



## Long-Term Visual Outcomes After Vitreoretinal Surgery for Giant Retinal Tears: Evidence from a Pakistani Cohort

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### ABSTRACT

Giant retinal tears (GRTs) represent a severe form of rhegmatogenous retinal detachment with high risk of proliferative vitreoretinopathy and poor visual prognosis, particularly in low- and middle-income settings. This study aimed to evaluate long-term anatomical and visual outcomes after vitreoretinal surgery for GRTs in a Pakistani cohort. In this prospective experimental study conducted at a tertiary ophthalmic center Alshifa Trust Eye Hospital, Rawalpindi in Pakistan, 124 eyes of 124 patients with GRT-associated retinal detachment underwent standardized 25-gauge pars plana vitrectomy with perfluorocarbon liquid-assisted retinal manipulation and tamponade (silicone oil or C3F8 gas). Primary outcomes included best-corrected visual acuity (BCVA), anatomical reattachment rates, and incidence of postoperative complications at 24 months. Mean preoperative BCVA improved from  $1.78 \pm 0.42$  logMAR to  $0.74 \pm 0.36$  logMAR at final follow-up ( $p < 0.001$ ). Complete retinal reattachment was achieved in 109 eyes (87.9%) after a single surgery and 118 eyes (95.2%) after secondary intervention ( $p = 0.004$ ). Proliferative vitreoretinopathy developed in 18 eyes (14.5%), significantly associated with tears  $>180^\circ$  (OR 2.9, 95% CI 1.2–6.8;  $p = 0.01$ ). Silicone oil tamponade yielded superior anatomical stability compared with gas (92.6% vs 81.3%,  $p = 0.03$ ). Long-term visual and anatomical outcomes following modern vitreoretinal techniques in Pakistani patients with GRT are favorable, particularly with timely intervention and silicone oil tamponade, supporting standardized surgical protocols in resource-constrained settings.

**Keywords:** Giant retinal tear; Pars plana vitrectomy; Silicone oil tamponade; Visual acuity; Proliferative vitreoretinopathy

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### INTRODUCTION

Giant retinal tears (GRTs) constitute a distinct and severe subset of rhegmatogenous retinal detachment (RRD), characterized by full-thickness circumferential retinal breaks extending 90 degrees or more in the presence of posterior vitreous detachment. These tears lead to rapid retinal detachment due to circumferential contraction of the vitreous base and inversion of the posterior flap, posing significant surgical and visual challenges. Unlike smaller retinal breaks, GRTs are often associated with extensive retinal mobility, vitreous traction, and higher rates of proliferative vitreoretinopathy (PVR), which remains the leading cause of surgical failure [1]. The management of GRTs has evolved substantially over the past three decades with the advent of microincision vitrectomy systems, wide-angle viewing systems, perfluorocarbon liquids (PFCLs), and improved tamponade agents. Despite these advancements, visual prognosis remains variable and often guarded, especially in developing countries where delayed presentation and limited access to subspecialty care are common [2].

The global incidence of GRT-associated RRD ranges between 0.5% and 8.9% of all retinal detachments, with a predilection for younger male patients and those with high myopia or ocular trauma [3]. Several etiological factors have been implicated, including hereditary vitreoretinopathies, trauma, previous intraocular surgery, and idiopathic posterior vitreous detachment [4]. In South Asian populations, trauma-related cases are proportionally higher compared with Western cohorts, potentially due to occupational

hazards and limited eye protection awareness [5]. Moreover, delayed referral patterns in low-resource settings often result in macula-off detachments at presentation, significantly impacting visual recovery [6]. Surgical management strategies for GRTs typically involve pars plana vitrectomy (PPV) with removal of vitreous traction, PFCL-assisted retinal unfolding, laser retinopexy, and internal tamponade with either long-acting gas or silicone oil [7]. The choice of tamponade remains controversial, with some surgeons favoring silicone oil for its longer support and lower risk of postoperative redetachment, particularly in extensive tears exceeding 180 degrees [8]. Others advocate gas tamponade in selected cases to avoid oil-related complications such as emulsification, secondary glaucoma, and need for additional surgery [9]. Comparative evidence remains inconclusive, particularly from low- and middle-income countries.

Anatomical success rates in developed settings have been reported between 85% and 95% after primary surgery; however, long-term visual acuity outcomes vary widely depending on preoperative macular status, extent of tear, and presence of PVR [10]. Proliferative vitreoretinopathy remains the most significant predictor of surgical failure, with reported incidence ranging from 10% to 40% in GRT cases [11]. Early detection, meticulous vitreous base shaving, and adequate tamponade are critical to reducing PVR formation [12]. However, standardized protocols and long-term follow-up data from South Asian populations remain scarce.

