Research Square

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# Long-Term Outcomes of 25-Gauge Pars-Plana Vitrectomy in Diabetic Tractional Retinal Detachment

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# Abstract

**Purpose :** To evaluate the long-term outcomes of 25G pars plana vitrectomy (PPV) for diabetic tractional retinal detachment (TRD).

**Methods :** This retrospective study included eyes with diabetic type 1 or 2 TRD, excluding cases with preoperative intravitreal hemorrhage or prior vitrectomy. Outcomes assessed included best-corrected visual acuity (BCVA), retinal reattachment rate, need for additional surgery, and postoperative complications.

**Results :** A total of 124 eyes from 116 patients with TRD were included. The mean postoperative follow-up was 19.9 ± 17.1 months. Before surgery, 55.6% (69 eyes) had macula-off detachment. The mean BCVA improved significantly from the initial postoperative visit and remained stable throughout follow-up ($p<0.001$). Preoperatively, 46 eyes had moderate-to-severe visual impairment, while 56 were legally blind. Postoperatively, 54 eyes remained in the moderate-to-severe impairment category, and legally blind eyes decreased to 22. Primary reattachment was achieved in 93.5% of cases, increasing to 99.2% with additional surgeries. Postoperative complications were vitreous hemorrhage (12.9%), elevated intraocular pressure (5.7%), iris neovascularization (2.4%), epiretinal membrane (4%), and full-thickness macular hole (2.4%).

**Conclusion :** Twenty-five–gauge PPV for diabetic TRD demonstrated high anatomical success, significant visual improvement, and a low complication rate. Early surgical intervention, particularly before foveal involvement, is recommended to optimize visual outcomes and minimize complications.


# Key message

What is known :

Diabetic tractional retinal detachment is a major cause of vision loss in proliferative diabetic retinopathy, and pars plana vitrectomy is the standard treatment, but long-term outcome data for 25-gauge vitrectomy in large cohorts are scarce.

What's new :

In our large cohort of 25-gauge PPV for diabetic tractional retinal detachment (124 eyes), primary anatomical success was 93.5%, rising to 99.2% after additional surgery, with low rates of postoperative complications.

Visual acuity improved significantly after surgery and remained stable long-term, with legally blind eyes decreasing from 45.2% preoperatively to 17.7% at final follow-up.

Preoperative macular status determined final visual outcome, supporting early surgical intervention before foveal involvement to optimize results.

# Introduction

Despite advancements in diabetic management, diabetic retinopathy continues to impact over 90 million people. Its prevalence rises to 54% after 10 to 20 years of diabetes progression. [1–3] Among patients with proliferative diabetic retinopathy, tractional retinal detachment (TRD) stands out as a notable complication, resulting in permanent retinal damage and vision loss. [4] Approximately 5% of patients with proliferative diabetic retinopathy are estimated to necessitate pars plana vitrectomy (PPV) for the management of TRD. [5]

During the past few years, surgical advancements such as the use of wide-angle viewing systems, small-gauge vitrectomy, new tamponade agents, and anti-vascular endothelial growth factor (anti-VEGF) injections both before and during surgery have introduced new perspectives to the treatment of TRD. [6–8] Compared with 20-gauge vitrectomy, micro-incisional instruments have provided significant benefits, including improved operating times, better fluidics, reduced inflammation, increased patient comfort, fewer intraoperative retinal breaks, and faster recovery. [9–14] Along with the general progress in metabolic control, it is possible that the surgical outcomes of TRD have been influenced. The aim of this study is to evaluate the long-term outcomes of 25-gauge pars-plana vitrectomy in the management of diabetic TRD.

# Materials and methods

A retrospective, cross-sectional, monocentric study was conducted in a tertiary ophthalmology center, Lariboisiere Hospital (APHP, University Paris Cité) including patients operated for TRD from January 2017 to August 2023. The study adhered to the tenets of the Declaration of Helsinki and was approved by the French institutional review board (IRB 00008855 Société Française d'Ophtalmologie IRB#1).

