

# Tug of war: A bimanual technique for anterior circumferential proliferative vitreoretinopathy in recurrent retinal detachment

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**Purpose:** To describe a bimanual technique, “tug of war” for managing anterior circumferential proliferative vitreoretinopathy (PVR) in eyes with recurrent retinal detachment (RRD). **Methods:** We retrospectively analyzed outcomes from eyes with RRD that underwent reattachment surgery using this maneuver and had a minimum of 6 months follow-up. A chandelier light was inserted for endo-illumination and the circumferential anterior PVR was tackled with two 25-gauge forceps stretching circumferential tractional membranes in opposite direction (tug of war) till they snapped. **Results:** Eleven eyes of 11 patients with a mean age of  $38.2 \pm 19.7$  years underwent surgery. All eyes had advanced PVR of Grade C A Type 4 (Circumferential). The median duration of RD from the time of first surgery was 6 months (interquartile range = 3–8 months). The tug of war maneuver was successful in relieving the anterior retinal traction leading to retinal reattachment in all eyes without the need for relaxing retinotomies or retinectomies. Small iatrogenic retina tears occurred at the time of tug of war maneuver in 3 (27%) eyes at the site of maximum traction. The mean best-corrected visual acuity (BCVA) improved from  $1.87 \pm 0.2$  logarithm of minimum angle of resolution (logMAR) to  $1.3 \pm 0.4$  logMAR at 6-months follow-up ( $P = 0.04$ ). **Conclusion:** The ‘tug of war’ maneuver is useful for relieving circumferential anterior traction and reattaching the retina in eyes with RRD without having to resort to large relaxing retinotomies or retinectomies.

**Key words:** Anterior proliferative vitreoretinopathy, proliferative vitreoretinopathy, recurrent retinal detachment, tug of war

Proliferative vitreoretinopathy (PVR) is widely recognized as the commonest cause of recurrent retinal detachment (RRD).<sup>[1]</sup> Risk factors for PVR such as giant retinal tears, traumatic retinal detachments, coexistent choroidal detachment, and severe hypotony have been recognized.<sup>[2-4]</sup> Strategies have been tried to minimize PVR formation during the initial reattachment procedure including the use of intravitreal 5-fluorouracil,<sup>[5]</sup> low molecular weight heparin,<sup>[6]</sup> serial intravitreal bevacizumab injections<sup>[7]</sup>, and dexamethasone implants<sup>[8]</sup> but most of these have yielded unsatisfactory results.

Previous studies have defined PVR in terms of the clock hours involved as well as by the anatomical location of PVR membranes into anterior and posterior PVR.<sup>[9]</sup> The updated Retina Society Classification described in 1991 by Machemer *et al.* classified full-thickness rigid retinal folds as grade-C PVR.<sup>[10]</sup> Anterior grade C PVR includes the subtype with circumferential contraction (Type 4) at the posterior edge of the vitreous base with the central displacement of the retina, peripheral stretched retina, and posterior retina in radial folds. Additionally, peripheral uncut vitreous is often present anteriorly, usually due to inadequate base dissection during the primary surgery, and this component makes it exceedingly difficult to reattach the retina.

Surgical strategies to tackle anterior circumferential PVR include membrane peeling with forceps, subretinal gliosis removal, relaxing retinotomies, and circumferential

retinectomies posterior to the site of traction, all aimed at relieving or redistributing the vitreous traction forces such that the retina is allowed to reattach.<sup>[11-16]</sup> Despite these aggressive maneuvers, recurrent PVR causing re-detachment and postoperative hypotony are likely to occur leading to dismal surgical reattachment rates and poor visual outcomes.

To avoid these potential complications in eyes with Grade C anterior PVR of the circumferential type, we present a simple bimanual surgical technique (Tug of war technique) to release traction in a relatively atraumatic manner, without the need for retinectomies, along with our preliminary results.

## Methods

This was a retrospective noncomparative study of all patients who underwent retinal reattachment surgery with the ‘tug of war’ technique for recurrent retinal detachment. The study was approved by the institutional ethics committee and followed the tenets of the declaration of Helsinki. Informed consent was obtained from all patients or legal guardians at the time of undergoing surgery.

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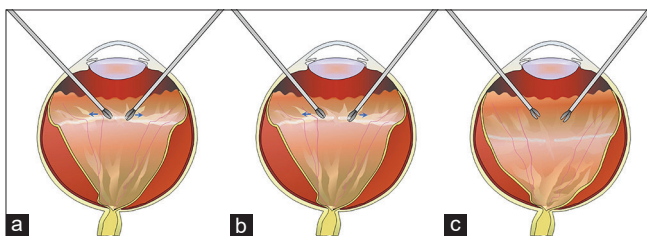
Clinical records of all patients who underwent surgery for RRD between December 2015 and December 2018 were drawn up from the operating room records. Those who had surgery using the tug of war maneuver as documented in case files and had at least 6 months follow-up were identified and data used for analysis. Surgical videos of all cases were reviewed to confirm that the maneuver was performed.

