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Research Article

Surgical Outcomes and Anatomic Success of 25-Gauge Pars Plana Vitrectomy in Rhegmatogenous Retinal Detachment

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Abstract

Transconjunctival sutureless vitrectomy using 25-gauge microincision vitrectomy surgery (MIVS) has become a primary surgical modality for repair of rhegmatogenous retinal detachment (RRD). This study evaluated primary anatomical reattachment, final visual acuity outcomes, and postoperative complication rates in eyes undergoing 25-gauge pars plana vitrectomy (PPV) for primary uncomplicated and complex RRD. A total of 185 eyes from 185 consecutive patients managed with 25-gauge PPV, fluid-air exchange, endolaser photocoagulation, and intraocular tamponade (gas or silicone oil) were analyzed. Primary single-surgery anatomical success was achieved in 91.4% of eyes (n = 169), and overall final anatomical reattachment reached 97.8% (n = 181) after secondary interventions. Mean best-corrected visual acuity (BCVA) improved significantly from 1.12 ± 0.48 { logMAR} preoperatively to 0.38 ± 0.26 { logMAR} at 6 months postoperatively ($p < 0.001$). Preoperative macula-on status was the strongest predictor of achieving final BCVA \le 0.30 { logMAR} (20/40 or better; OR: 4.82, $p < 0.001$). Postoperative hypotony (intraocular pressure < 6 { mmHg}) occurred in 4.9% of eyes on day 1 but resolved spontaneously without wound leakage or reoperation. Small-gauge 25-gauge PPV offers excellent anatomical reattachment, rapid visual rehabilitation, and a favorable safety profile in the management of RRD.

Keywords: Rhegmatogenous retinal detachment, 25-gauge vitrectomy, microincision vitrectomy surgery, anatomical reattachment, intraocular tamponade, macular status.

Introduction

Rhegmatogenous retinal detachment (RRD) is a sight-threatening ophthalmic emergency occurring when a full-thickness retinal break allows liquefied vitreous to enter the subretinal space, separating the neurosensory retina from the underlying retinal pigment epithelium (RPE). Without prompt anatomical reattachment, permanent photoreceptor degeneration and irreversible visual loss ensue. [1–3]

Surgical management of RRD has evolved significantly from scleral buckling (SB) and traditional 20-gauge pars plana vitrectomy (PPV) toward microincision vitrectomy surgery (MIVS), including 23-gauge, 25-gauge, and 27-gauge systems. Small-gauge 25-gauge instrumentation utilizes self-sealing valved cannulas inserted transconjunctivally through angled sclerotomies, reducing operative time, minimizing surgical trauma, and accelerating postoperative patient recovery. [4–6]

High-speed vitrectomes operating up to 10,000 cuts per minute (CPM) combined with duty-cycle control allow safe peripheral vitreous traction relief near mobile detached retina while minimizing retinal traction risks. Despite these technical advantages, concerns regarding sclerotomy leakage, postoperative hypotony, endophthalmitis, and adequacy of peripheral vitreous base clearance with flexible 25-gauge instruments remain relevant clinical considerations. [7–10]

This study evaluates the primary and final anatomical reattachment rates, functional visual outcomes, and complication profiles in a clinical series of patients undergoing 25-gauge PPV for primary RRD.

Methodology

A clinical study was conducted evaluating 185 eyes of 185 patients undergoing primary 25-gauge PPV for RRD over 24 months at Gujranwala Medical College, Gujranwala, Pakistan a tertiary

vitreoretinal center. The study adhered to the tenets of the Declaration of Helsinki, and written informed consent was documented for all patients.

Inclusion criteria comprised primary RRD involving any quadrant, with or without macular involvement (macula-on vs. macula-off), and proliferative vitreoretinopathy (PVR) up to Grade B. Exclusion criteria included traumatic giant retinal tears (> 90^\circ), active proliferative diabetic retinopathy, prior vitreoretinal surgery, or advanced PVR Grade C or higher.

Surgical procedures were performed under local peribulbar or general anesthesia using a standard 3-port 25-gauge transconjunctival MIVS system. Valved trocars were inserted at an angle of 30^\circ to 45^\circ parallel to the limbus, 3.5 { mm} (pseudophakic) or 4.0 { mm} (phakic) posterior to the limbus. Core and peripheral vitrectomy were performed under wide-field non-contact viewing. Scleral depression was routinely applied to achieve maximal vitreous base shave.

Subretinal fluid (SRF) drainage was completed via primary retinal breaks or fluid-air exchange (FAX). Endolaser photocoagulation was applied around all identified retinal breaks (360^\circ laser was performed at the surgeon's discretion). Endotamponade was selected based on break location and PVR status: sulfur hexafluoride (SF_6, 20%), perfluoropropane (C_3F_8, 14%), or 1000-cSt silicone oil. Sclerotomies were checked for leakage upon trocar removal; polyglactin 8-0 sutures were placed if active wound leakage occurred.

Follow-up examinations occurred on day 1, week 1, month 1, month 3, and month 6. Key outcomes measured included primary single-surgery anatomical success (defined as complete retinal reattachment at 6 months without secondary vitreoretinal intervention), final anatomical success, pre- and postoperative BCVA (logMAR), and postoperative intraocular pressure (IOP).

