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Vitrectomy for diabetic retinopathy: A review of indications, techniques, outcomes, and complications

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Abstract:

Diabetic retinopathy is one of the most severe forms of retinopathy and a leading cause of blindness all over the world. Of a greater concern is proliferative diabetic retinopathy which leads to vitreous haemorrhage and tractional retinal detachment in such cases. A majority of these cases require a surgical intervention to improve vision and prevent further vision loss. Surgical manouevers in these cases require a complex combination of vitrectomy, membrane dissection, judious usage of endodiathermy, endolaser, vital dyes, bimanual dissection and usage of intraoperative and post-operative tamponades. Each case presents a unique challenge and necessitates an appropriate combination of the steps mentioned above. In the current review we present the current understanding of the need for surgery in diabetic retinopathy, various surgical approaches and a summary of current literature on the same. Multiple surgical video clips demonstrating these steps are also included in this review.

Keywords:

Diabetic vitrectomy, proliferative diabetic retinopathy, posterior hyaloid, subhyaloid hemorrhage, vitreous hemorrhage

Introduction

Diabetic retinopathy (DR) is a severe and prevalent cause of blindness in the global workforce. As a matter of global concern, its incidence is rapidly rising worldwide.[1-3] Advanced DR is characterized by macular leakage, exudation, and retinal vasoproliferation, all of which are caused by microvascular complications resulting from diabetes. Although medical therapy, such as intravitreal injection of anti-vascular endothelial growth factor (VEGF), steroids, and retinal laser photocoagulation, can be used to treat early stages of DR, some eyes may still require surgical treatment to preserve visual function as the condition progresses.[4-7]

For a nonclearing vitreous hemorrhage (VH) with minimal fibrovascular proliferation (FVP) and posterior vitreous detachment (PVD), a simple vitrectomy can be used to clear the vitreous. However, combined tractional and rhegmatogenous retinal detachment (TRD/RRD) or TRD affecting the macula require more complex surgeries.[8,9] The specific preoperative preparations, surgical techniques, and postoperative results may differ significantly depending on the complexity and risk factors of the patient's vitreoretinal condition and the possible intra- and postoperative complications. In the last few decades, there has been significant technological advancement in surgical techniques for treating complications of DR. Starting with Robert Machemer's successful procedure on a diabetic patient with VH in the late

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1970s,[10] surgical instruments have made significant strides in recent times. The size of the vitrectomy instruments has become smaller, down from 20G to 23G, 25G, and 27G, making minimally invasive surgery and microincision vitrectomy surgery (MIVS) possible.[11-13] Furthermore, vitrectomy machines of today also have a great advancement. They feature enhanced fluidics, optimized control of intraocular pressure during surgery, and faster cutting rates, resulting in more efficient and safer procedures than in the past.[14] With these innovations, surgeons can perform a more thorough vitreous shaving while minimizing tractions to the retina and reducing the risk of iatrogenic retinal breaks or bleeding.

In addition, advanced technologies such as wide-angle panoramic viewing systems, modern accessory endoillumination devices (known as chandeliers), and innovative curved or steerable endolaser probes allow for precise and comprehensive treatment of the entire retina. With the advancement of higher-resolution optical coherence tomography (OCT), it is now possible to assess macular microstructural changes more accurately, and even predict the visual outcome after vitrectomy. In addition, dynamic focusing and windowed averaging swept-source OCT have advanced our understanding of the vitreoretinal interface in proliferative DR (PDR). In the current communication, a literature review was conducted through Google Scholar and PubMed, followed by a review of the references procured. All relevant literature was studied in detail and summarized in the study. The purpose of this review is to provide update information on diabetic vitrectomy, including its indications, pathophysiology, surgical principles, preoperative considerations, intraoperative techniques, and contemporary outcomes.

Indications for Vitrectomy in Diabetic Retinopathy

Over the years, the indications for performing vitrectomy in advanced DR have greatly expanded. Diabetic vitrectomy is now widely recognized as the recommended treatment for numerous conditions such as nonclearing VH, TRD, combined RRD/TRD, vitreomacular traction (VMT), traction-induced diabetic macular edema (DME), rubeosis iridis, and macular distortion (including dragging of the macula), to mention a few.[15-20]

Nonclearing Vitreous Hemorrhage

Nonclearing VH [Videos 1 and 2] is the primary indication for diabetic vitrectomy, as several studies have demonstrated [Figure 1].[19,21,22] 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 [Video 3]. 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. The timing of vitrectomy for VHs has been a topic of debate in the past. The Diabetic Retinopathy Vitrectomy Study (DRVS) conducted a randomized study comparing the outcomes of early versus delayed vitrectomy in eyes with advanced DR and VH on a large scale.