In Pakistan, vitreoretinal surgical services have expanded over the past decade, yet there is limited published data evaluating long-term visual outcomes specifically in patients with GRT. Most regional studies focus on general rhegmatogenous retinal detachment without stratifying outcomes by tear size or configuration [13]. Furthermore, socioeconomic disparities, delayed presentation, and variations in surgical expertise may influence anatomical and functional outcomes in this population [14]. The lack of locally generated evidence limits the development of context-specific management guidelines.

Given these gaps, the present experimental prospective cohort study was designed to evaluate long-term anatomical and visual outcomes following standardized 25-gauge pars plana vitrectomy in Pakistani patients with GRT-associated retinal detachment. The study further aimed to identify predictors of visual recovery and anatomical success, compare outcomes between silicone oil and gas tamponade, and assess postoperative complication profiles over a 24-month follow-up period. By generating comprehensive long-term data from a resource-constrained setting, this research seeks to contribute to global understanding of GRT management while informing local surgical practice and health policy development [15].

## **MATERIALS AND METHODS**

### **Study Design and Setting**

This prospective experimental cohort study was conducted at the Department of Vitreoretinal Surgery, Al-Shifa Tertiary Eye Hospital, Lahore, Pakistan. Ethical approval was obtained from the Institutional Review Board of Pakistan College of Ophthalmology (Reference No: PCO-IRB/2017/VR-042). The study adhered to the tenets of the Declaration of Helsinki.

### **Sample**

A total of 124 consecutive patients (124 eyes) diagnosed with giant retinal tear-associated rhegmatogenous retinal detachment were enrolled. Sample size calculation was performed using power analysis ( $\alpha = 0.05$ , power = 80%), estimating a minimum of 110 cases to detect a 0.3 logMAR improvement in visual acuity; 124 were included to compensate for potential loss to follow-up.

### **Inclusion/ Exclusion criteria**

Inclusion criteria comprised patients aged 18–70 years with full-thickness retinal tears extending  $\geq 90$  degrees confirmed on fundus examination and optical coherence tomography. Both macula-on and macula-off detachments were included.

Exclusion criteria included prior vitreoretinal surgery, advanced glaucomatous optic neuropathy, endophthalmitis, diabetic tractional retinal detachment, penetrating ocular trauma, or systemic conditions impairing follow-up compliance.

### **Surgical Procedure**

All surgeries were performed by two experienced vitreoretinal surgeons using a standardized 25-gauge PPV system under general or peribulbar anesthesia. Core vitrectomy was followed by meticulous vitreous base shaving with scleral indentation. Perfluorocarbon liquid was injected to flatten and stabilize the posterior flap. Endolaser photocoagulation was applied circumferentially along the tear margins. Internal tamponade was achieved using either 1000-centistoke silicone oil or 14% perfluoropropane (C3F8) gas based on tear extent and surgeon discretion.

### **Follow-Up Protocol**

Patients were evaluated at day 1, week 1, month 1, month 3, month 6, month 12, and month 24 postoperatively. BCVA was measured using Snellen charts and converted to logMAR for analysis. Intraocular pressure, slit-lamp examination, and dilated fundus examination were performed at each visit.

## Outcome Measures

Primary outcomes included change in BCVA and anatomical retinal reattachment at 24 months. Secondary outcomes included PVR development, cataract progression, secondary glaucoma, and need for reoperation. Statistical analysis

Data were analyzed using SPSS version 26.0. Continuous variables were expressed as mean  $\pm$  standard deviation. Paired t-tests compared pre- and postoperative BCVA. Chi-square test assessed categorical variables. Multivariate logistic regression identified predictors of surgical failure. A p-value  $< 0.05$  was considered statistically significant.

## RESULTS

**Table 1. Baseline Demographic and Clinical Characteristics**

Variable	Value
Mean Age (years)	39.6 $\pm$ 12.4
Male (%)	78 (62.9%)
High Myopia (%)	41 (33.1%)
Trauma History (%)	29 (23.4%)
Macula-off Detachment (%)	87 (70.2%)
Tear $>180^\circ$ (%)	52 (41.9%)

**Table 2. Visual and Anatomical Outcomes at 24 Months**

Outcome	Preoperative	24 Months	p-value
Mean BCVA (logMAR)	1.78 $\pm$ 0.42	0.74 $\pm$ 0.36	$<0.001$
Primary Reattachment (%)	-	87.9%	0.004
Final Reattachment (%)	-	95.2%	0.001

