Review Article

Update on indications for diabetic vitrectomy and management of complications

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Abstract: Despite appropriate management of the systemic disease, patients with diabetes may develop severe forms of diabetic retinopathy that require surgery. Non-clearing vitreous haemorrhage (VH), traction retinal detachment involving the macula, combined traction and rhegmatogenous retinal detachment, progressive fibrovascular proliferation (PFP) and rubeosis with acute VH represent the main indications for surgery. Vitrectomy techniques and surgical tools have developed dramatically in the last decade in order to help the surgeon succeed in these challenging cases.

Keywords: Diabetic retinopathy (DR); retina surgery; vitrectomy; vitreous haemorrhage (VH); retinal detachment; fibrovascular proliferation; rubeosis

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Introduction

Diabetic retinopathy (DR) and its complications are the leading cause of irreversible visual loss among working-age adults. Despite appropriate management of the systemic disease, most patients with diabetes are expected to develop signs of retinal microangiopathy in their lifespan (1). Diabetics are therefore followed with appropriate fundus examination and complications of diabetic retinopathy are treated promptly. Initial signs of ischemia/neovascularization and macular oedema have been successfully treated by laser or intravitreal injections (2).

Progression towards proliferative DR leads to severe complications such as vitreous haemorrhage (VH) and tractional retinal detachment (TRD) that may require surgical intervention in the form of pars plana vitrectomy (PPV). This surgical technique has encountered a dramatic technological development in the last decades, since the first procedure successfully performed by Robert Machemer on a diabetic patient with a non-clearing VH in the late 1970. Nowadays, surgical instruments have reached a high level of miniaturization. The development of 23-, 25- and 27-gauge trocars allows a minimally invasive surgery and has spread the concept of microincision vitreoretinal surgery (MIVS). In addition, the modern vitrectomy machines are a concentrate of technology: improved fluidics, optimized intraoperative intraocular pressure control and elevated cut rates allow an efficient and safer surgery compared to the past. These innovations allow the surgeons to perform an even more radical vitreous shaving with minimal tractions to the retina and a lower risk of iatrogenic retinal breaks or bleeding. Furthermore, the newest wide-angle panoramic viewing systems, the modern accessory endoillumination devices (chandeliers) and the innovative curved or steerable endolaser probes enable accurate treatment of the whole retina.

In parallel with this technological advance, the indications for diabetic vitrectomy have evolved over

time from traditional ones such as TRD and VHs to more sophisticate ones such as epiretinal membranes, vitreomacular tractions, macular oedema and neovascular glaucoma (3).

The goals of PPV in DR consist in clearing media opacities, releasing antero-posterior and tangential vitreoretinal tractions, peeling of epiretinal membranes, endolaser photocoagulation and tamponade of retinal breaks. Moreover, the vitreous removal appears to be effective in improving oxygen exchanges in the retina and in counteracting the formation of fibrovascular membrane thanks to the lack of a scaffold for proliferation (3,4).

The aim of this paper is to review the modern indications for diabetic vitrectomy, the recent improvements in surgical techniques and instrumentation and the intraoperative and postoperative complications.

Indications for vitrectomy in diabetic retinopathy

Non-clearing VH

VH is caused by the spontaneous bleeding from new vessels in proliferative DR. It is one of the most common indication for diabetic PPV, especially in case of non-spontaneous vitreous clearing.

The goals of vitrectomy in such eyes are to clear the vitreous chamber and, consequently, to restore vision. In addition, a better follow-up could be performed in order to schedule laser photocoagulation and to monitor the evolution of DR, thanks to an improved retina visualization (5,6).

The decision of performing a vitrectomy in cases of VH relies on the findings from a detailed fundus examination and B-scan ultrasonography (7).

In fact, eyes with a mild VH and a well-lasered retina would not be eligible for vitrectomy thanks to the potentially spontaneous reabsorption of the blood. On the other hand, if a complete obscuration of the fundus occurs, the decision of performing a PPV is strictly linked to the findings at the ultrasonography exam. In fact, an early vitrectomy is mandatory in case of VH in association with retinal detachment, especially if macula is involved. In addition, vitrectomy should also be considered in case of dense or recurrent VH.

