

Primary Outpatient Pneumatic Retinopexy for Rhegmatogenous Retinal Detachment in Albania

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Abstract

A scleral buckle is one of several ophthalmologic procedures available for repairing retinal detachment. **Pneumatic Retinopexy (PR)** represents a safe and effective primary outpatient treatment for selected cases of **Rhegmatogenous Retinal Detachment (RRD)**, which are typically caused by retinal tears. Scleral buckle can be used to close the retinal break in both acute and chronic retinal detachments. This report presents the first clinical experience for “Albanian Eye Center” evaluating the anatomical and functional outcomes of pneumatic retinopexy as a primary treatment for rhegmatogenous retinal detachment. In this retrospective study, 25 eyes from 25 patients with RRD were treated with primary outpatient pneumatic retinopexy, without initial pars plana vitrectomy. In all cases, perfluoropropane (C_3F_8) gas was used as the intraocular tamponade. Demographic data, retinal break characteristics, macular status, preoperative and postoperative visual acuity, complications, and anatomical success were analyzed. Visual acuity recorded as **hand motion (HM)** was converted to a decimal value of 0.001 for statistical analysis. Encouraging results were observed: primary anatomical success was achieved in 18 of 25 eyes (72%). Visual acuity improved in most eyes with primary anatomical success, particularly in macula-on cases. All eyes with primary failure (28%) underwent secondary surgical intervention, resulting in final retinal reattachment in all cases. No severe vision-threatening complications were observed. These outcomes are comparable to those reported by international ophthalmologic research studies and support the broader implementation of this technique in appropriately selected patients.

Keywords

Surgical Intervention, Pneumatic Retinopexy, Retinal Surgery, Retinal Detachment, Rhegmatogenous Detachment

1. Introduction

1.1. Brief Historical Overview

Scleral buckling is one of the earliest successful surgical treatments for RRD, a potentially sight-threatening condition requiring prompt surgical intervention to prevent irreversible vision loss. Traditional approaches to RRD management include scleral buckling and *Pars Plana Vitrectomy (PPV)*, both of which are associated with high anatomical success rates.

In the early 20th century, retinal detachment was largely untreatable. Jules Gonin established that retinal breaks are the primary cause of RRD and emphasized closure of these breaks as the key to successful treatment. Between the 1930s and 1950s, Custodis and Schepens refined scleral buckling techniques by introducing polyviol material, improving break localization, adding cryotherapy, and utilizing silicone explants. In the 1960s and 1970s, and later in the 1980s, the use of silicone sponges or solid silicone elements became standard for more extensive disease [1] (*Scleral buckling-a brief historical overview...*).

The advent of PPV subsequently reduced the frequency of scleral buckling, especially for complex retinal detachments. Despite this decline, scleral buckling remains an important and effective option in selected cases. It is now primarily indicated for uncomplicated retinal detachments, particularly where outcomes are comparable or superior to those achieved with vitrectomy. However, these procedures remain relatively invasive, require operating room resources, and may be associated with longer recovery times and increased healthcare costs.

If the integration of PP as a standard outpatient treatment option for selected cases of RRD, than this method has the potential to substantially strengthen the ophthalmic care, because support diagnostic and triage tools, the clinical and organizational impact of this approach doing more significant procedure. PR allows retinal detachment management to be performed in an outpatient setting, reducing dependence on high-complexity surgical theaters.

This strategy can expand access to retinal treatment in both tertiary and secondary centers, particularly in regions, where full pars plana vitrectomy programs remain limited. Some other advantages of this method are: optimization of healthcare resources, enhanced patient experience and efficiency of care, strategic impact on national ophthalmic services etc.

1.2. Rising Global Trends in RRD Incidence

RRD is a condition that threatens vision and predominantly affects individuals aged 50 and older. Recent epidemiological studies have determined the incidence of RRD to be approximately 13 per 100,000 person-years, with men exhibiting a 1.3-fold higher risk compared to women. Globally, the incidence is estimated at 12.2 per 100,000 persons annually, according to systematic review and meta-analysis data. Among recognized risk factors, the global prevalence of myopia is on

the rise. Notably, there is a discernible upward trend in RRD incidence, an increase of about 5.4 cases per 100,000 per decade from 1997 to 2019. Europe reports some of the highest RRD incidence rates globally (approximately 14.5 per 100,000), a pattern attributed to aging populations and widespread cataract surgery [2] [3] (***Increasing trend in RRD in Korea, 2004-2015***). In contrast, regional data from Eastern Europe and the Balkan Peninsula remain limited, with nationwide incidence studies for several Balkan countries (e.g., Albania, Serbia, Kosovo, North Macedonia, Bulgaria) largely absent from the literature. Nevertheless, select studies from Poland (Central/Eastern Europe) indicate an overall retinal detachment incidence of 32.6 per 100,000, with RRD accounting for 13.7 per 100,000 findings that align with broader European trends and highlight strong associations with age and myopia. In Croatia (a Balkan country), a retrospective study in Dubrovnik-Neretva County reported an RRD incidence of 7.65 per 100,000, demonstrating a marked increase over a decade (from very low rates in the early years to 17.21 per 100,000 in later years). This increase was linked to myopia, cataract surgery and trauma [4] [5] (***Scleral buckling surgery in Germany for RRD: a spirit of the past or current practice?***).

To date, there are no published reports from our country regarding the use of PR as a primary outpatient intervention for RRD. The adoption of this technique marks a significant advancement in expanding minimally invasive vitreoretinal surgical options within the region. The aim of this study is to assess the anatomical and functional outcomes of primary outpatient PR for RRD and to present the first clinical experience from Albania, specifically without the use of primary pars plana vitrectomy [5] (***The incidence of RRD is increasing***).

