectomy (left eye). (A) Surgeon's view of the anterior segment (left eye). The fourth sclerotomy was made in the inferior nasal position followed by fibreoptic insertion. The infusion cannula was sutured in the inferotemporal quadrant. (B) The schematic illustrates the anterior segment (left eye). The primary surgeon inserted two active dissecting instruments, such as the vitreous cutter and forceps. The assistant inserted a light pipe through an inferior nasal cannula to provide dynamic illumination. (C) Surgeon's view of the posterior segment (left eye). As the illumination was held by the assistant in the inferior nasal position, the fibrovascular membranes were dissected under good visibility by the primary surgeon with vitreoretinal forceps (left) and membrane scissors (right). (D) The schematic illustrates an intraocular view of the membrane scissors and forceps used for bimanual dissection of a fibrovascular membrane with diabetic tractional detachment (63).

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