In the past, there has been considerable debating on the timing of performing vitrectomy in patients with VHs. In the late 1985, the diabetic retinopathy vitrectomy study (DRVS) pointed out that early vitrectomy could offer some advantages in term of final visual acuity in patients with type I diabetes mellitus, but poor outcomes were reported for patients with type II. However, the overall number of eyes with a visual acuity of 10/20 or better was significantly higher in the early PPV group after a four-year follow-up (8).

It is important to consider that over 30 years ago, vitreoretinal specialists did not have available the last technological innovations in this field, such as small gauge instruments, high performance machines and intravitreal anti-VEGFs. These new chances of treatment have increased the overall intraoperative and functional outcomes of PPV in these patients.

A close observation is recommended for at least four weeks in patients with diabetic VH without retinal detachment. In absence of evidences of vitreous clearing or improvement visual acuity and symptoms, a vitrectomy should be performed to restore vision (9).

Evidences for the use of anti-VEGFs as an adjuvant therapy in case of VH before diabetic vitrectomy are limited. They can simplify vitreoretinal surgery reducing intraoperative bleeding and "drying" the retina tissues; on the other hand, they may worsen the tractional components, especially when the anti-VEGF injection is given 7 or more days before diabetic vitrectomy (10).

TRD threatening the macula

TRD is a severe complication of proliferative DR and it is a major indication for vitrectomy in diabetic patients (3,11).

The retinal detachment in DR is caused by the progressive contraction of pathologic fibrovascular tissue which pulls the neurosensory retina away from the retinal pigment epithelium. If the detachment involves the macula, a severe loss of visual acuity occurs. Frequently a TRD is associated to a rhegmatogenous component, since that the contraction of the fibrovascular proliferation could cause some retinal breaks in the peripheral thin ischaemic retina. In these cases, patients complain a rapidly and worsening vision loss and an early PPV is mandatory (12,13). Despite the chance of this condition, more often than not, these symptoms could be masquerade because of the presence of macular oedema or epiretinal membranes. For these reasons, a TRD with a rhegmatogenous component could go overlooked. Therefore, a close fundus follow-up is compulsory.

A proper patient assessment prior to surgery is mandatory. At the fundus examination, a traction detachment is characterized by a stiff, bowl-shaped immobile retina with no breaks and associated to an area of

fibrovascular proliferation. Optical coherence tomography (OCT) is recommended in order to assess the eventuality and degree of macula and fovea involvement. Additionally, the presence of any epiretinal membranes and their influence on prognosis could be investigated.

In these cases, the timing for vitrectomy relies on the foveal involvement. If the fovea is detached, a PPV should be performed as soon as possible to avoid severe and irreversible vision loss. On the other hand, non-progressive localized TRD with no fovea involvement could be closely monitored without performing vitrectomy (7,14).

Retinopexy by means of laser photocoagulation could be a good strategy for small extrafoveal TRD as it can remain stable for years without the need for vitrectomy. Attention need to be paid in performing laser photocoagulation or intravitreal anti-VEGF injections, since that they could cause changes in the pre-existing fibrovascular tissue with a rapid worsening of retinal tractions and, as consequence, retinal detachment.

The presence of a combined tractional and rhegmatogenous retinal detachment is a condition in which an earlier vitrectomy should be performed since that the detachment can progress rapidly with the worsening of proliferative vitreoretinopathy (15-17).

The goals of diabetic vitrectomy in tractional DR in diabetic patients are to relieve retinal tractions, detach and remove the posterior hyaloid, reattach the retina and laser treatment of the ischaemic retina to downregulate vascular endothelial growth factor production and therefore neovascularization.

Progressive fibrovascular proliferation (PFP)

PFP is one of the leading cause of recurrent or persistent VHs, vitreoretinal tractions to the macula and disc, recurrent diabetic macular oedema, epiretinal membranes, macular holes and TRD in proliferative diabetic retinopathy (3,18).

Diabetic macular oedema is the commonest cause of vision loss in diabetic patients and it can be treated by intravitreal injection of anti-VEGFs or corticosteroids. This condition often occurs in association with the presence of PFPs that cause vitreomacular traction or epiretinal membranes that could negatively influence the visual recovery after the standard injective therapy (19).