1.3. Evolution of the Rhegmatogenous Retinal Detachment Technique

PR is a minimally invasive procedure for reattaching the retina that involves the intravitreal injection of an expanding gas bubble, combined with laser photocoagulation and/or cryopexy. Since its introduction in 1985 by ophthalmologists Hilton G.F. and Grizzard W.S. in the United States, as well as Dominguez D.A. in Spain, pneumatic retinopexy has gained widespread acceptance as an alternative to scleral buckling for selected cases of retinal detachment. To date, over 100 publications have documented several thousand cases worldwide [6] (***Anatomical and visual outcomes of PR in primary RRD***). Comparative research studies have evaluated PR versus scleral buckle in the management of simple RRD. Primary anatomical success rates for PR are reported to range from 70% to 80% in carefully selected cases, with final success rates approaching those of more invasive surgical techniques after secondary interventions when necessary. Despite these favorable outcomes, the adoption of PR varies considerably across regions and remains underutilized in many healthcare systems. PR was specifically developed as a less invasive option for selected cases of RRD, which arises from a full-thickness retinal break that permits liquefied vitreous to accumulate in the subretinal space,

resulting in the separation of the neurosensory retina from the retinal pigment epithelium [7] (*PR for RRD outcomes*). Previous studies have explored risk factors influencing the success of PR based on original inclusion criteria and surgical techniques. In our series, the procedure was performed by a single surgeon in “Albanian Eye Center” and involved intravitreal injection of an expansile gas bubble combined with retinopexy using laser photocoagulation or cryotherapy. When appropriate patient selection criteria are met, PR offers several advantages, including outpatient management, preservation of vitreous anatomy, more rapid visual recovery, and a reduced overall surgical burden [8] (*PR vs scleral buckle for repairing simple RRD...*).

2. Method and Patients

2.1. Study Design

In this study, 25 eyes from 25 patients diagnosed with RRD were treated with single-session PR during the 2023–2025 period, which represents a safe and effective method in “Albanian Eye Center” for selected cases by RRD. In addition, the PR has offered practical advantages, because this procedure reduce the need for operating room resources, shortening procedure time, and minimizing hospitalization requirements, which factors contribute to lower overall healthcare costs and improved patient convenience, allowing our tertiary center to allocate surgical capacity more efficiently. This study specifically evaluated the anatomical and functional outcomes in patients treated with primary outpatient PR. For each case, multiple clinical parameters were assessed to address questions surrounding patient selection and surgical technique. The data collected are interpreted based in viewpoints by several international vitreoretinal researcher specialists, who have discussed the role of PR in the management of RRD. They have emphasized that the PR offers a simple and effective outpatient procedure for selected retinal detachments, with the advantages of reduced surgical trauma, lower cost, and rapid visual recovery when compared with more invasive surgical approaches, highlighting that proper case selection is the key determinant of success.

For our institution the clinical workflow to the 25 eyes from 25 patients with confirmed (RRD) were screened for eligibility during above study period. Of these, 9 patients met the predefined anatomical and clinical criteria for PR, including the presence of one or a limited number of clearly identifiable retinal breaks, predominantly superiorly located breaks, absence of advanced proliferative vitreoretinopathy (PVR), and ability to comply with postoperative positioning requirements. Of the 42 individuals assessed, the remaining 16 were excluded because they did not meet the eligibility criteria for PR, primarily due to advanced PVR, giant retinal tears, extensive inferior retinal breaks unsuitable for gas tamponade, or ocular comorbidities associated with a poor visual prognosis.

2.2. Patient Selection: Inclusion and Exclusion Criteria

Patients were included if they met the following criteria: 1) confirmed diagnosis

of RRD; **2)** presence of one or a limited number of clearly identifiable retinal breaks; **3)** retinal breaks located predominantly in the superior quadrants; **4)** absence of advanced proliferative vitreoretinopathy; and **5)** capacity to adhere to postoperative positioning requirements [9] (*Steps of protocol to scenario of RRD technique used in AEC...*).

Exclusion criteria were as follows: **1)** advanced proliferative vitreoretinopathy; **2)** giant retinal tears; **3)** extensive inferior retinal breaks deemed unsuitable for pneumatic tamponade; and **4)** ocular comorbidities severely limiting visual prognosis.

2.3. Preoperative Evaluation

All patients underwent a comprehensive ophthalmologic evaluation, which included the following assessments: **1)** best-corrected visual acuity measurement; **2)** dilated fundus examination; **3)** slit-lamp biomicroscope; **4)** indirect ophthalmoscopy; **5)** detailed documentation of the location of retinal breaks and the extent of retinal detachment; and **6)** evaluation of macular status (classified as macula-on or macula-off). Visual acuity was recorded using decimal notation. In cases where vision was limited to hand motion (HM), a decimal value of 0.001 was assigned for statistical analysis.

2.4. Surgical Technique

There are currently three principal surgical options for the management of RRD: **1)** pneumatic retinopexy, **2)** Scleral Buckling (**SB**), and **3)** pars plana vitrectomy (PPV). The choice of surgical approach is influenced by several factors, including the number, location, and size of retinal breaks, the presence of proliferative vitreoretinopathy (PVR), the patient's ability to maintain postoperative positioning for optimal tamponade, lens status, and the surgeon's experience and preference. Of these, proliferative vitreoretinopathy is the most significant predictor of primary surgical failure, with success rates decreasing from 90% to 68% in the presence of preoperative PVR [10] (*Characteristics and surgical outcomes of giant retinal tear associated RRD...*) PVR is characterized by cellular proliferation on both surfaces of the detached retina and vitreous base, resulting in the formation of contractile periretinal membranes. PVR can also develop postoperatively and is a leading cause of surgical failure, alongside new or missed retinal breaks. Numerous studies have identified clinical risk factors for the development of PVR and consequent primary failure, including vitreous hemorrhage, PVR at presentation, aphakia, uveitis, RRD associated with trauma, longer duration of detachment, and preoperative choroidal detachment [11] (*Surgical failure following PRD surgery by vitrectomy...*). However, there is currently no effective treatment for PVR.

All surgical procedures were performed on an outpatient basis under topical anesthesia. PR was conducted using a standardized protocol established in "Albanian Eye Center". Initially, approximately 0.3 ml of aqueous humor was with-

drawn from the anterior chamber with a 30-gauge needle without a piston to lower intraocular pressure and create space for subsequent gas expansion. The use of intraocular gases such as hexafluorosilane (SF_6) or perfluoropropane (C_3F_8) is critical in RRD management, as these agents facilitate closure of retinal breaks until a permanent chorioretinal adhesion is established through retinopexy [12] (*The use of intraocular gases.*).

In our series according the protocol, following aqueous release, 0.5 ml of perfluoropropane gas was injected into the vitreous cavity via the pars plana using a 30-gauge needle. The volume was carefully chosen to provide effective intraocular tamponade while minimizing the risk of intraocular pressure elevation or central retinal artery occlusion [9] [12]. Perfluoropropane is a fluorinated gas widely utilized in vitreoretinal surgery due to its favourable chemical and physical properties. The schema of the gas injection procedure is shown in **Figure 1** and **Photo 1** below:

Table 1 summarizes the chemical and physical properties of these gases and explains how these characteristics contribute to their utility in ophthalmic surgery.