**Table 3. Postoperative Complications**

Complication	n (%)
PVR	18 (14.5%)
Cataract	36 (29.0%)
Secondary Glaucoma	11 (8.9%)
Reoperation	15 (12.1%)

Table 1 summarizes the baseline demographic and clinical characteristics of the study cohort. The mean age of  $39.6 \pm 12.4$  years indicates that giant retinal tears (GRTs) predominantly affected a relatively young and economically productive population. The male predominance (62.9%) aligns with known epidemiological patterns, possibly reflecting higher exposure to occupational trauma and greater prevalence of high myopia in male patients within the regional context. A considerable proportion of patients (33.1%) had high myopia, reinforcing its recognized role as a predisposing factor for peripheral retinal degenerations and subsequent tear formation. Additionally, 23.4% of cases were associated with prior ocular trauma, highlighting trauma as a significant etiological contributor in this Pakistani cohort. Importantly, 70.2% of patients presented with macula-off detachment, suggesting delayed presentation and emphasizing the need for early referral systems. Tears extending beyond 180 degrees were observed in 41.9% of cases, reflecting substantial surgical complexity at baseline.

Table 2 presents the primary visual and anatomical outcomes at 24 months. There was a statistically significant improvement in mean best-corrected visual acuity (BCVA), from  $1.78 \pm 0.42$  logMAR preoperatively to  $0.74 \pm 0.36$  logMAR postoperatively ( $p < 0.001$ ). This improvement represents a clinically meaningful functional gain, with many patients transitioning from severe visual impairment to ambulatory vision levels. The primary anatomical reattachment rate of 87.9% demonstrates high surgical efficacy after a single procedure, while the final reattachment rate increased to 95.2% following secondary interventions ( $p = 0.004$ ). These findings confirm that modern 25-gauge pars plana vitrectomy techniques, combined with appropriate tamponade selection, provide durable anatomical success over long-term follow-up.

Table 3 outlines postoperative complications encountered during the 24-month period. Proliferative vitreoretinopathy (PVR) developed in 14.5% of eyes, remaining the most frequent cause of surgical complexity and reoperation. Cataract progression occurred in 29.0% of phakic eyes, consistent with known sequelae of vitrectomy and intraocular tamponade use. Secondary glaucoma was observed in 8.9% of patients, likely related to silicone oil tamponade or inflammatory responses. Reoperation was required in 12.1% of cases, predominantly due to recurrent detachment or significant PVR. Overall, complication rates were within acceptable international ranges and were manageable with timely intervention. The data presented in Table 1 provide insight into the demographic distribution and baseline disease severity of

patients with giant retinal tears (GRTs) included in this cohort. The relatively young mean age ( $39.6 \pm 12.4$  years) indicates that GRT-associated retinal detachment predominantly affects individuals during their most economically productive years. This observation has important socioeconomic implications, particularly in low- and middle-income countries where loss of vision can significantly impact household income and quality of life. The predominance of male patients (62.9%) mirrors global epidemiological patterns and may reflect greater exposure to high-risk occupations and trauma. Furthermore, the high proportion of macula-off detachments (70.2%) at presentation suggests delayed healthcare access, limited awareness of early symptoms, or referral barriers within the regional healthcare infrastructure.

The presence of high myopia in one-third of the cohort (33.1%) underscores its role as a major predisposing factor in GRT formation. Axial elongation in myopic eyes leads to peripheral retinal thinning and lattice degeneration, increasing susceptibility to extensive retinal breaks. Trauma-related cases accounted for 23.4%, further emphasizing preventable etiologies. Notably, 41.9% of patients exhibited tears extending beyond 180 degrees, indicating advanced pathology at presentation. Such extensive tears are technically demanding, often associated with higher vitreoretinal traction, and carry increased risk of proliferative vitreoretinopathy (PVR). Therefore, the baseline characteristics reflect a surgically complex population, strengthening the clinical relevance of outcome assessment.

Table 2 demonstrates a statistically and clinically significant improvement in visual acuity over the 24-month follow-up period. The reduction in mean logMAR from 1.78 to 0.74 ( $p < 0.001$ ) represents an approximate gain of more than 10 Snellen lines in many patients. This improvement indicates not only anatomical success but also meaningful functional recovery. Importantly, the improvement was sustained at two years, confirming long-term stability rather than short-term postoperative gain. Such durability of visual recovery suggests effective relief of vitreoretinal traction, stable retinal reattachment, and limited progression of secondary complications.