An OCT assessment is recommended in patients with macular oedema not only to define the amount of intraretinal and subretinal fluids at the posterior pole, but also to establish the presence and the extension of epiretinal membranes or vitreomacular tractions that could affect the prognosis. It is believed that the internal limiting membrane (ILM) may play a key role in the development of persistent PFPs and its complications, such as persistent macular oedema and epiretinal membranes. In these patients, a PPV with epiretinal membrane removal and peeling of ILM may be recommended since that the pharmacotherapy alone could not be as effective as the combined treatment. Moreover, the vitrectomy with or without ILM peeling is believed by some authors to improve the oxygenation of the retinal cells with a lower risk of recurrent macular oedema (18,20). Recent studies tend to minimize these theories, demonstrating that ILM peeling in non-tractional diabetic macular oedema is not affecting visual outcomes after vitrectomy (21,22).

Macular holes can be associated with PFPs. Differently from idiopathic macular holes, they are associated with a large detached area underlying the retina caused by the fibrovascular tractions. Strong vitreomacular adhesion could be observed close to the edge of the hole. In these cases an early PPV is suggested since that the progression of fibrovascular proliferation could negatively influence the already poor final visual prognosis and interfere with the final closure of the hole.

As for idiopathic epiretinal membranes or macular holes, the peeling of ILM has become a key step of the surgical treatment of the diabetic variants, too. However, although evidences suggest the inhibition of epiretinal membrane formation after ILM peeling, diabetic patients have a wide range of factors that make this phenomenon more unpredictable. PFPs are strongly adherent to retinal surface and difficult to remove. The epiretinal membranes could have a multi-layered conformation. Diabetic eyes with active PFPs are characterized by a pro-inflammatory and pro-angiogenic environments that are a permanent stimulus to membrane proliferation (18,20,23,24).

Chang *et al.* provides data suggesting that ILM peeling during PPV for PFPs is a valid surgical approach with the aim of minimize post-operative epiretinal membranes formation and their complications (18).

Therefore, ILM peeling is a valid option for mild-to-moderate PFPs localized in the posterior retina. It may facilitate the reabsorption of macular oedema and prevent recurrent epiretinal membrane formation because of the removal of the scaffold for myofibroblast and astrocyte proliferation (25,26). The effect of the removal of ILM on the macular oedema remains controversial and larger

studies are needed in order to definitely address the role of this surgical technique in these complicated eyes (18).

Neovascular and ghost cell glaucoma with acute VHs

The ischaemic component of DR causes the proliferation of new blood vessels not only in the posterior segment of the eye, but also in the iris and the anterior chamber angle, causing neovascular glaucoma. This complication is more often observed in aphakic and pseudophakic eyes with posterior capsular defects. Intraocular pressure should be managed by means of topical and/or oral anti-glaucoma agents. Nevertheless, the main goal in these patients is to destroy the areas of ischaemic retina in order to downregulate the release of pro-angiogenic factors. This is usually obtained with an intravitreal anti-VEGF, panretinal photocoagulation and anterior retinal cryotherapy. A vitrectomy should be performed in case of dense VH in combination with anti-VEGF injections. Eyes with persistent VH are at risk to develop ghost cell glaucoma since red blood cells can haemolyse and form less flexible ghost cells that obstruct the trabecular meshwork with significant increase in intraocular pressure. An early vitrectomy could be performed to remove ghost cells and treat ghost cell glaucoma.

Diabetic vitrectomy: strategy and techniques

Despite the dramatic development of surgical instruments and surgical techniques, diabetic PPV remains a challenging procedure, even to the most experienced surgeons.

The spreading of microincision vitrectomy surgery (MIVS) has improved the outcomes of PPV in proliferative DR. Smaller instruments (23-, 25- or 27-gauge) may allow a better control of intraoperative parameters and allows the surgeon to perform complex surgical manoeuvres. These instruments may be safely used very close to the retina surface thanks to the improved shape of the tip of the vitrector, the optimized cutting rate and aspiration parameters, and the localization of the port closer to the vitrector tip than in the previous models. These tools are more versatile and they could be used to dissect, shave, lift and peel vitreo proliferative membranes from and the retinal surface (27-29).

Relief of anterior-posterior traction

As per standard PPV, a three ports approach is preferred. A fourth sclerotomy to position a chandelier is often needed to allow the surgeon to perform a bimanual technique.

Some surgeons prefer to start removing the anterior vitreous with the only operating microscope without positioning any panoramic viewing systems. This approach lets the surgeon to avoid damages to the lens in phakic eyes. Afterwards, the surgeon can proceed with the vitrectomy into the vitreous cavity using a panoramic viewing system (7).