Patients who underwent 25-gauge PPV for primary repair of diabetic TRD or for combined rhegmatogenous – tractional detachment (RRD-TRD) were included in the study. Patients lacking preoperative visual acuity were excluded from the study. Moreover, patients with a preoperative intravitreal hemorrhage were excluded due to the potential bias in assessing visual acuity improvement. Finally, patients with a history of prior vitrectomy and those with other co-existing proliferative vitreoretinopathies, such as proliferative sickle cell retinopathy or proliferative retinal venular occlusion were also excluded.

For each patient, demographic data were collected including age, sex and type of diabetes. Additionally, the following preoperative ophthalmologic data were extracted: best corrected visual acuity (BCVA), intraocular pressure (IOP), the presence of iris rubeosis and the history of preoperative anti-VEGF injections. BCVA was evaluated one to six months postoperatively and at the final visit of each patient. The pre- and postoperative images including ultra-wide color retinophotography (Optos® California) and spectral-domain optical coherence tomography (SD-OCT, Heidelberg Engineering, Germany or Zeiss Cirrus 5000) were analyzed. The occurrence of postoperative complications such as recurrence of TRD, were recorded at three months (± 2 months) after surgery and at the final visit.

# Surgical technique

PPV was performed by various surgeons using the Alcon Constellation vitrectomy machine and the Ultravit 25-gauge vitreous cutter (Alcon Laboratories, Inc., Fort Worth, TX, USA). All procedures were performed under either peribulbar or general anesthesia. In case of co-existing cataract, phacoemulsification with a limbal incision and in-the-bag intraocular lens implantation preceded vitrectomy. Vitrectomy, vitreous base shaving and 360° depressed peripheral examination were performed using a wide-angle viewing system (Resight®, Zeiss). A contact flat lens was used for membrane dissection or internal limiting membrane peeling. Fibrovascular proliferations were segmented using the vitreous probe, or for cases requiring bimanual dissection of extensive fibrovascular membranes, vitreoretinal scissors and micro-forceps were used along with an illuminated 25-gauge chandelier. When necessary, perfluoro-n-octane liquid was used. Endolaser photocoagulation was used in all patients to treat neovascularization or to barricade retinal breaks. Fluid-air exchange was performed, and injection of sulfur hexafluoride (SF6), hexafluoroethane (C2F6), octafluoropropane (C3F8), silicone oil, air or balanced salt solution was injected at the surgeon's discretion.

# Statistical analysis

The primary outcome was the BCVA gain assessed using the logMAR scale and was converted to Snellen. As recommended by the World Health Organization, we defined moderate-to-severe vision impairment as a BCVA of < 6/18 but ≥ 3/60 Snellen in the better eye or both eyes, and blindness as a BCVA of < 3/60 Snellen in the better eye or both eyes.[15] Secondary outcomes included the proportion of eyes that achieved successful reattachment of the retina after the initial surgery, the number of surgeries required to achieve retinal reattachment or to address complications, the percentage of patients that developed iris neovascularization and neovascular glaucoma and the percentage of patients encountering perioperative or postoperative complications.

Continuous variables were described with mean (± standard deviation (SD)) and categorical variables with percentages (%). The Shapiro-Wilk test was used to test the normality of the data. Continuous outcomes were compared between groups with unpaired Student t test, Welch t test or Mann-Whitney U test and categorical outcomes with the chi-squared or Fisher exact test according to the data distribution. A sub-analysis of final BCVA and BCVA gain was performed after dividing the patients into a macula-on and a macula-off group. For all tests, $p < 0.05$ was considered significant.

## Results

# Baseline characteristics and surgical maneuvers

A total of 124 eyes from 116 patients were included. Baseline characteristics are summarized in Table 1. Eighty-seven eyes (70%) had purely tractional retinal detachment, while 37 (30%) eyes had mixed tractional and rhegmatogenous retinal detachment. The retinal detachment did not involve the macula in

55 (44.35%) eyes (referred to as the macula-on group), while the macula was detached in 69 (55.64%) eyes, (referred to as the macula-off group).