Results

Table 1: Baseline Patient Demographics and Preoperative Ocular Characteristics

Parameter	Overall Cohort (N=185)	Macula-On (n=62)	Macula-Off (n=123)	p-value
Age (Years ± SD)	58.4 ± 11.2	56.8 ± 10.9	59.2 ± 11.3	0.172
Gender (Male / Female %)	114 / 71 (61.6% / 38.4%)	39 / 23 (62.9% / 37.1%)	75 / 48 (61.0% / 39.0%)	0.801
Lens Status (Phakic / Pseudophakic %)	108 / 77 (58.4% / 41.6%)	34 / 28 (54.8% / 45.2%)	74 / 49 (60.2% / 39.8%)	0.485
Preoperative BCVA ({logMAR} ± {SD})	1.12 ± 0.48	0.32 ± 0.18	1.52 ± 0.35	< 0.001
Duration of Symptoms (Days, Median [IQR])	5 [3–10]	2 [1–4]	8 [4–14]	< 0.001
Number of Retinal Breaks (Mean ± SD)	1.6 ± 0.8	1.4 ± 0.6	1.7 ± 0.9	0.018
PVR Grade A / B (%)	132 (71.4%) / 53 (28.6%)	51 (82.3%) / 11 (17.7%)	81 (65.9%) / 42 (34.1%)	0.024

Note: Patients in the macula-off group presented with significantly longer symptom duration, worse baseline visual acuity, and higher rates of Grade B PVR.

Table 2: Operative Characteristics and Tamponade Distribution

Surgical Variable	**Value (N=185)**
Operative Duration (Minutes ± SD)	42.5 ± 12.8
Surgical Variable	**Value (N=185)**
Combined Phacoemulsification with IOL Implant (%)	48 (25.9%)
Sclerotomy Suturing Required (\ge 1 site) (%)	14 (7.6%)
Intraocular Tamponade Selection	
SF_6 Gas (20%) (%)	98 (53.0%)
C_3F_8 Gas (14%) (%)	64 (34.6%)
Silicone Oil (1000-cSt) (%)	23 (12.4%)

Note: Sclerotomy suturing was required in only 7.6% of eyes, confirming the high rate of self-sealing wound closure achieved with angled 25-gauge incision techniques.

Table 3: Functional Visual Acuity Outcomes at 6 Months Follow-Up

Baseline Status	**Preop BCVA (logMAR)**	**6-Month Postop BCVA (logMAR)**	**Mean BCVA Gain (logMAR)**	**p-value**
Macula-On (n = 62)	0.32 ± 0.18	0.14 ± 0.12	-0.18 ± 0.11	< 0.001
Macula-Off (n = 123)	1.52 ± 0.35	0.50 ± 0.24	-1.02 ± 0.28	< 0.001
Total Cohort (N = 185)	**1.12 ± 0.48**	**0.38 ± 0.26**	**-0.74 ± 0.32**	**< 0.001**

Note: Visual gain was most marked in macula-off detachments, whereas macula-on eyes achieved superior final absolute visual acuity.

Table 4: Postoperative Complication Rates

Complication Type	Incidence (n, %)	Management / Clinical Outcome
Transient Postoperative Hypotony (< 6 { mmHg} , Day 1)	9 (4.9%)	Conservative management; self-resolved within 5 days
Early IOP Spike (> 25 { mmHg} , Day 1–7)	18 (9.7%)	Topical anti-glaucoma medication; controlled within 2 weeks
Redetachment (Primary Failure)	16 (8.6%)	Re-operation with repeat PPV, scleral buckle, or oil
Cataract Progression (in Phakic eyes, n = 108)	42 (38.9%)	Elective phacoemulsification within 12 months
Postoperative Endophthalmitis	0 (0.0%)	None reported

Note: Primary failure occurred in 8.6% (n = 16), leading to secondary reattachment interventions.

Discussion

The outcomes of this clinical study demonstrate that 25-gauge transconjunctival pars plana vitrectomy is a highly effective primary procedure for rhegmatogenous retinal detachment repair, yielding a primary single-surgery anatomical success rate of 91.4% and an overall final reattachment rate of 97.8%.

Primary anatomical success in RRD repair depends on complete relief of vitreoretinal traction, thorough identification and treatment of all retinal tears, and adequate endotamponade. Modern 25-gauge high-speed vitrectomes permit ultra-high cut rates (up to 10,000 CPM), which reduce port-surface acceleration and turbulence during vitreous shaving. This allows safe, meticulous removal of the peripheral vitreous base close to detached, mobile retina without inducing iatrogenic retinal breaks. [11–13]

Postoperative visual acuity outcomes correlated strongly with preoperative macular status. Eyes presenting with macula-on detachments achieved a mean final BCVA of 0.14 { logMAR} (approximately 20/25 Snellen equivalent), reflecting preservation of foveal photoreceptor architecture. Conversely, while macula-off eyes demonstrated a large absolute improvement in visual acuity (mean gain of 1.02 { logMAR}), final visual outcomes were limited by preoperative outer retinal ischemic duration prior to reattachment. [14, 15]

The complication profile in this series highlights the safety of 25-gauge MIVS. Transient postoperative hypotony (< 6 { mmHg}) occurred in 4.9% of eyes on postoperative day 1, attributable to mild trans-sclerotomy fluid egress. All cases resolved spontaneously without persistent shallow anterior chambers or choroidal detachments, and no eye developed endophthalmitis. Sclerotomy suturing was needed in only 7.6% of eyes, confirming that oblique, two-plane incision techniques effectively preserve wound architecture. [16–18]

Limitations of this study include its observational design, single-center setting, and inclusion of a heterogeneous range of intraocular tamponade agents (SF_6 , C_3F_8 , and silicone oil).

In conclusion, 25-gauge MIVS achieves high primary anatomical reattachment, significant visual restoration, low rates of sclerotomy-related complications, and rapid postoperative recovery in patients with primary rhegmatogenous retinal detachment.

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