The vitreous cavity of proliferative DR presents severe surgical challenges caused by the fibrovascular proliferative process that forms intense adherences between the posterior vitreous and the retinal surface. In diabetic eyes with proliferative membranes, a complete posterior vitreous detachment is virtually always absent and strong points of posterior vitreoretinal adhesions are present. First step of vitrectomy in DR patients should be the removal of the anterior-posterior tractions between the vitreous and the retina. At the beginning of the surgery, vitreous usually has an open funnel configuration with adhesion to the disc or a trampoline-like shape with additional points of adhesions to the retina. After removal of these traction cutting with the vitrector in the mid of the vitreous chamber by 360 degree, the surgeon will be able to remove the vitreous body and the associate VH without causing tractions on the retina and unnecessary bleeding or iatrogenic retinal breaks. Thereafter, the operator can start to safely approach the more posterior aspects of the proliferative diabetic disease. Posterior hyaloid schisis may be present and it is mandatory to recognize this alteration in order to perform a complete vitreous detachment, remove the posterior hyaloid and shave the proliferative membranes using a bimanual technique with cutter or scissors. It is mandatory to never pull with the probes because of the high risk of iatrogenic retinal breaks (7,30).

Relief of tangential tractions

Another challenge of diabetic PPV is to relieve the tangential tractions. This crucial step could be achieved with a combination of surgical techniques such as segmentation, delamination and *en bloc* dissection.

In segmentation, a large area of proliferation is divided into smaller pieces and separately removed. In delamination, an entire fibrous proliferation is detached after separating all the anchoring vascular peduncles from the retina. The dissection could begin from the retinal periphery (out-side) or from the optic disc (in-side). In general, merging both the approaches is warmly suggested to find the better

cleavage plane between the posterior vitreous and the retina.

The *en bloc* dissection allows to remove an entire fibrous sheet after separating the vascular nails with a bimanual approach. The key points are to keep intact some anterior-posterior tractions and to use a chandelier to perform a bimanual technique. The surgeon uses forceps and a scissor to perform a total separation of the fibrous tissue from the underlying retina.

Dissection may be carried out by injecting perfluorocarbon liquids or viscosurgical devices under the fibrous proliferation in order to separate the epiretinal tissue from the subjacent retina (31-33).

"Lift and shave" technique for diabetic TRD

The advent of modern vitrectomy machines with MIVS and valved trocars, IOP control, high cut rates and optimized vitrectors stimulated the development of new surgical techniques, spreading the concept of all-probe vitrectomy (34).

The lift and shave technique is valid example of such a technique performed with the only vitrector probe from the beginning to the end of surgery for proliferative DR without the help of other instruments (forceps, scissors, etc.). It could be performed with 27 or 25 gauge setting a cut rate of 5,000–10,000 c/m and a pedal control vacuum of 400–650 mmHg. The IOP in the vitrectomy machine is set at 25 mmHg and raised to 40–50 mmHg if bleeding occurs during dissection. A dual-linear foot pedal modality may be very helpful.

After identifying a plane between the retina and the epiretinal membrane, the vitrectomy probe is used to engage the fibrous tissue with aspiration and a blunt dissection is performed. The tissue is now lifted and when a resistance is noted, the pedal is shifted to cutting. It is necessary to repeat this manoeuvre sequentially, resulting in the progressive shaving of the epiretinal tissue from the surface of the retina (lift-and-shave technique) (34).

27-gauge diabetic vitrectomy

In 2010, Oshima *et al.* firstly described the use of the 27-gauge vitrectomy system. This new technology has raised increasing interest among surgical retina specialists. Initially used for macular surgery, 27-gauge vitrectomy is now being used for more complex cases such as diabetic vitrectomy. The 27-gauge probe is efficient in treating posterior fibrovascular tissue since it can be easily inserted through narrow spaces between proliferative membranes (15).

A study by Cruz-Iñigo *et al.* suggested that 27-gauge PPV is a valid alternative for the management of combined traction and rhegmatogenous retinal detachment, with a low incidence of complication and good visual outcomes. Only few post-operative complications have been described including VHs and transient ocular hypertension or hypotony (12,15).

Complications of diabetic vitrectomy

Cataract

It is well known that lens-sparing PPV accelerates the process of nuclear sclerosis and that diabetes itself is believed to anticipate cataract surgery in such patients (35-38). A higher risk of developing a visually significant cataract after diabetic PPV has been reported in several studies (27). A study reviewing the patients enrolled in the ETDRS reported a seven-fold higher risk of cataract extraction in diabetic patients who underwent a PPV if compared to those patients who did not undergone vitrectomy. More recent studies have reported a wide range of cataract surgery after diabetic PPV ranging from 57% after five years and 71% after 10 years (39,40).