Table 1
Baseline and intra-operative characteristics of the studied population Data are expressed as n (%), or mean ± standard deviation

| **Number of eyes / patients, n** | **124 / 116** |
|---|---|
| **Baseline characteristics** | |
| Age, years | 54.25 ± 13.99 |
| Gender: female/male, n | 66 / 50 |
| Type of diabetes: Insulin- / Non-insulin-dependent, n (%) | 31 / 85 |
| Duration of the diabetes, years | 14.49 ± 9.17 |
| HbA1c, % | 8.44 ± 2.24 |
| Hypertension, n (%) | 69 (59.5%) |
| Phakic, n (%) | |
| Intraocular pressure, mmHg | 14.08 ± 3.29 |
| Iris rubeosis, n (%) | 12 (9.7%) |
| Pan-retinal photocoagulation, n (%) | 36 (29%) |
| - Complete | 47 (37.9%) |
| - Partial | 41 (33.1%) |
| - None | |
| Type of retinal detachment, n (%) | 87(70.2%) |
| - Purely tractional | 37 (29.8%) |
| - Mixed | |
| Attached macula, n (%) | 55 (44.4%) |
| Preoperative anti-VEGF intravitreal injection, n (%) | 118 (95%) |
| **Surgical Manoeuvres** | |
| Combined surgery with cataract extraction, n (%) | 15 (12.1%) |
| Bimanual dissection technique, n (%) | 32 (29%) |
| Silicone tamponade, n (%) | 55 (44.4%) |
| Gas tamponade, n (%): | 34 (27.4%) |
| - SF6 tamponade, n | 15 (12.1%) |
| - C2F6 tamponade, n | 19 (15.3%) |
| No tamponade, n (%): | 35 (28.2%) |

| Number of eyes / patients, n | 124 / 116 |
|---|---|
| - Balanced salt solution, n | 13 (10.5%) |
| - Air, n | 22 (17.7%) |

A preoperative intravitreal injection of anti-VEGF was performed in 118 eyes (95%), three to five days before surgery. An intra-operative anti-VEGF injection was also performed in 115 (92.7%) eyes at the end of the surgical procedure.

All eyes underwent 25-gauge vitrectomy, and 32 (29%) of those required the use of a 25-gauge chandelier and bimanual technique for dissection of extensive fibrovascular membranes. During dissection, an iatrogenic retinal break occurred in 36 eyes (29%), and all were treated immediately by endolaser photocoagulation. A tamponade was used in 111 (89.52%) eyes.

The mean postoperative follow-up duration was 19.90 ± 17.11 (range 1 to 65) months.

## Functional results

The mean preoperative BCVA was 1.54 ± 0.77 logMAR (range 0.2 to 2.6) (Snellen 20/600 ± 20/125) and improved to 0.90 ± 0.7 logMAR (Snellen 20/160 ± 20/100) at the 3-month immediate postoperative visit ($p < 0.001$) and to 0.79 ± 0.7 logMAR (Snellen 20/125 ± 20/100) at final visit ($p < 0.001$). No difference was found between the BCVA at the early postoperative visit and the final visit ($p = 0.10$).

The proportion of eyes with moderate-to-severe vision impairment was 37.09% (n = 46) of eyes preoperatively and increased to 43.54% (n = 54) at the final visit ($p = 0.3$), while the proportion of eyes legally blind significantly decreased from 45.16% (n = 56 ) at baseline to 17.74% (n = 22) of eyes at the final visit ($p < 0.001$). Twenty-four eyes in the macula-on group and 22 in the macula-off group had moderate-to-severe vision impairment before surgery, while 11 in the macula-on and 45 in the macula-off group were legally blind. Postoperatively, 20 eyes in the macula-on group and 34 in the macula-off group had moderate-to-severe vision impairment before surgery, while 7 in the macula-on and 15 in the macula-off group were legally blind. (Table 2, Table 3)

Table 2
Functional results in the whole cohort (n = 124 eyes) (BCVA : Best-corrected visual acuity)

| Functional results | Preoperative | Postoperative | P-value |
|---|---|---|---|
| BCVA, logMAR [range] | 1.54 ± 0.77 [0.2–2.6] | 0.79 ± 0.7 [0-2.6] | |
| BCVA, Snellen equivalent | 20/600 ± 20/125 | 20/125 ± 20/100 | |
| Eyes with moderate-to-severe visual impairment, n (%) | 46 (37.1) | 54 (43.5) | 0.3 |
| Eyes legally blind, n (%) | 56 (45.2) | 22 (17.7) | < 0.001 |
| Data are expressed as n (%), or mean ± standard deviation [range] | | | |