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.[15] 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.[21] 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.

Tractional Retinal Detachment Threatening the Macula

TRD is a major indication for vitrectomy in diabetic patients.[23,24] 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 [Video 4]. When the macula is involved, a significant reduction in vision clarity results. 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).[25,26] 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 [Figure 2]. 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 [Video 4]. However, if there's nonprogressive localized TRD without fovea involvement, monitoring the situation closely without vitrectomy may be an option.[26,27] 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.[28-30]

Laser photocoagulation as a treatment for small extrafoveal TRD is a viable option as it can remain stable for years, eliminating the 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. The goal of the surgery is to alleviate retinal tractions, reattach, and provide laser treatment to the ischaemic retina. This is paramount in reducing the production of VEGF and preventing neovascularization.

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 [Figure 3].[23,31] 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.[32] The primary causes are residual fibrovascular membranes, reproliferative neovascularization of the retina, and neovascularization at the site of sclerotomy (fibrovascular ingrowth).[33,34] 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.[35] Cryotherapy is a highly recommended method for treating the peripheral retina and sclerotomy entry points.[36] 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.[33] Occasionally, silicone oil tamponade may be necessary to ensure clear media.

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.[36,37] 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.[38] For cases of DME with massive hard exudate, vitrectomy with ILM peeling may facilitate the resolution of hard exudate and edema.

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.[39-41] However, it is important to note that fibrovascular contraction postbevacizumab can worsen the condition. The incidence of macular holes in TRD is 1% in the absence of anti-VEGF treatment.[41] 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.[42] 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.[43] Holes can be closed by relieving tractional forces, and the TRD can be repaired without ILM peeling.[39,44] However, ILM peeling may be necessary for complete membrane removal, especially if vitreoschisis is suspected.[43] Real-time intraoperative OCT has been found to be useful in these cases.[45] Tamponade must always be used, with identical outcomes between oil and gas, as well as between short or long-acting gas.[39,43] Draining subretinal fluid through the macular hole is highly likely to cause damage to the subfoveal RPE.[41] 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.

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.[40] 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.[46] Preoperative intravitreal injections of anti-VEGFs may not be necessary since schisis cases predominantly have fibrous tissue rather than active FVP.[47,48] 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.[40]

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.[27,49]

Preoperative Evaluation

Before undergoing vitreoretinal surgery, every patient should have a comprehensive eye examination for both eyes. Measuring the preoperative visual acuity is absolutely essential. It is a determining factor in predicting the likelihood of visual improvement after vitrectomy.[50] It is important to conduct a slit-lamp biomicroscopy and observe any indications of anterior segment ischemia closely. Performing gonioscopy is crucial in detecting neovascularization at the angle. Moreover, it is imperative to measure intraocular pressure and eliminate the possibility of NVG. During a diabetic vitrectomy, it is preferred to keep the crystalline lens intact because it effectively prevents VEGF from diffusing to the anterior chamber. After vitreoretinal surgery, 75% of patients develop cataracts. However, combined phacoemulsification with intraocular lens implantation and PPV should be considered for cases with visually significant cataracts.[51] Although the risk of NVG does not increase significantly with combined surgery, it's important to note that there is a possibility that macular edema could worsen. To avoid this, any preexisting macular thickening should be addressed before surgery, and ERM and ILM peeling should be considered during surgery. Avoiding lensectomy is crucial to prevent the occurrence of NVG, caused by the spread of VEGF toward the anterior region.[24] When examining the fundus, it is important to check for any detachment of the posterior vitreous, as it can affect the surgery's level of difficulty. When dealing with TRD, it is important to document the configuration of the retinal detachment and areas of vitreoretinal adhesion to help with surgical planning. It is important to pay close attention to cases of chronic TRD with thin and atrophic retina, as they are highly susceptible to developing iatrogenic breaks while dissecting fibrovascular membranes.[41] Assessing the condition of the macula using OCT plays a pivotal role in predicting outcomes for patients with TRD. If macula detachment is present, the risk of unfavorable outcomes increases by 13 times.[52] Prompt surgical action is crucial in these situations.[52] If a macular hole is present, it may indicate macular ischemia, traction, and a poor visual prognosis.[53] If there is macular edema, specifically DME with a tight posterior hyaloid [Video 5], vitrectomy with posterior hyaloid removal and ILM peeling may facilitate the resolution of macular edema.[54] It is important to thoroughly examine the other eye for DR, as approximately one-third of patients with DR in one eye may require vitrectomy within 3–4 years.[55,56] It is important to quickly treat any active neovascularization with sufficient pan-retinal photocoagulation (PRP). If the other eye is already blind, using silicone oil instead of long-acting gas as the tamponing agent for the primary eye may lead to quicker visual recovery.