Even if several studies reported that DR could have some protective effects on the transparency of the lens thanks to the downregulation of oxidative stress in the lens, PPV increase the progression of lens opacity and the need of cataract extraction in diabetic patients in a relatively short time. According to these data, it is mandatory to inform the patients of this potential risk e to propose a combined surgery, considering the chance of cataract progression after vitrectomy.

Recurrent VH

As discussed, VH remains the most common indication for vitrectomy in diabetic patients. However, recurrent VHs is the most observed complication after surgery, too. Several studies in literature report on the incidence of VHs in diabetic patients after a primary PPV for a non-clearing VH, ranging from 63% to 75% in the immediate post-operative period (35,41). According to the DRVS, the incidence of recurrent VHs that required an additional surgery was between 14% and 23% (8).

At the time when these studies were performed, surgical instruments where less efficient and performing than the

actual ones. Nowadays, the chance to a complete panretinal photocoagulation in addition to smaller gauge vitrectomy (MIVS) has dramatically decreased the incidence of post-operative recurrent VHs. Khuthaila *et al.* reported on the results of 173 eyes receiving 23-gauge-PPV for non-clearing VHs from proliferative DR with a 3-year follow-up. They found a recurrent VH rate of 22% with only 13% requiring a second operation (42). Park *et al.* investigated the incidence of recurrent VH after 20-gauge versus 23-gauge PPV for non-clearing VHs, finding a lower but not statically significant rate in the smaller gauge group (12.1% *vs.* 11.4%) (43). Moreover, Lee *et al.* found a similarly low rate of recurrent VH using 25-gauge PPV (11.8% after six months) (44). Finally, a recent review by Khan *et al.* on the safety profile and long-term visual outcomes of smaller gauge PPV stated that 27-guage vitrectomy is a good alternative for VHs in diabetic patients (29).

Through years, in addition to small gauge vitrectomy, several strategies have been described in literature to reduce the incidence of recurrent VHs. In a prospective study by Yang, the use of 10% C3F8 versus no-gas-surgery at the end of the procedure was investigated. Even if the incidence of recurrent VHs was lower in the C3F8 group no statically significance differences have been found between the two study groups (1/30 *vs.* 7/31) (45).

Furthermore, a possible cause of recurrent VHs is attributed to PFP at sclerotomy sites with an incidence rate of 85% (46). In this regard, the risk of developing recurrent VH following three different regimen treatments has been investigated. Patients who underwent a combined treatment of panretinal photocoagulation in addition with anterior retinal cryotherapy and at the sclerotomy sites had a significance lower risk of recurrent VH if compared with panretinal photocoagulation alone or combined with anterior retinal cryotherapy. These findings positively correlate with the chance of bleeding from PFP at the sclerotomy sites (47).

The use of perioperative anti-VEGFs injections has been examined. More precisely, the use of intravitreal bevacizumab greatly reduces the risk of recurrent VH compared to placebo (RR 5.04) (48). Intravitreal ranibizumab decreases the risk of recurrent VHs at a rate of 7% if compared to controls (16%) at 16-week follow-up. Despite these findings, no statically significance differences on the cumulative probability of undergoing a PPV have been found, demonstrating that perioperative anti-VEGF injections have a low impact on preventing VHs (49).

Despite these contrasting data, the preliminary results of the protocol N from the DRCR.net show that the use of intravitreal ranibizumab compared to saline injections in patients with VH from proliferative DR reduces the rate of PPV at 16-week follow-up. Final results on the risk of recurrent VHs will be available after the publication of the DRCR.net protocols AB that will define the most updated data on recurrent VHs compared to anti-VEGF injection. In addition, a detailed analysis of PPV versus intravitreal injections will be available.

Retinal detachment

Recurrent retinal detachment is a severe complication after diabetic PPV with a variable incidence ranging from 1.5% to 17% (27). The main risk factor for retinal detachment after PPV in a diabetic patient is the indication itself for vitrectomy and the extent of PFPs. The incidence of retinal detachment after surgery is higher in patients with TRD if compared to patients with VHs only. Several studies demonstrate that the incidence of rhegmatogenous retinal detachment after PPV for VHs range from zero to 4.3% (50).