Table 3
Characteristics' comparison between the macula on and the macula off group (BCVA : Best-corrected visual acuity)

| Characteristics | Macula on<br>n = 55 eyes | Macula off<br>n = 69 eyes | P-value |
|---|---|---|---|
| Age, years [range] | 53.1 ± 14.8 [29–86] | 55.2 ± 13.4 [27–81] | 0.43 |
| Gender: female/male, n | 20 / 33 | 30 / 33 | 0.75 |
| Type of diabetes: Insulin-dependent / non-insulin-dependent, n (%) | 14 / 39 | 18 / 45 | 0.95 |
| Pre-operative BCVA, LogMAR<br>Snellen equivalent | 1.25 ± 0.75<br>20/400 | 1.77 ± 0.72<br>20/1200 | < 0.001 |
| Post-operative BCVA, LogMAR<br>Snellen equivalent | 0.59 ± 0.88<br>20/80 | 0.87 ± 0.88<br>20/160 | 0.023 |
| BCVA change (logMAR) | + 0.65 ± 0.57 | + 0.90 ± 0.74 | 0.041 |
| Moderate-to-severe visual impairment pre-operatively, n (%) | 24 (43.6%) | 22 (31.9%) | 0.34 |
| Moderate-to-severe visual impairment post-operatively, n (%) | 20 (36.4%) | 34 (49.3%) | 0.1 |
| Legal blindness pre-operatively, n (%) | 11 (20%) | 45 (65.2%) | < 0.001 |
| Legal blindness post-operatively, n (%) | 7 (12.7%) | 15 (21.7%) | 0.16 |
| Data are expressed as n (%), or mean ± standard deviation | | | |

# Anatomic results and postoperative complications

Primary reattachment of the retina was achieved in 116 (93.5%) eyes. (Fig. 1,2) Eight eyes re-detached from which, one underwent one additional surgery and six two additional surgeries to achieve retinal reattachment. The final reattachment rate was 99.2%. One patient had a persistent retinal detachment in one eye but refused further surgery.

Regarding the postoperative complications, 16 (12.9%) eyes developed vitreous hemorrhage in the first six months following vitrectomy and 14 (11.3%) of them required surgery. Three (2.4%) eyes developed iris neovascularization following surgery because they were lost to follow up and came back only a few months later. The mean postoperative IOP one week following surgery was 14.2 ± 4.8 mmHg (range 5 to 35). Seven (5.7%) eyes developed intraocular hypertension (IOP ≥ 22 mmHg) which was controlled with IOP-lowering drops. At the final visit, only two of these eyes required additional anti-VEGF injections to control neovascular glaucoma. During the follow-up period, 46 (37.1%) eyes required cataract surgery. Five (4%) eyes developed an epiretinal membrane and 3 (2.4%) developed a macular hole requiring a second surgery.

# Discussion

In this series of 124 eyes with diabetic TRD operated on with 25-gauge vitrectomy, we observed both favorable anatomical and functional outcomes. A high reattachment rate (93.5% after a single procedure, increasing to 99.2% after additional surgeries) and a significant improvement in BCVA were achieved. Notably, BCVA improved in both macula-on and macula-off detachments, with maximal gains appearing soon after surgery and remaining stable. Nevertheless, because ischemic damage may be established prior to surgery, especially in long-standing detachments, final BCVA often remains limited in eyes with macula-off TRD.[16] Even so, the improvement from legal blindness preoperatively to moderate or severe visual impairment postoperatively offers a substantial gain in functional independence for many patients in this series. In our study, the proportion of eyes legally blind was significantly reduced from 45.2% to17.7% postoperatively. These findings align with previous studies that have reported a significant improvement in visual acuity in eyes operated for TRD. [17] These results underscore that early vitrectomy, before the fovea is compromised, can help optimize final visual outcomes. This recommendation is consistent with previous studies indicating that patients with attached maculae ultimately attain better BCVA. [17] Furthermore, our data confirm that 25-gauge PPV for TRD not only yields a high reattachment rate but also contributes to reducing diabetes-related blindness.