Besides slit-lamp and fundoscopy, other examinations are also helpful. When patients have dense media opacities, such as VH, it can be helpful to use a B-mode ultrasound scan to evaluate their retina, particularly the macula, for any signs of traction or retinal detachment. B scan is a useful diagnostic tool that can detect whether a PVD is present or absent. This information is important in preparing the eye for diabetic vitrectomy. For example, certain surgeons may administer preoperative intravitreal anti-VEGF to eyes lacking a PVD and avoid from doing so in eyes in which a PVD already exists. B scan can identify the presence of vitreoschisis or a second membrane. For individuals suffering from DR, vitreoschisis is highly likely to occur in their eyes Therefore, it is crucial in identifying any remaining vitreous layer and finding the correct surgical plane [Video 6]. Acknowledging its existence is crucial for achieving a desirable outcome. When the media is clear, OCT should be performed for the thorough assessment of ERM, DME, and the degree of foveal involvement in TRD, fibrovascular tissue-induced macular tractional retinoschisis, and macular hole.[39,40,52] The presence of diffuse macular thickening, loss of foveal depression, and diffuse retinal thinning are OCT features that can predict visual improvement after vitrectomy. The size and extent of the cone outer segment tip line defects before surgery can also be used to predict visual recovery in diabetic vitrectomy. Fluorescein angiography can assess retinal perfusion and detect any significant macular ischemia or neovascularization. If there are large areas of ischemia or the foveal avascular zone is enlarged, it suggests a poor prognosis. OCT angiography is a new modality that can detect areas of ischemia and neovascularization in the posterior pole without the need for intravenous dye. It can selectively image different layers of the retina, and its use is becoming more widespread.

Preoperative Anti-vascular Endothelial Growth Factor

Administering anti-VEGF agents such as bevacizumab, ranibizumab, or aflibercept through an intravitreal injection before undergoing vitrectomy for diabetes can be helpful. This is because it leads to quick regression of active neovascularization. Reducing neovascularization through regression can have multiple positive effects during surgery. This includes less intraoperative bleeding, improved visibility for the surgeon, reduced reliance on endodiathermy, and, ultimately, quicker procedures with fewer instrument changes.[18] Furthermore, the occurrence of vitreous or preretinal bleeding after surgery is decreased. According to a systematic review, using anti-VEGF medication before eye surgery may lead to better visual outcomes for those with PDR up to 12 months after the procedure.[57] The optimal timing for intravitreal anti-VEGF injection is 3–7 days before the surgery. It is important to be careful when treating patients with anti-VEGF therapy if surgery is not planned or may be delayed due to medical conditions. This is because the anti-VEGF agent can cause the fibrovascular membranes to contract and potentially worsen TRD in PDR patients over time.

Surgical Techniques

Despite advancements in surgical technique and instruments, diabetic PPV remains one of the most challenging surgery in the VR field. The use of microincision vitrectomy surgery (MIVS) has enhanced the success of PPV in treating proliferative DR. With the help of advancements such as an improved vitrector tip shape, optimized cutting rate and aspiration parameters, and a port thats positioned closer to the tip, and these instruments can now be confidently and securely utilized in extremely proximity to the surface of the retina. These versatile tools can be used to dissect, shave, lift, and peel fibroproliferative membranes from the retinal surface.[58-60]

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.[59] 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.

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.[61] 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[62,63] [Video 7].

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[64] 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 [Video 6]. This knowledge will aid in identifying and dissecting any nails or pegs using appropriate tools such as cutters or scissors.[65,66] Dye-assistant peeling of ILM and ERM may facilitate the complete removal of the posterior hyaloid.