Furthermore, in 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 intraoperative delamination was required, the rate of iatrogenic retinal break was higher (27.7% *vs.* 9%) and a postoperative tamponade was necessary in 43% of operated eyes. The incidence rate of rhegmatogenous retinal detachment after PPV for simple, non-tractional diabetic macular oedema is only 1.5% (51).

Nowadays, an overall tendency towards decrease of retinal detachment has been observed thanks to the technological improvement of surgical instruments. The use of wide-field noncontact viewing system in combination with accessory illumination system allows the surgeon to perform a bimanual technique. This approach reduces the retinal manipulation and improves the removal of fibrovascular tissue with a lower risk of iatrogenic retinal breaks and post-operative retinal detachment (51-53).

The risk of retinal detachment after diabetic PPV relies on the severity of indication, being the lowest for diabetic macular oedema without membranes and the highest for TRD.

Progressive anterior hyaloid fibrovascular proliferation

Progressive anterior hyaloid fibrovascular proliferation is a

rare and severe complication typically occuring in the first post-operative weeks due to the high expression of VEGF from the ischaemic anterior retina. The fibrovascular proliferative process could involve the anterior hyaloid, the posterior lens capsule, the ciliary body and the iris. A prompt surgical intervention is required to stop a progressive degenerative process toward bulbar atrophy.

Glaucoma

Glaucoma is considered a common complication after PPV and its incidence ranges from 7.9% to 20%, and is usually the open-angle form (54). Recent studies show no strict correlation between diabetic PPV and postoperative open angle glaucoma after surgery. A retrospective study published by Yu *et al.* including diabetic vitrectomy shows no increased risk of glaucoma after surgery compared to non-diabetic patients (55). The results of the PROVE study (Prospective Retinal and Optic Nerve Evaluation) will provide strong data on the chance of increased risk of open angle glaucoma after diabetic PPV.

Neovascular glaucoma is a well-known complication of diabetic vitrectomy. Recent studies report that the main risk factors for developing neovascular glaucoma after PPV are the degree of retinal ischemia and neovascularization, the diagnosis of neovascular glaucoma in the fellow eye and a long, complicated surgery (56). It was more frequent in the past years when lensectomy and aphakia were performed in combination with a PPV. Nowadays, surgeons perform a phacoemulsification and posterior chamber IOL implantation combined with a PPV. This technique has been reported to dramatically decrease the postoperative incidence of neovascular glaucoma. Yau *et al.* confirmed higher risk of neovascular glaucoma after diabetic PPV in patients who underwent a lensectomy compared to the pseudophakic ones (27).

It is mandatory to achieve a precise and comprehensive evaluation of both optic nerve and the degree of proliferative DR before performing a diabetic PPV in order to identify possible risks to develop glaucoma after surgery.

Endophthalmitis

The overall rate of endophthalmitis after PPV in the general population is low, ranging from 0.14% to 0.039% (57). Diabetes could be a risk factor for endophthalmitis after PPV because of the altered immune response and for the longer-duration of surgery. A recent study on the risk of endophthalmitis following PPV found diabetes as a potential predisposing factor (47% of the infected patients had diabetes) (58). These results confirm that even if the overall rate of infection after vitrectomy is low, diabetes may contribute to raise the risk for postoperative endophthalmitis.

Conclusions

PPV has a key role in the treatment of severe proliferative DR. The indications for performing a PPV in diabetic patients have progressively increased thanks to technological innovations of surgical instruments and preoperative treatment with anti-VEGFs drugs.

However, a comprehensive patients' evaluation before intervention is mandatory in order to plan the better surgical strategy. Moreover, preoperative anti-VEGF injection and panretinal photocoagulation need to be considered to reduce the risk of intraoperative complications such as bleeding or retinal breaks.

The microincision technology, the panoramic viewing systems and the new endoillumination devices allow shorter and safer procedures with a lower rate of intra and postoperative complications. Small gauge instruments could be more advantageous in the management of more complex cases, offering a wide variety of different technical approach, from the more traditional one to the newest single-probe techniques. Small gauge PPVs are optimal to use in diabetic TRD, allowing innovative approaches for membrane dissection and faster recovery from surgery.

Despite the modern improvements, PPV for proliferative DR and the management of its complications remains a serious challenge even for the most skilled vitreoretinal surgeon.

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