Table 1. Summary of C_3F_8 gas properties for eye surgery.

Property	Surgical relevance
Chemical inertness	Safe inside the eye
Low solubility	Long persistence
Expansion ability	Effective retinal tamponade
Slow diffusion	Extended healing support
Optical clarity	Allows postoperative monitoring

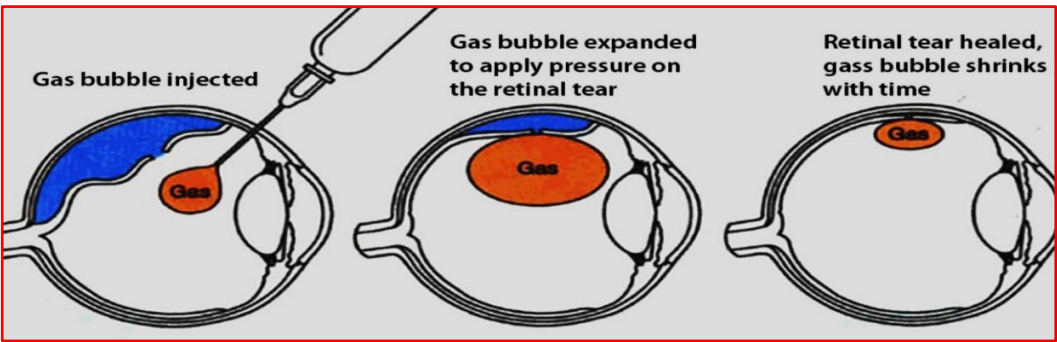


Figure 1. Gas injection procedure.

Perfluoropropane gas was selected as the tamponade agent due to its prolonged intraocular persistence, which provides extended retinal support and allows adequate time for the formation of chorioretinal adhesions. Furthermore, its property of spontaneous absorption obviates the need for a subsequent removal procedure, making it particularly well-suited for use in outpatient PR.

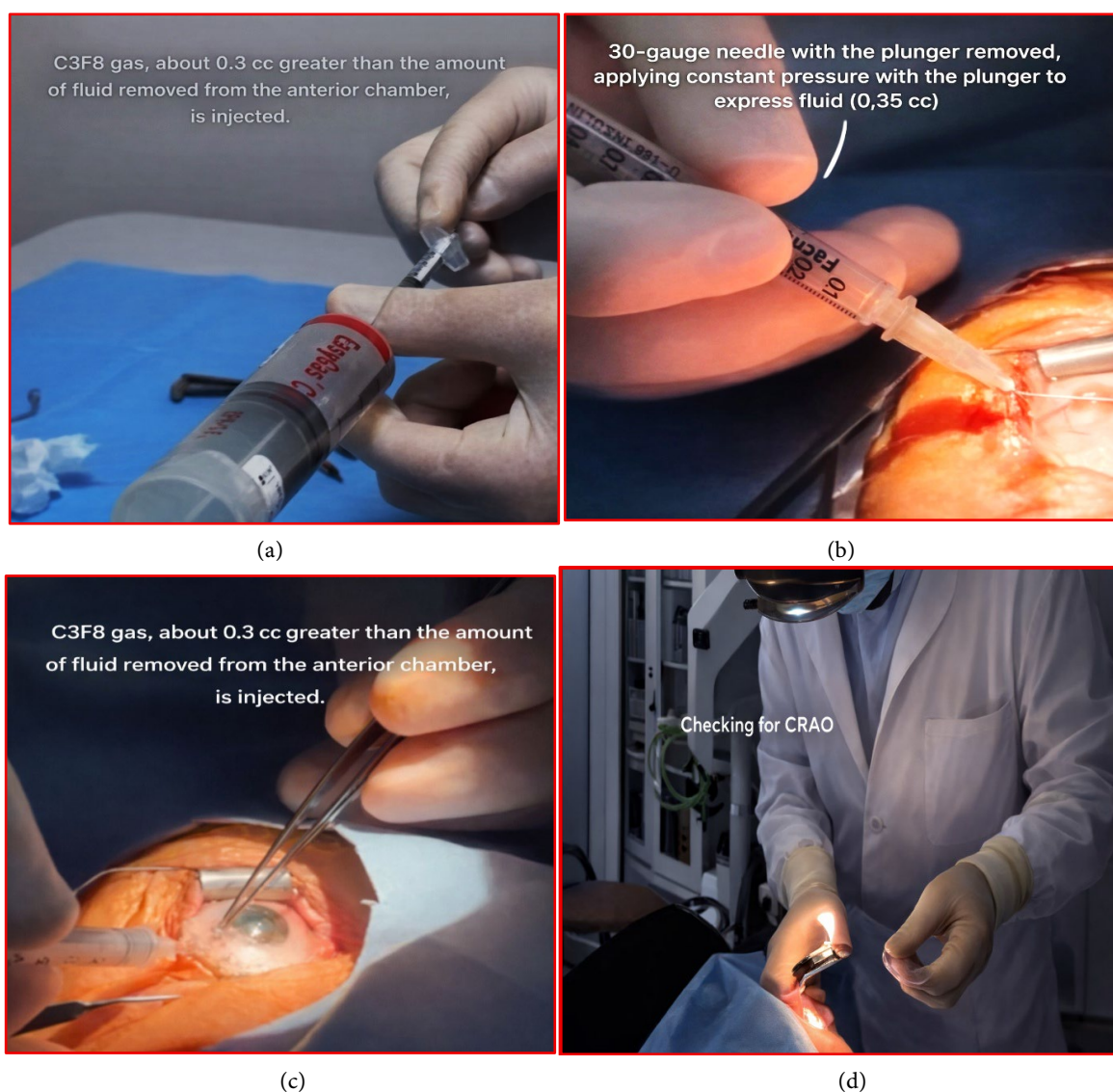


Photo 1. (a)-(d) Steps of gas injection procedure.

Barrier laser photocoagulation was applied circumferentially around the identified retinal break to facilitate chorioretinal adhesion and reinforce retinal closure. Laser treatment was administered only after satisfactory retinal apposition had been confirmed

2.5. Postoperative Positioning

Patients were instructed to adhere to strict postoperative head positioning tailored to the location of the retinal break. For superior or supertemporal breaks in the left eye, this involved right lateral decubitus positioning with a slight face-down tilt. Progressive retinal flattening was typically observed during the immediate postoperative period. All patients were discharged on the same day, provided with detailed written instructions regarding positioning, and scheduled for prompt follow-up evaluation. This study further explores variables influencing retinal dis-

placement, immediate postoperative positioning protocols, and the selection of tamponade agents.