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.[58]

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.[27,65]

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.

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 fibrovascular adhesion points is then removed using curved scissors or a small-gauge cutter[67] [Video 8].

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.[68] 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[68] [Video 9]. 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.[69,70]

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.[71] With the bimanual technique assisted with chandelier illumination, forceps are held in one hand and scissors in the other.

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.[72] 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 first 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.[72]

Figure 1: Pre and post fundus photograph of subhyaloid hemorrhage

Special Consideration

Combined traction-rhegmatogenous retinal detachment (CRD)

In this type of CRD, the retinal break is often not detected before surgery. The usual location of the break is at the base of the proliferation, where there is the most anteroposterior traction. The diagnosis of CRD is based on the configuration of retinal detachment and its associated attributes, such as a convex surface, rather a sudden loss of vision, and a relatively less tangential traction component.[27] The goal is to relieve tangential traction as soon as possible to prevent fluid from entering the subretinal space, which can cause a more severe bullous detachment of the retina and make subsequent dissection harder. When dealing with active FVP, preoperative use of anti-VEGF medication 4–7 days before surgery can help make the dissection process easier and result in less bleeding. After the core vitrectomy procedure, the opacified vitreous is removed and a safe opening is made in the posterior hyaloid, at a place where the retina is at a safe distance from the vitreous cortex. Then anterior–posterior vitreoretinal traction is released to the possible. To remove the thick

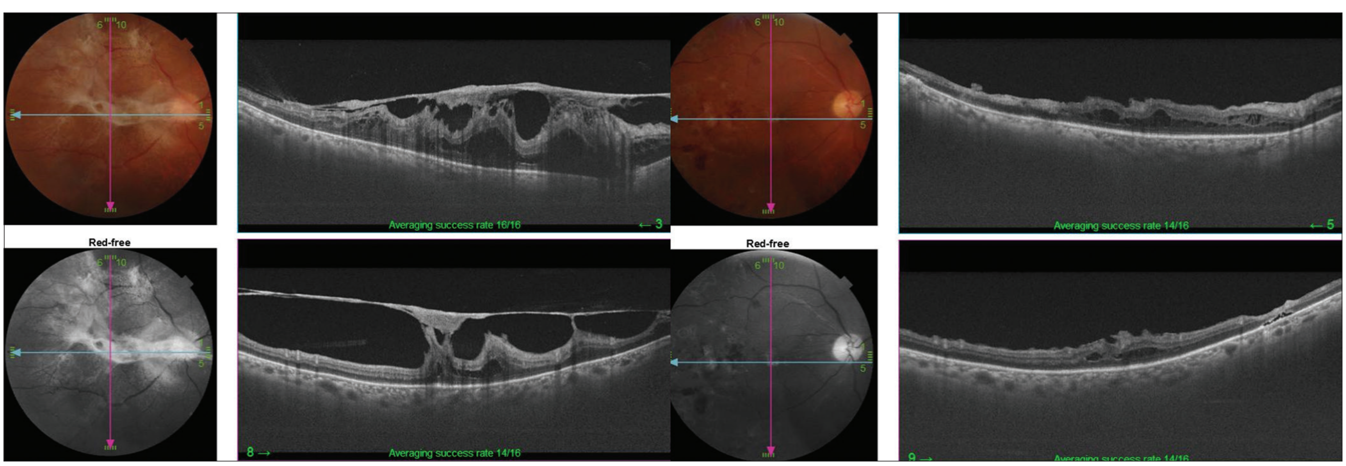

Figure 2: Pre and post photograph of vitreomacular traction and adhesion

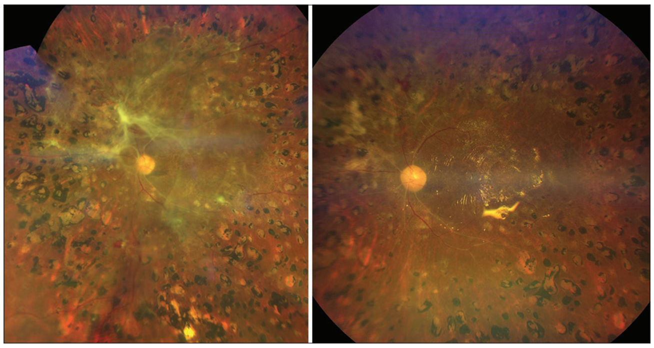

Figure 3: Pre and post fundus photo of progressive fibrovascular proliferation

fibrotic plaque from the retina, scissors segmentation and delamination are used. Gentle use of forceps to lift tissue from the disc is crucial for precise surgical identification. The removal of the hyaloid is done as much as possible towards the periphery. If the thin and nontaut peripheral hyaloid is still attached to the retina, it may be best to leave it as is to avoid causing any breaks.[73]