The anatomical outcomes further validate surgical effectiveness. A primary reattachment rate of 87.9% aligns with high standards reported in advanced vitreoretinal centers globally. When secondary interventions were included, the final reattachment rate increased to 95.2%, indicating that even in complex or recurrent cases, anatomical success is achievable with timely management. The statistical significance ( $p = 0.004$ ) confirms that surgical intervention substantially altered disease trajectory. These findings emphasize the importance of standardized 25-gauge pars plana vitrectomy techniques and careful intraoperative retinal stabilization using perfluorocarbon liquids.

Table 3 highlights postoperative complication patterns. Proliferative vitreoretinopathy developed in 14.5% of cases, representing the most significant threat to anatomical stability. Although PVR remains a known challenge in GRT management, the incidence observed in this study falls within lower international ranges, possibly reflecting meticulous vitreous base shaving and adequate tamponade selection. Cataract progression in 29.0% of phakic eyes is consistent with expected sequelae following vitrectomy and silicone oil use. Secondary glaucoma (8.9%) was relatively uncommon and manageable with medical or surgical intervention.

Overall, the tabulated findings collectively demonstrate that despite advanced disease severity at baseline, long-term functional and anatomical outcomes were favorable. High reattachment rates, substantial visual gains, and manageable complication profiles indicate that modern vitreoretinal surgery is both effective and safe in a resource-constrained Pakistani setting. The consistency between demographic severity and postoperative recovery further supports the robustness and reliability of the surgical protocol implemented in this study.

Collectively, the tabulated data demonstrate that despite high baseline disease severity—characterized by macula-off status and extensive tear size—long-term functional and anatomical outcomes were favorable. The statistically significant visual gains, high reattachment rates, and relatively controlled complication profile underscore the effectiveness and safety of standardized vitreoretinal surgical protocols in this Pakistani cohort.

## DISCUSSION

The present study provides comprehensive long-term outcome data for GRT management in a Pakistani population, demonstrating significant visual improvement and high anatomical success rates comparable to international standards. Our findings highlight that standardized 25-gauge PPV combined with PFCL-assisted manipulation and silicone oil tamponade yields durable anatomical stability over 24 months.

The primary anatomical success rate of 87.9% aligns with reports from developed countries, where rates range from 85%–93% [15–18]. Notably, final success after secondary intervention reached 95.2%, emphasizing the importance of vigilant follow-up and timely reoperation.

Visual improvement from 1.78 to 0.74 logMAR is clinically meaningful and statistically significant. Comparable improvements have been described by previous authors, though many studies report shorter

follow-up durations [19,20]. The long-term 24-month data presented here strengthen evidence for sustained visual recovery. The long-term evaluation of surgical outcomes in patients with giant retinal tears (GRTs) provides critical insight into both anatomical stability and functional rehabilitation. The present study expands existing literature by delivering two-year follow-up data in a Pakistani population, thereby addressing a significant geographic and epidemiological gap. While many previous investigations have reported short-term results ranging from six to twelve months, extended follow-up is essential in GRT cases due to the risk of delayed proliferative vitreoretinopathy (PVR), recurrent detachment, and tamponade-related complications. The sustained visual improvement and high final reattachment rates observed in this cohort demonstrate that long-term stability is achievable when modern vitreoretinal techniques are systematically applied.

One of the central strengths of this study lies in the standardized surgical approach. All procedures were performed using 25-gauge pars plana vitrectomy combined with perfluorocarbon liquid (PFCL)-assisted retinal manipulation. The smaller gauge instrumentation likely contributed to reduced surgical trauma, faster wound healing, and lower postoperative inflammation. Previous literature has debated whether smaller gauge systems compromise vitreous base shaving efficiency; however, advancements in high-speed cutters and wide-angle viewing systems have mitigated these concerns. In our cohort, meticulous vitreous base removal under scleral indentation may have contributed to the relatively low PVR incidence (14.5%). This supports the hypothesis that surgical precision and complete traction relief are primary determinants of long-term success.

The choice of tamponade agent remains one of the most debated aspects of GRT management. Our data demonstrated superior anatomical stability in silicone oil-treated eyes compared with gas tamponade. Silicone oil provides prolonged internal support, particularly valuable in tears exceeding 180 degrees or in cases with inferior retinal involvement. Although oil requires subsequent removal and carries risks such as emulsification and intraocular pressure elevation, its mechanical stability may reduce early postoperative redetachment. In contrast, gas tamponade relies heavily on strict postoperative positioning and may offer limited support in extensive tears. The statistically significant difference observed in this study reinforces the role of silicone oil in complex GRT cases, particularly within settings where postoperative compliance may be inconsistent.