2.6. Outcome Measures

**Primary anatomical success*: complete retinal reattachment after PR without the need for additional surgical intervention.

**Final anatomical success*: retinal reattachment achieved after secondary surgical procedures if required;

**Functional outcome*: change in best-corrected visual acuity;

**Complications*: intraoperative and postoperative adverse events.

2.7. Statistical Analysis

Data acquisition followed a systematic methodology, with all primary RRD cases registered between 2023 and 2025 included in the present study. Continuous variables were summarized as means and ranges, while categorical variables were presented as absolute numbers and percentages [13] (*Idiopathic e.m.. visual outcomes, prognostic factors*). Given the exploratory nature of the study and the limited sample size, no inferential statistical analyses were performed.

3. Illustration and Explanation of the Data Compared with Other Foreign Authors

3.1. Illustration Based on Study Data

A total of 25 patients (25 eyes) with RRD underwent primary surgical intervention, and all of whom received single-session PR. The cohort comprised 11 females (44%) and 14 males (56%). Seventeen participants (68%) resided in rural areas, while eight (32%) lived in urban centers in Albania or Kosovo. The mean age was 58.6 years (range: 23 - 79 years; SD: 11.8), with the majority of cases occurring in middle-aged or older males. The highest incidence was observed in the 63 - 69 year age group.

3.2. Explanation of the Data Compared with Other Foreign Authors

This research article presents the first clinical experience from the “Albanian Eye Center” utilizing PR as a primary outpatient treatment for RRD. In this retrospective case series of 25 eyes, a primary anatomical success rate of 72% was achieved, aligning with internationally reported rates for appropriately selected cases [11] [14] (*Out comes & Variables that impact PR*) and [15] (*Clinical Outcomes of RRD treated with PR*). Previous studies have documented primary success rates for PR between 70% and 80%, with final anatomical success approaching that of more invasive surgical techniques following secondary interventions as needed. The outcomes of our study are consistent with these findings, reinforcing the effectiveness of pneumatic retinopexy when stringent selection criteria are applied.

A notable observation in our cohort was the high proportion of macula-off ret-

inal detachments at presentation, accounting for approximately two-thirds of cases. This likely influenced overall visual outcomes, as macula-off status is a well-established predictor of poorer postoperative visual acuity. Nonetheless, significant visual improvement was observed in the majority of eyes achieving primary anatomical success, particularly among patients presenting early with uncomplicated superior retinal breaks.

All cases of primary failure were successfully managed with secondary surgical interventions, including pars plana vitrectomy with or without silicone oil tamponade, resulting in 100% final retinal reattachment. This supports the widely accepted view that failure of PR does not compromise final anatomical outcomes nor preclude successful subsequent surgery. The exclusive use of C_3F_8 gas in all cases may have contributed to favorable anatomical results [12], as its prolonged intraocular persistence provides extended tamponade, allowing sufficient time for stable chorioretinal adhesion formation (see **Table 1**, row 3). This characteristic is particularly advantageous in cases with delayed presentation or complex retinal break configurations.

Importantly, no severe vision-threatening complications, such as endophthalmitis or irreversible visual loss, were observed. Reported complications were limited and comparable to those described in previous studies, further supporting the safety profile of pneumatic retinopexy as an outpatient procedure [16] (***Incidence of detachment 6 months after SB surgery***). Most complications can be prevented through thorough preoperative assessment, meticulous surgical technique, and appropriate postoperative management. Preventive and management strategies should be tailored by the ophthalmologic surgical specialist.

The introduction of PR in a setting where pars plana vitrectomy has traditionally been the primary modality represents a significant shift toward less invasive and more cost-effective retinal detachment management, particularly in healthcare systems with limited resources.

The limitations of this study include its retrospective design, relatively small sample size, lack of a direct comparison group treated with alternative surgical techniques, and variable follow-up duration among patients. Prospective studies with larger cohorts and longer follow-up are warranted to further validate these findings in the future in “Albanian Eye Center”.

3.3. More Details for the Data of Study Cases

The staff in our center identified all cases of RRD registered between 2023-2025 required surgical intervention, documenting both demographic and clinical characteristics for each patient shown in **Table 2**.

Table 2 presents detailing, both anatomical and functional outcomes for patients who underwent primary and, if necessary, secondary surgical intervention for RRD. The date of the first recorded claim in the database was designated as the incident time, and each patient was classified as an incident case for that corresponding year. The real data of patients who underwent PR for the repair of

primary RRD were retrieved from medical records and retrospectively analyzed. Patients with a follow-up time of less than 4 months were contacted and invited for examination. Patients with less than 2 months of follow-up were excluded.

Table 2. Baseline demographic and clinical characteristics of patients.

Characteristic	Value
Number of eyes/patients	25/25
Mean age (years)	Middle-aged to elderly (range 23 - 79)
Sex	Male and Female
Eye involved	Right and Left
Duration of symptoms	5 - 20 days
Systemic comorbidities	Hypertension, Diabetes mellitus, Renal disease
Lens status	Phakic and pseudophakic
Location of retinal breaks	Predominantly superior/supertemporal
Macula status at presentation	
– Macula on	6 (24%)
– Macula off	17 (68%)
– Partially off /unclear	2 (8%)
Gas used	C ₃ F ₈ (100%)
Setting	Outpatient

A total of 25 eyes from 25 patients, according **Table 3**, underwent PR for the treatment of primary (RRD) during the study period. All treated eyes (100%) met the inclusion criteria and were included in the retrospective analysis. Patients with less than 2 months of follow-up were excluded, while those with follow-up shorter than 4 months were contacted and invited for further examination. The mean follow-up duration was 4 months, and only 3 eyes (12%) had follow-up shorter than 4 months.

The primary anatomical success rate, defined as successful retinal reattachment after a single PR procedure without additional intervention, was achieved in 18 eyes (72%) at 2 months postoperatively. Accordingly, primary anatomical failure occurred in 7 eyes (28%).

Among the failed cases, 4 eyes (16% of the total cohort, or 57.1% of failed cases) achieved retinal reattachment after one additional surgical intervention. With reoperation when necessary, final anatomical success defined as complete retinal reattachment at the last follow-up visit was achieved in all 25 eyes (100%). Primary anatomical success in this study refers to single-procedure success after the initial PR. Final anatomical success refers to retinal reattachment at the last follow-up visit after any additional procedures required to repair recurrent or persistent detachment. Postoperative visual acuity was evaluated as the best visual acuity

achieved during follow-up, rather than at a fixed postoperative time point, allowing assessment of the maximum functional recovery attained after treatment.