Forceps are used to remove avascular preretinal membranes. When dealing with extensive FVP (adhesions that spread beyond one site in front of the equator) or significant breaks, a bimanual approach is commonly used. This involves using forceps in one hand and cutters or scissors in the other hand while under chandelier light illumination. Once the traction force is completely released, we perform air-fluid exchange. Then, we apply laser PRP around the break and along the peripheral retina, followed by injecting the tamponade. Silicone oil is utilized in cases where the eyes have multiple large retinal breaks (either preexisting or iatrogenic), possible undiscovered breaks, or are undergoing retinotomy or retinectomy. It is also used for eyes with residual vitreoretinal traction.[73]

Complications of Diabetic Vitrectomy

Cataract

It is well-known fact that lens-sparing PPV (this is the first time that PPV is used in this article. Vitrectomy itself might be enough. Otherwise, PPV should be used from the beginning of this article) undeniably accelerates the progress of nuclear sclerosis. Furthermore, it is widely believed that patients with diabetes have a higher chance of requiring cataract surgery.[74-76] Several studies have reported a higher chance of developing a visually significant cataract after diabetic PPV.[52] According to a study that reviewed patients in the ETDRS, diabetic patients who underwent a PPV had a seven times higher risk of cataract extraction compared to those who did not have vitrectomy. Recent research indicates that the incidence of cataract surgery subsequent to diabetic PPV ranges from 57% after 5 years to 71% after 10 years.[77,78] Although some studies have suggested that DR may offer protection to the lens by reducing oxidative stress, PPV can actually accelerate the development of lens opacity and increase the need for cataract surgery in diabetic patients within a relatively short period.

Intraocular Bleeding

Bleeding inside the eye can happen either during surgery or as a complication after surgery. Intraoperative bleeding during surgery in diabetic eyes is a frequent issue, particularly in the eyes with existing neovascularization [Video 10]. In some cases, completing the procedure can be extremely challenging. Bleeding can occur during the peeling of the fibrovascular membrane or due to sudden changes in intraocular pressure when exchanging instruments.[27] New vitrectomy systems with smaller sclerotomies, valved microcannulas, and controlled intraocular pressure have significantly reduced the occurrence of intraoperative bleeding. Using an antiangiogenic agent before surgery can make it easier to dissect the membrane in areas with less blood flow. Briefly increasing the pressure inside the eye, gentle instrument compression or utilizing intraocular diathermy or green light endolaser can effectively halt intraocular bleeding.[27]

Iatrogenic Breaks

During vitrectomy for TRD, there is a higher occurrence of intraoperative break formation, with reported rates ranging from 27% to 50% of eyes.[13,79-81] It is essential to remove any traction adjacent to the break [Video 11]. The break should be encircled with laser spots, and an adequate internal tamponade should be used. RRD rate after vitrectomy for nonclearing VH is 1%. It usually results in periphery or, rarely, from posterior retinal breaks.[82] The iatrogenic break commonly occurs close to the active sclerotomies. Always perform scleral indentation and examination of the peripheral retina using a wide-angle viewing system to look for tears or breaks at the end of surgery.

Recurrent Vitreous Hemorrhage

As discussed, VH remains the most common indication for vitrectomy in diabetic patients. However, recurrent VHs are the most observed complication after surgery, too [Video 12]. Various studies have reported the incidence of VHs in diabetic patients after a primary PPV 63%–75% for a nonclearing VH in the immediate postoperative period.[74,83] According to the DRVS, the incidence of recurrent VHs requiring additional surgery was between 14% and 23%.[15]