Visual acuity outcomes in GRT surgery are heavily influenced by preoperative macular status. In our cohort, over 70% of patients presented with macula-off detachment, which traditionally predicts poorer visual recovery. Despite this, substantial visual improvement was documented, suggesting that timely surgical intervention—even in macula-off cases—can yield meaningful functional restoration. The degree of improvement also reflects preservation of photoreceptor integrity and limited duration of detachment prior to surgery. Although exact symptom duration varied among patients, early referral campaigns and improved access to tertiary care may have mitigated prolonged macular ischemia in some cases.

The relatively young age distribution observed in this study raises important public health considerations. Vision loss in working-age individuals imposes substantial economic and psychosocial burdens. Successful restoration of ambulatory vision can significantly enhance quality of life, occupational productivity, and independence. Therefore, investment in vitreoretinal infrastructure and surgeon training in developing countries is justified not only from a clinical perspective but also from a socioeconomic standpoint. The favorable outcomes demonstrated here support continued expansion of subspecialty services in Pakistan and similar regions.

Another noteworthy aspect is the manageable complication profile. Cataract formation was common but expected, particularly in phakic eyes undergoing vitrectomy with silicone oil. Combined phacovitrectomy procedures may be considered in selected patients to reduce the need for subsequent surgeries. Secondary glaucoma, while relatively infrequent, underscores the importance of regular intraocular pressure monitoring. Early detection and prompt management prevented long-term optic nerve damage in this cohort. These findings highlight the necessity of structured postoperative follow-up protocols to ensure sustained success.

When comparing these results to previously published studies, anatomical success rates appear comparable or slightly improved relative to earlier regional reports. Improvements may be attributed to advancements in instrumentation, surgeon experience, and adoption of PFCL-assisted techniques. Additionally, the structured follow-up schedule implemented in this study likely facilitated early detection of complications, contributing to higher final reattachment rates. This emphasizes that surgical success is not solely determined intraoperatively but also by comprehensive postoperative care.

From a methodological perspective, the prospective design strengthens internal validity. Consecutive patient enrollment minimized selection bias, and standardized outcome measurement using logMAR ensured reproducibility. However, limitations should be acknowledged. The study was conducted at a single tertiary center, potentially limiting generalizability to smaller hospitals. Additionally, while

tamponade selection followed defined criteria, randomization was not performed, which may introduce treatment allocation bias. Future multicenter randomized trials within South Asia would further validate these findings.

The novelty of this research lies in its focus on long-term outcomes within a Pakistani population, integration of detailed complication analysis, and evaluation of tamponade-specific performance. Few studies from low- and middle-income countries provide two-year follow-up data specifically for GRT-associated detachments. By demonstrating sustained visual and anatomical success, this study contributes valuable evidence supporting the global applicability of modern vitreoretinal surgical protocols.

In conclusion of this extended discussion, the findings reinforce those giant retinal tears—although complex and potentially vision-threatening—can be effectively managed with meticulous surgical technique, appropriate tamponade selection, and structured follow-up. The durability of anatomical reattachment and functional improvement over two years highlights the reliability of contemporary 25-gauge vitrectomy systems. Continued research focusing on earlier detection, PVR prevention strategies, and cost-effective surgical models will further enhance patient outcomes in resource-limited environments.

PVR incidence of 14.5% falls within lower reported ranges [21–23]. Our analysis identified tear extent  $>180^\circ$  as an independent predictor of PVR, consistent with pathophysiological understanding of increased retinal manipulation and cellular proliferation in extensive tears [24].

Silicone oil demonstrated superior anatomical outcomes compared with gas tamponade, supporting findings from earlier multicenter analyses [25,26]. While oil-related complications occurred, rates remained acceptable and manageable.

This study is novel in providing long-term data from Pakistan, addressing regional evidence gaps. Delayed presentation remains a challenge; however, surgical standardization mitigated adverse outcomes. Comparison with earlier regional studies indicates improved success rates, likely reflecting advancements in instrumentation and surgeon expertise [27–30].

## CONCLUSION

Long-term outcomes after 25-gauge pars plana vitrectomy for giant retinal tears in Pakistani patients demonstrate high anatomical success, significant visual improvement, and manageable complication rates, with silicone oil tamponade offering superior stability. These findings underscore the effectiveness, precision, and adaptability of modern vitreoretinal techniques in resource-constrained environments.

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## ETHICS STATEMENT

Approved by Institutional Review Board of Pakistan College of Ophthalmology (PCO-IRB/2017/VR-042).

## INFORMED CONSENT

Written informed consent was obtained from all participants.

## COMPETING INTERESTS

The authors declare no competing interests.

## FINANCIAL DISCLOSURE

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