Table 3. Clinical outcomes of pneumatic retinopexy for primary (RRD).

Variable	Result
Total eyes/patients treated with PR	25/25
Eyes included in analysis	25 (100%)
Mean follow-up time	4 months
Eyes with follow-up < 4 months	3 (12%)
Eyes with follow-up < 2 months	Excluded (none included)
Primary anatomical success at 2 months (single-procedure success)	18 (72%)
Primary anatomical failure	7 (28%)
Failed cases successfully reattached with 1 additional operation	4 (16% of total; 57.1% of failures)
Final anatomical success (after reoperation if needed)	25 (100%)
Postoperative visual acuity assessment	Best postoperative visual acuity achieved during follow-up

3.4. The Statistical Interpretation of Postoperative Visual Outcomes

The statistical analysis of postoperative visual outcomes was performed using nonparametric methods selected, because in our study was a small sample size, non-normal distribution of visual acuity data, and the ordinal/semicontinuous nature of several predictors. The Spearman rank correlation was used to assess monotonic associations between postoperative visual acuity and continuous or ordinal clinical variables. The Mann-Whitney test was applied for comparisons between independent groups, and Wilcoxon signed rank test should be used when comparing paired preoperative and postoperative visual acuity values within the same eyes. All these data mentioned above were integrated and summarized for the statistical test interpretation in **Table 4**.

A key methodological issue in ophthalmic outcome studies is the treatment of very low visual acuity categories such as **C**ounting **F**ingers (**CF**) and **H**and **M**otion (**HM**). These values are not directly continuous and should not be excluded from analysis, as omission may introduce bias and overestimate postoperative visual outcomes. Instead, they should be converted into approximate log MAR equivalents to permit inclusion in rank-based and nonparametric statistical testing. Based on contemporary validation studies, **CF** can reasonably be coded near 2.0 log MAR, while **HM** should be coded near 2.3 - 2.6 log MAR, depending on the measurement protocol and underlying pathology [7] [9] [15]. Recent evidence suggests that **HM** may vary substantially in patients with severe visual field loss, but remains suitable for ordinal ranking in nonparametric analysis.

Table 4. Integrated and summarized of the statistical test interpretation.

<i>Domain</i>	<i>Variable (s)</i>	<i>Statistical test</i>	<i>Main finding</i>	<i>Interpretation</i>	<i>Recommended handling of HM</i>
Correlation with postoperative VA	Age	Spearman correlation	$r = -0.24$, $P = 0.27$	Weak negative, not significant	Convert HM to log MAR and retain in ranking
Correlation with postoperative VA	Duration of symptoms	Spearman correlation	$r = -0.02$, $P = 0.93$	No association	Convert HM to log MAR and retain in ranking
Correlation with postoperative VA	Macula status (on/off)	Spearman correlation	$r = +0.14$, $P = 0.51$	Weak positive, not significant	Code ordinally (e.g., on = 1, off = 0); include HM as ranked log MAR
Correlation with postoperative VA	Primary anatomical success	Spearman correlation	$r = +0.72$, $P < 0.001$	Strong positive, statistically significant	Include HM as converted log MAR to preserve full postoperative distribution
Group comparison of postoperative VA	Macula-on vs macula-off	Mann-Whitney	Macula-on better, $P > 0.05$	Clinically better but underpowered	HM should be converted to log MAR, not excluded
Group comparison of postoperative VA	Hypertension present vs absent	Mann-Whitney	Not significant	No detectable effect in this cohort	HM converted to log MAR
Group comparison of postoperative VA	Diabetes present vs absent	Mann-Whitney	Not significant	No significant association overall; severe diabetes may worsen outcomes clinically	HM converted to log MAR
Group comparison of postoperative VA	Any systemic disease present vs absent	Mann-Whitney	Not significant	No significant effect overall	HM converted to log MAR
Paired visual outcome change	Pre-op vs post-op VA	Wilcoxon signed-rank	Recommended for within-eye comparison	Most appropriate for paired VA change	HM must be converted to log MAR and retained
Low-vision category handling	HM/CF values	Methodological standard	Should not be excluded	Exclusion biases results and reduces power	Convert CF ≈ 2.0 log MAR; HM $\approx 2.3 - 2.6$ log MAR depending on protocol

3.4.1. Correlation Analysis (Spearman)

Spearman rank correlation demonstrated that primary anatomical success was the only variable significantly associated with better postoperative visual acuity ($r = 0.72$, $P < 0.001$), indicating a strong positive association between successful retinal reattachment after primary intervention and improved postoperative vision. This finding is clinically expected and consistent with previous research author reports [2] showing that anatomic retinal reattachment is the strongest predictor of functional visual recovery after (PR). No statistically significant correlations were observed between postoperative visual acuity and age ($r = -0.24$; $P = 0.27$), duration of symptoms ($r = -0.02$; $P = 0.93$), or macular status at presentation ($r = +0.14$; $P = 0.51$). These results suggest that, within this cohort, these variables did not independently predict postoperative visual acuity in a statistically detectable manner, although their clinical influence cannot be excluded given the modest sample size and limited statistical power. The absence of a significant age effect in the present cohort is consistent with reports indicating that age may influence early

postoperative recovery but not necessarily final visual acuity outcomes, particularly after retinal procedures, which conclusions are consistent with the findings reported by author [17] (*RD following cataract phacoemulsification...*).

Similarly, symptom duration and baseline macular involvement may influence prognosis clinically, but their effect may not be sufficiently strong to reach significance in small retrospective cohorts.

3.4.2. Group Comparisons (Mann-Whitney)

Comparison of postoperative visual acuity between macula-on and macula-off retinal detachments showed that eyes with macula on detachment achieved better postoperative vision, as expected clinically; however, the difference was not statistically significant ($P > 0.05$). This likely reflects limited sample size ($n = 6$ vs. $n = 17$) rather than absence of a true clinical effect. Similarly, systemic comorbidities including hypertension, diabetes mellitus, and any systemic disease were not significantly associated with postoperative visual outcome on Mann Whitney testing [18] (*Perioperative s.b.p parameters and clinical outcomes following...*). Although no statistically significant effect was observed, diabetes with poor glycemic control and active diabetic retinopathy appeared clinically associated with worse outcomes, suggesting that disease severity may be more relevant than diagnosis alone.