Previous studies have shown that tamponade does not seem to play a role in visual acuity improvement except in cases where silicone oil was used due to a poor preoperative status. [6, 7] In our study, an additional stratification of patients based on preoperative macular status was performed. Patients with a detached macula before surgery exhibited a greater improvement in visual acuity. However, final BCVA was better in patients who had an intact macula. Hence, early intervention, prior to macular detachment holds the potential to ensure better final visual outcomes.

The reattachment rate in our study was 93.5% after the first surgery and 99.2% after additional surgeries. Our results are in accordance with a recent systematic review on the outcomes of PPV in TRD which reports a reattachment rate of 94% after the first surgery and 99% after subsequent surgeries. [18] Similarly, studies exclusively evaluating 25-gauge instruments demonstrated reattachment rates ranging from 90–91 % ater the first surgery to 98–99 % ater the final surgery. [6, 7, 19, 20]

The surgical approach itself demands careful consideration. A major challenge in TRD repair is the dissection of fibrovascular proliferations, which are frequently dense and adherent. Meticulous membrane peeling is critical to prevent iatrogenic retinal breaks or traction, both of which heighten the risk of re-detachment and proliferative vitreoretinopathy (PVR). Likewise, thorough hyaloid removal, including in the periphery, is essential to minimize secondary contraction. Given the complexity of these maneuvers, a high level of surgical experience is desirable, particularly in handling delicate fibrovascular membranes to avoid complications that can compromise the final anatomical outcome.

In our cohort, postoperative complications remained relatively low. We recorded rates of vitreous hemorrhage, transient elevation of intraocular pressure, and iris neovascularization similar to or below those reported in previous studies focusing on 25-gauge techniques. Vitreous hemorrhage occurred in 12.9% of eyes, which is lower compared to the rate of 22.5% reported in the systematic review including various gauge size, [18] but similar to the rate reported in series using 25-gauge, even though instrument size has not been identified as a significant risk factor for vitreous hemorrhage. [6, 7]

The broad use of anti-VEGF agents may also have contributed to our favorable surgical and postoperative profile. Anti-VEGF injections though, prior to surgery, has been proven to lower the risk of intraoperative and postoperative bleeding. [8, 21] In contrast to previous studies, we found a low percentage of pressure-related complications, notably with zero cases of hypotony. [18] Despite early studies suggesting a higher incidence of low pressure in 25-gauge PPV, tunneling incisions and suturing the sclerotomies, when necessary, appear to prevent hypotony. [14, 22, 23] Lastly, in our study few patients developed an epiretinal membrane or a macular hole and no patient developed endophthalmitis. Nonetheless, patients and clinicians should be aware that, despite these benefits, disease severity and permanent ischemic damage often limit visual recovery. Clear preoperative counseling is, therefore, necessary to ensure realistic expectations.

Our study has certain limitations related to its retrospective design. Tamponade and sclerotomy suturing was based on surgeons’ discretion according to pre- and intraoperative findings. Moreover, postoperative visual acuity might be influenced by factors such as the time between the presentation of TRD and the operation, the extent of macular ischemia and the tamponade used. This study focuses on evaluating the long-term outcomes of 25-gauge PPV in TRD within a real-world practice setting. Rather than aiming to directly compare the 25-gauge system with other port systems, our objective is to comprehensively evaluate its performance over time. It's important to note that this evaluation considers inherent limitations that are inevitable in real-world scenarios.

To our knowledge, this study represents the largest published cohort investigating long term outcomes of 25-gauge PPV in diabetic TRD. [6, 7, 11, 19, 23–25]

In summary, our findings confirm that 25-gauge vitrectomy for diabetic TRD is an efficient, low-risk procedure that can reduce blindness and improve quality of life in patients with advanced diabetic retinopathy. With appropriate surgical expertise and early intervention, particularly before macular detachment, long-term anatomical and functional results can be significantly enhanced.

## Declarations

**Competing Interests :**

The authors have no competing interests to declare that are relevant to the content of this article.