These studies were conducted in an era where surgical instruments were less efficient and performed than the actual ones. Nowadays, the smaller gauge vitrectomy (MIVS) has dramatically decreased the incidence of postoperative recurrent VHs and completing pan-retinal photocoagulation intraoperatively. Lee BJ *et al*. reported the results of 173 eyes undergoing 23G PPV for nonclearing VHs with follow-up of up to 3 years. They discovered a recurrent VH rate of 22%, with only 13% requiring additional operation.[84] Park *et al*. compared the incidence of recurrent VH between 20G and 23G PPV for nonclearing VHs and found a lower but not statically significant rate in the smaller gauge group (12.1% vs. 11.4%).[85] Similarly, Lee *et al*. found a low rate (11.8% after 6 months) of recurrent VH using 25G PPV.[86] Finally, a recent study by Khan *et al*. on the safety profile and long-term visual outcomes of smaller gauge PPV described that 27G vitrectomy is a good alternative for VHs in diabetic patients.[58]

Yeh *et al*. investigated the use of 10% C3F8 versus no-gas surgery in a prospective study. They found that the incidence of recurrent VHs was lower in the C3F8 group, but no statistically significant differences between the two study groups (1/30 vs. 7/31).[34]

Furthermore, the factor responsible for recurrent VHs is attributed to PFP at sclerotomy sites, with an incidence rate of 85%.[87] A study has described that patients who underwent a combined treatment of pan-retinal photocoagulation in addition to anterior retinal cryotherapy and at the sclerotomy sites had a significantly lower risk of recurrent VH if compared with pan-retinal photocoagulation alone or combined with anterior retinal cryotherapy. These findings were directly correlated with the possibility of bleeding from PFP at the sclerotomy sites.[88]

The role of perioperative anti-VEGF injections has been studied. A study described Intravitreal bevacizumab dramatically reducing the risk of recurrent VH compared to placebo (RR 5.04).[89] In comparison, intravitreal ranibizumab decreased the risk of recurrent VHs at a rate of 7% if compared to controls (16%) at a 16-week follow-up.

Retinal Detachment

The incidence of recurrent retinal detachment after diabetic PPV ranges from 1.5% to 17%.[18] The main risk factor is indications for PPV itself and the extent of PFPs. Compared to patients with VH, the incidence of retinal detachment after surgery is higher in patients with TRD. Various studies demonstrated that the incidence of RRD after PPV for VHs ranges from 0% to 4.3%.[90]

While a large series of diabetic vitrectomy from the Royal College of Ophthalmologists, the incidence of iatrogenic retinal breaks positively correlates with the complexity of the procedure itself. If delamination was required intraoperatively, the rate of the iatrogenic retinal break was higher (27.7% vs. 9%), and a postoperative tamponade was necessary for 43% of operated eyes. RRD incidence rate after PPV for simple, nontractional diabetic macular edema is only 1.5%.[91]

The recent retinal detachment trend has decreased due to the technological improvement of surgical instruments. A wide-field noncontact viewing system combined with a chandelier illumination system allows the surgeon to perform a bimanual technique. This approach has reduced retinal manipulation and improved the removal of fibrovascular tissue with a lower risk of iatrogenic retinal breaks and postoperative retinal detachment.[91-93] The risk of retinal detachment after diabetic PPV depends on indication; the severity is the lowest for diabetic macular edema without membranes and the highest for TRD.

Progressive Anterior Hyaloid Fibrovascular Proliferation

Progressive AHFVP is an uncommon and severe complication due to the high expression of VEGF from the ischaemic anterior retina, typically occurring at the sclerotomy site in the 1st postoperative weeks.[34] The progressive AHFVP process can involve the anterior hyaloid, the posterior lens capsule, the ciliary body, and the iris. Urgent surgical intervention is required, and retinal ablation such as laser or cryo to the anterior retina is needed to stop a progressive degenerative process toward bulbar atrophy.[34]

Conclusion

Surgical management of diabetic eye diseases requires careful attention to overall systemic health, and understanding of basic pathophysiology. Diabetic vitrectomy is a key role in the treatment of severe proliferative DR, but it requires a comprehensive evaluation and preoperative anti-VEGF injection and pan-retinal photocoagulation to reduce intraoperative complications. Microincision technology, panoramic viewing systems, and endoillumination devices enable shorter and safer procedures with lower complications. Small gauge instruments are ideal for diabetic TRD.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given her/his consent for her/his images and other clinical information to be reported in the journal. The patient understands that her/his name and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

Data availability statement

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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Conflicts of interest

The authors declare that there are no conflicts of interests of this paper.

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