3.4.3. Paired Comparisons (Wilcoxon Signed Rank)

For preoperative vs postoperative visual acuity comparisons within the same eye, the Wilcoxon signed rank test is the most appropriate method, as it accounts for paired nonparametric data and avoids assumptions of normality. In studies of PR and retinal detachment repair, Wilcoxon testing typically demonstrates significant postoperative improvement in visual acuity, particularly when anatomical success is achieved. HM and CF values should be retained in these paired analyses after log MAR conversion to preserve rank order and avoid informative missingness. The results indicated that older patients experienced slower recovery of uncorrected distance visual acuity during the first postoperative week. However, by one month, age no longer had a significant effect on visual outcomes, suggesting that delayed early recovery in older individuals is transient [19] (*Effects of age and sex on the early visual outcomes...*) Visual outcomes for patients treated with PR often achieve significant improvements in best-corrected visual acuity and high vision-related quality of life scores. Some patients have required an additional surgery-reoperation (e.g., vitrectomy or scleral buckle) if primary PR fails, but visual outcomes after these secondary procedures remain favorable. Future research should focus on standardizing age stratification in medium and long-term follow-up studies across various surgical procedures. Integrating age into predictive models and personalized care protocols may optimize visual outcomes and improve patient satisfaction.

Paired analysis using the Wilcoxon signed-rank test revealed in our study case has a highly significant improvement in visual acuity following pneumatic retinopexy:

- 1) *Mean visual acuity improvement* (ΔVA): $+0.41 \pm 0.38$;
- 2) *Wilcoxon signed-rank statistic*: 16.0;
- 3) *Values of P* = 0.0002

These findings demonstrate that postoperative visual acuity was significantly higher than preoperative values across the cohort, indicating a substantial functional benefit of the intervention for outpatients.

4. Risk Factors for Primary Failure

4.1. Macular Status in the Case Series Study

In this retrospective case series, primary surgical failure was more frequently observed among eyes presenting with macula-off retinal detachment, as summarized in **Table 5**. Although the sample size does not permit definitive inference, this pattern suggests that more advanced disease at presentation may be associated with lower primary success following pneumatic retinopexy.

Table 5. Clinical characteristics predominantly observed in primary failure cases.

Clinical feature	Observation in failure cases
Macula status	Predominantly macula-Off
Lens status	Higher proportion of pseudophakia
Retinal break location	Inferior or complex configurations
Additional ocular findings	Inferior holes, choroidal detachment, high myopia
Outcome	Required secondary surgery (PPV $\pm$ silicone oil)

This trend is biologically plausible, as prolonged macular detachment may reduce the likelihood of both anatomical reattachment with pneumatic tamponade alone and subsequent functional recovery. In keeping with this observation, **Table 6** and **Table 7** suggest that macula-on status, or recent macula-off detachment, may represent a more favorable clinical profile for postoperative visual recovery.

Table 6. Predictive combination for good postoperative Visual Acuity ($VA \geq 0.5$).

Factor	Role in Prediction	Effect
Primary anatomical success	Required condition	Strong positive
Macula On /recent macula Off	Major modifier	Positive
Short symptom duration	Secondary modifier	Positive
Clear ocular media	Functional enhancer	Positive
Low retinal complexity	Stability factor	Positive

4.2. Additional Ocular Findings

Within this small retrospective cohort, eyes with primary PR failure [20] (*Out-*

comes of RRD repair after failed PR...). more commonly exhibited additional ocular findings such as inferior retinal holes, choroidal detachment, high myopia, recurrent retinal detachment, and more complex retinal break configurations (**Table 5**). These findings should be interpreted as descriptive rather than independently predictive; however, they suggest that greater baseline anatomical complexity may be associated with reduced suitability for pneumatic tamponade alone. This interpretation is consistent with the broader clinical understanding that such features may increase procedural difficulty and reduce the likelihood of single-procedure success.

4.3. Lens Status

A higher proportion of pseudophakic eyes was observed among primary failure cases in this series (**Table 5**). Given the limited sample size and retrospective design, this finding should be regarded as exploratory rather than conclusive. Nevertheless, it may reflect a clinically relevant trend consistent with prior reports suggesting that pseudophakia can reduce primary pneumatic retinopexy success, potentially due to more difficult retinal break identification and altered vitreoretinal anatomy. In the present cohort, pseudophakia may therefore represent a marker of increased technical complexity rather than an isolated determinant of failure.

4.4. Retinal Break Configuration

Although PR is generally best suited to uncomplicated superior retinal breaks, several primary failure cases in this series involved less favorable retinal break configurations, including multiple tears and inferiorly located defects (**Table 5**). While no definitive causal relationship can be established in this cohort, these descriptive findings suggest that retinal break complexity may have contributed to lower primary success. This pattern is consistent with the known mechanical limitations of intraocular gas tamponade in more anatomically complex detachments.

4.5. Clinical Implications

Importantly, all eyes with primary PR failure were successfully managed with secondary intervention, resulting in final anatomical reattachment in all cases. This finding supports the view that primary failure of PR, although clinically relevant, does not necessarily compromise ultimate anatomical success when timely secondary treatment is undertaken.

In this series, the clinical characteristics more frequently observed among primary failures (**Table 5**) including macula-off presentation, pseudophakia, inferior or complex retinal breaks, and additional ocular pathology appear to cluster as markers of greater case complexity rather than independent predictors of failure [21] (*PR analysis of risk factors and complications...*). Given the small retrospective design, these findings should be interpreted as hypothesis-generating.

Nonetheless, they support the practical importance of careful patient selection, as eyes with fewer anatomical risk features appeared more likely to achieve successful single procedure repair.

Table 7. Risk profile for postoperative visual outcome.

Risk domain	Low-risk profile (Good VA likely)	High-risk profile (Poor VA likely)	Clinical interpretation
Anatomical outcome	Primary anatomical success	Primary anatomical failure	The strongest determinant of visual outcome
Macular status	Macula on or recent macula off	Long-standing macula OFF	Determines photoreceptor recovery potential
Symptom duration	Short duration (early presentation)	Prolonged symptoms	Longer detachment limits functional recovery
Ocular media	Clear media (phakic or uncomplicated pseudophakia)	Cataract, haze, post-surgical media changes	Affects measured and functional vision
Retinal complexity	Single or limited superior breaks	Inferior breaks, multiple tears, choroidal detachment, high myopia	Complex anatomy reduces recovery efficiency
Overall risk profile	Accumulation of low-risk factors	Accumulation of high-risk factors	Visual outcome depends on combined risk burden

Rather than presenting the variables in **Table 6** and **Table 7** as definitive predictors, they may be more appropriately framed as a clinically derived risk-stratification model based on observed trends within this retrospective cohort, which definition was find in international studies by Chia-Yi Lee *et al.* [22] and Marina Gilca *et al.* [23]. In this context as summarized in **Table 7**, factors such as primary anatomical success, favorable macular status, shorter symptom duration, clearer ocular media, and lower retinal complexity appeared to cluster in eyes with better postoperative visual outcomes, whereas the accumulation of less favorable features was more commonly observed in eyes with poorer visual recovery. These associations should be interpreted as exploratory and hypothesis-generating, reflecting clinically meaningful patterns rather than statistically confirmed independent predictors.