**Disclosure of funding** :

No funding was received for conducting this study.

**Ethics approval :**

The study adhered to the tenets of the Declaration of Helsinki and was approved by the French institutional review board (IRB 00008855 Société Française d'Ophtalmologie IRB#1).

**Consent to participate :**

Informed consent was not required given the retrospective nature of the study and anonymity which was respected throughout the whole process of data collection and analysis.

# Author Contribution

BM and AA collected the data. VC, BM and AA analysed the data. VC, BM and AC prepared the figures. VC and AC wrote the manuscript. All authors reviewed the manuscript.

# Acknowledgement

The authors would like to pay tribute to the memory of Professor Ramin Tadayoni, whose valuable contributions greatly enriched this work.

# Data Availability

The datasets used during the current study, which include anonymized individual patient clinical and imaging data, are available from the corresponding author on reasonable request and with approval from

the hospital's institutional review board.

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# Figures

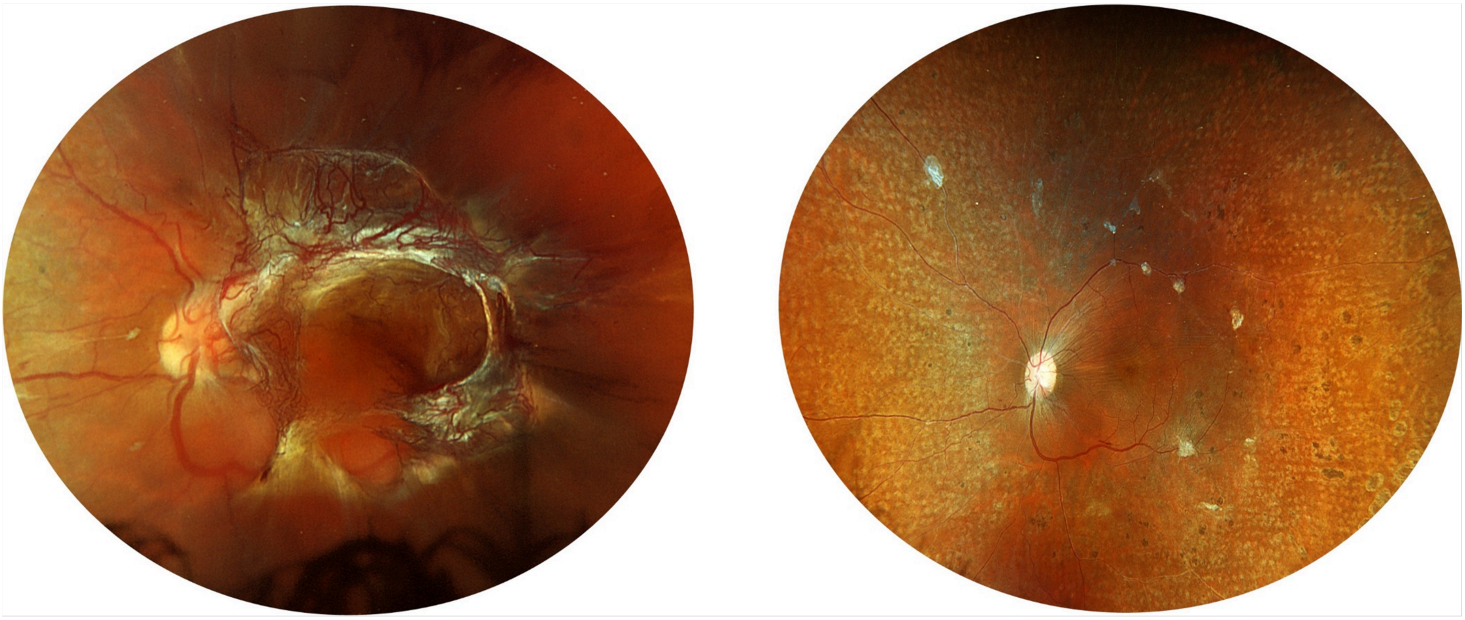


**Figure 1**

Retinophotography of diabetic tractional detachment, macula-off with preoperative BCVA at counting fingers (left). Postoperative outcome with BCVA 0.80 logMAR (right).