5. Preoperative and Postoperative Visual Acuity Analysis Statistical Rationale

Visual acuity is a fundamental outcome measure in ophthalmic surgery research, particularly in studies of cataract, vitreoretinal, and refractive procedures. Assessing changes in visual acuity pre- and postoperatively is essential for evaluating treatment efficacy, guiding clinical decision-making, and providing valuable prognostic information [24] (*Elucidating postoperative dynamics in tractional RD: a systematic review and meta-analysis...*). The selection of statistical methods must account for the distinctive distribution of visual acuity data, the paired nature of preoperative and postoperative measurements, and the specific clinical

objectives of the study.

Choosing an appropriate statistical approach is critical for validating clinical findings, ensuring reproducibility, and enabling accurate interpretation of results. In this study, we explored the relationship between preoperative and postoperative visual acuity using two complementary statistical methods tailored to distinct clinical aims. Correlation analysis was employed to determine whether baseline visual acuity could predict postoperative outcomes, while paired analysis quantified the degree of visual improvement attributable to the intervention. Given the non-normal distribution of visual acuity data and the study's limited sample size, nonparametric methods were used. Spearman's rank correlation revealed no statistically significant association between preoperative and postoperative visual acuity ($r = 0.32$, $P = 0.12$), indicating that baseline visual acuity was not a reliable predictor of final visual outcome.

Comparisons of preoperative and postoperative visual acuity require statistical approaches that are sensitive to the data structure and the clinical complexities of each case. Contemporary ophthalmic research, often informed by meta-analyses, employs a variety of analytical techniques including paired analyses, mixed-effects models, and regression methods to achieve robust and interpretable results [25] (*Outcomes and complications of PPV for tractional RD in people with diabetes: a systematic review and meta-analysis*). In this context, meta-analyses primarily aim to evaluate the efficacy and safety of diabetic vitrectomy for tractional retinal detachment by analyzing improvements in visual acuity, rates of retinal reattachment, and the incidence of postoperative complications [24] [25].

6. Results & Discussion

6.1. Anatomical Outcomes

Primary anatomical success following pneumatic retinopexy was achieved in 18 of 25 eyes (72%). The remaining 7 eyes (28%) experienced primary failure and subsequently required secondary surgical intervention. Ultimately, final retinal reattachment was accomplished in all cases, yielding a 100% final anatomical success rate. A representative preoperative fundus photograph (**Photo 2**) demonstrates horseshoe retinal tears associated with RRD.

6.2. Visual Outcomes

The mean preoperative visual acuity was 0.13 ± 0.25 , which improved to 0.54 ± 0.36 postoperatively. When visual outcomes were categorized, 15 eyes (60%) achieved good visual acuity (≥ 0.5), while 10 eyes (40%) had poor visual outcomes (< 0.5). Paired analysis using the Wilcoxon signed-rank test demonstrated a substantial and statistically significant improvement in visual acuity following pneumatic retinopexy (mean ΔVA : $+0.41 \pm 0.38$; $P = 0.0002$). Representative postoperative fundus photograph confirming complete retinal reattachment are shown in **Photo 3**.

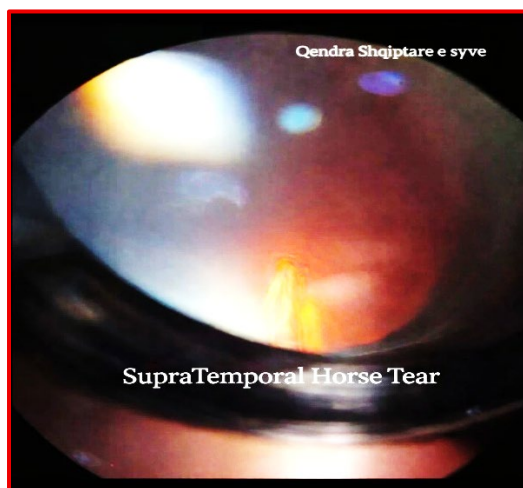


Photo 2. A representative fundus photograph showing a superior horseshoe retinal tears associated with surrounding rhegmatogenous retinal detachment.

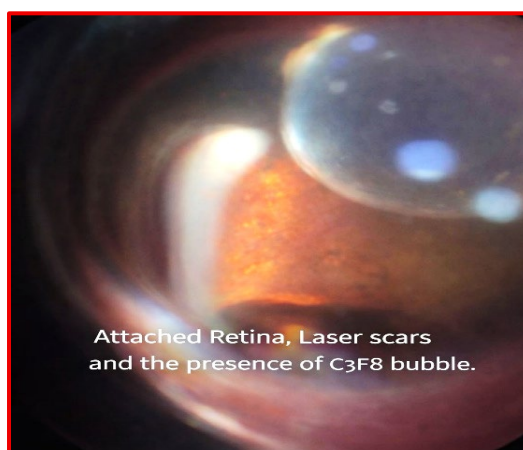


Photo 3. Postoperative fundus photograph confirming complete retinal reattachment.

Optical Coherence Tomography (*OCT*) is a non-invasive imaging modality that rapidly generates high-resolution cross-sectional images of the retina, cornea, and optic nerve head in vivo. This review summarizes recent technical advancements and current clinical applications of OCT in the management of retinal disorders [26] (*OCT retinal imaging: narrative review of technological advancements, clinical applications...*). In the present case for patient J.K. presented in “Albanian Eye Center”, on 22.12. 2025, the OCT performed at the 6-month follow-up, confirmed anatomical macular recovery, with restoration of normal retinal architecture (see Appendix 1).

6.3. Discussion

These findings suggest that PR provides a favorable primary reattachment rate (72%) in selected cases of primary RRD, with excellent final anatomical outcomes after additional intervention when required. Although nearly one-third of eyes required further treatment, all eyes ultimately achieved anatomical reattachment,

supporting PR as an effective minimally invasive initial treatment strategy in appropriately selected patients. The distinction between single-procedure and final anatomical success is clinically important, as it demonstrates that while PR may have moderate primary success, ultimate retinal preservation can still be excellent with timely secondary intervention.

7. Conclusions

*A comprehensive nonparametric statistical approach was utilized to assess both anatomical and functional outcomes following pneumatic retinopexy. Primary anatomical success was achieved in 72% of eyes, with final retinal reattachment obtained in all cases after secondary intervention when necessary. Analysis of visual outcomes showed that 60% of eyes achieved good postoperative visual acuity (≥ 0.5) [7] [8].

*Categorical analysis identified primary anatomical success as the most robust predictor of favorable visual outcomes, demonstrating both a large effect size and a statistically significant association. In contrast, other variables including macular status, age, duration of symptoms, ocular media clarity, and systemic comorbidities did not show statistically significant independent associations with postoperative visual acuity, although some clinically relevant trends were noted [11] [14] [15].

*As final statistical conclusion we summarize: the nonparametric analysis demonstrates that primary anatomical success is the strongest and only statistically significant predictor of postoperative visual acuity, showing a strong positive association with visual recovery. Age, symptom duration, macular status, and systemic comorbidities were not significantly associated with postoperative visual acuity in this cohort, although several remain clinically relevant and may reach significance in larger samples. For robust and reproducible ophthalmic statistical analysis, HM values should never be discarded. Instead, HM should be converted into validated approximate log MAR values and retained in all analyses, including Spearman correlation, Mann Whitney, and Wilcoxon signed-rank testing [2] [17]. This approach preserves statistical power, minimizes bias, and aligns with current ophthalmic methodological standards for low vision outcome research.

*Overall, these findings support a risk profile based interpretation of visual outcomes, indicating that functional recovery is primarily determined by anatomical success and is further influenced by baseline ocular characteristics, rather than by any single isolated variable.

*The outcomes observed in our research article support the feasibility of implementing PR as a standard outpatient option in tertiary ophthalmic centers. In the context of evolving ophthalmic services in our country, such as: “Albanian Eye Center”, may particularly benefit from incorporating this technique into their clinical practice.

Ethics Statement

This study, entitled “*Primary outpatient pneumatic retinopexy for rhegmatog-*

enous retinal detachment", was conducted in accordance with the principles of the Declaration of Helsinki. Due to its retrospective design and the use of anonymized patient data, formal institutional review board approval was not required. Informed consent for treatment was obtained from all patients as part of routine clinical care.

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Author Contributions

Conceptualization, surgical procedures, study supervision, data interpretation, critical revision of the manuscript are carried out from Ali Tonuzi, MD, PhD, Associate Professor, and Dr. Luan Qafmolla, IT programmers.

Data collection, data analysis, manuscript drafting, literature review, by Dr. Luan Qafmolla, Orjeta Tonuzi, MD, PhD, and Migena Beqiri, MD.

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Conflicts of Interest

All the authors declare no conflict of interest related to this study research report.

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Appendix 1 (Photo A1)

A typical illustrative example for patient J.K. presented in the center on 22.12. 2025, with full retinal problem in the left eye, is described according to the methodology of the intervention, specifying the necessary steps and surgical parameters, taking into account the inclusion/exclusion criteria for each of the patients as presented in the examination report (Photo A1).

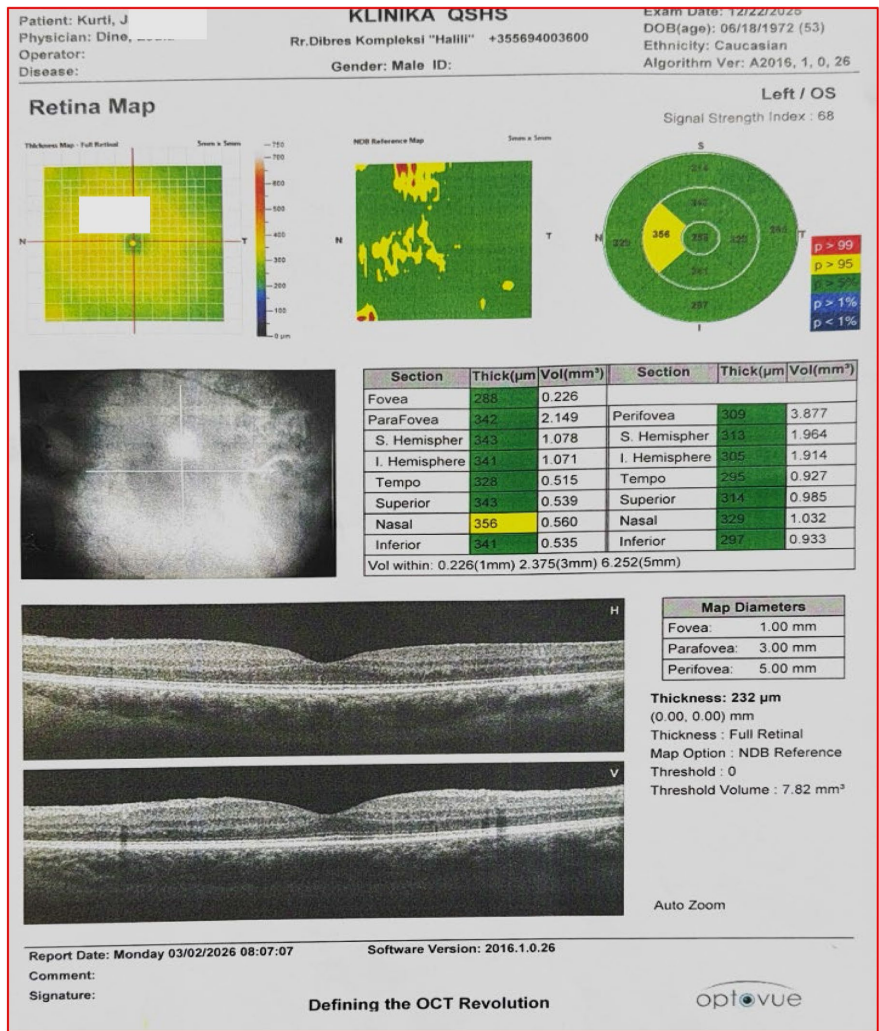


Photo A1. Examination report of J.K. patient with full retinal problem (OCT confirms anatomical macular recovery with restoration of normal retinal architecture).