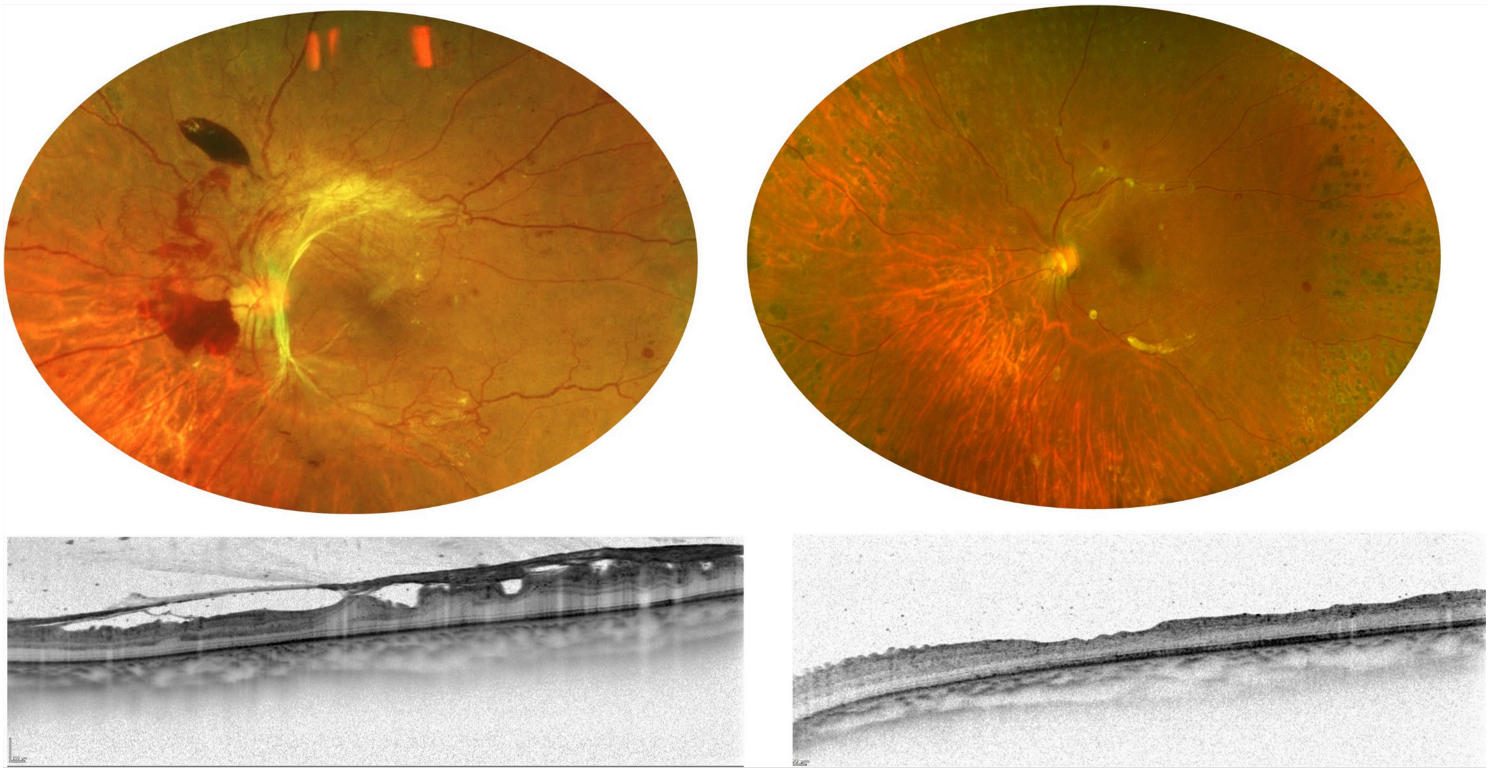


**Figure 2**

Retinophotography of diabetic tractional detachment with preoperative BCVA 1.00 logMAR (left). Postoperative outcome with BCVA 0.80 logMAR (right) with the corresponding spectral-domain optical coherence tomography passing through the fovea.