Baseline demographics, previous surgical intervention for retinal detachment (scleral buckle or vitrectomy), predisposing factors for retinal detachment, presence of tamponade *in situ* at the time of redetachment, duration of the redetachment, grade and location of PVR<sup>[10]</sup> and configuration of the detachment at the time of taking up for the new maneuver, best-corrected visual acuity (BCVA), intraocular pressure (IOP), and lens status (phakic, cataract, or pseudophakic) were recorded from case files. Use of a circumferential buckle at the time of surgery, type of silicone oil used, combination with lens surgery, and intraoperative complications were noted from the surgical videos and operative notes in the files. The BCVA, IOP, postoperative complications, and retinal status (attached vs. detached) were noted at various time points from the case files during the follow-up period.

### Surgical technique

All surgeries were performed under peribulbar anesthesia or general anesthesia for pediatric patients. After fashioning 3 standard ports with 25 gauge trocar and cannula systems, cataract surgery with or without an intraocular lens was performed if planned. Silicone oil removal (SOR) was done in eyes that had RD under oil. Any residual vitreous was cleared using the cutter. To initiate the tug of war maneuver, a chandelier light source was placed at 12 'O' clock, 3.5 mm from the limbus. With two opposing 25-gauge end gripping forceps, membranes causing circumferential traction were held and stretched apart [Fig. 1a] till the membrane snapped or shredded apart [Fig. 1b]. The free edge created was either peeled or dissected bimanually both circumferentially and anteriorly. The residual membranes and anterior vitreous were subsequently trimmed/shaved with the vitrectomy cutter. This maneuver was repeated at multiple sites along the circumferential anterior PVR till all membranes were addressed and all traction released [Fig. 1c] making the peripheral retina mobile. A small posterior retinotomy was made and fluid air exchange was performed to reattach the retina. Laser was done 360° and silicone oil was injected. Video 1 depicting the Tug of war technique in a child with recurrent RD.

The retinal reattachment rate at 6 months follow-up was the primary outcome measure. Visual acuity, IOP, and persistent hypotony were secondary outcome measures.



**Figure 1:** Diagrammatic depiction of the 'Tug of war' technique. (a) The circumferential anterior PVR membranes at the vitreous base are grasped by two end gripping forceps. (b) The membranes causing circumferential traction are stretched in opposite directions. (c) Once the traction due to anterior circumferential PVR is released, the retina can reattach

### Statistical analysis

Continuous variables were expressed as mean with standard deviation or median with interquartile range (IQR) while categorical variables were expressed as proportions (n, %). Differences in variables before and after surgery were analyzed using the paired t-test. All data were entered in Microsoft Excel and analyzed using STATA 12.1 I/c (Fort Worth, Texas, USA).

### Results

Eleven eyes of 11 patients underwent surgery using the tug of war technique and satisfied the inclusion criteria. The mean age was  $38.2 \pm 19.7$  years (range 9–71 years) and 10 (91%) were men. Patients had undergone primary retinal surgery for RD ( $n = 9$ ), epiretinal membrane (ERM) removal ( $n = 1$ ) and non-clearing vitreous hemorrhage (VH) ( $n = 1$ ) in the past. The cases with ERM removal and VH had developed RD as a postoperative complication. They then both underwent RD surgery elsewhere, which had failed. They hence presented to us with recurrent RD.

Four eyes with RD had high myopia of  $>6D$ , one had traumatic RD and one had combined tractional and rhegmatogenous RD following proliferative diabetic retinopathy. All eyes had Grade C A (anterior) Grade 4 (circumferential) PVR as per the Updated Retina Society Classification of 1991. The detailed categorization of PVR is described in Table 1. The median duration of RD from the time of first surgery was 6 months (IQR = 3–8 months). The mean preoperative IOP was  $9.8 \text{ mm Hg} \pm 5.8 \text{ mm Hg}$ .

Seven (64%) eyes had undergone the previous vitrectomy while the remaining four eyes had undergone prior scleral buckling with cryotherapy for the RD. An encirclage (#240 band) was already present in 7 (64%) eyes. At the time of taking up for the tug of war maneuver, six eyes had silicone oil *in situ* with a detachment under oil, one had gas, and four did not have any tamponading agent. All eyes had inferior RD with a detached macula at the time of resurgery.

The tug of war maneuver was successful in relieving the circumferential retinal traction in all eyes. In seven eyes, perfluorocarbon liquid (PFCL) was used to stabilize the anterior retina during the maneuver. Four eyes did not have an encirclage band and received one at the time of surgery to take care of residual traction or intrinsic contracture. None of the eyes required additional retinectomy and reattached well after fluid air exchange. Silicone oil was used in all eyes at the end of surgery as a tamponading agent. Small iatrogenic retina tears occurred at the time of tug of war maneuver in 3 (27%) eyes at the site of maximum traction. The mean BCVA improved from  $1.87 \pm 0.2 \text{ logMAR}$  (range = 1.3–2logMAR) to  $1.30 \pm 0.4 \text{ logMAR}$  (range 0.8–1.8logMAR) at 6-months follow-up ( $P = 0.04$ ). The mean BCVA at the last follow-up was  $1.26 \pm 0.4 \text{ logMAR}$ . Nine (82%) eyes gained at least one line in vision and six of these gained two lines or more in vision. All eyes had an attached retina at a mean follow up time of  $11.4 \pm 4.8$  months. SOR was performed in 7 out of 11 eyes at an average timing of  $5.43 \pm 0.54$  months postoperatively. In four eyes, SOR was not performed at the last follow-up.

The mean IOP at 6 months was  $12.8 \pm 4.9 \text{ mm Hg}$ . Only one eye developed persistent hypotony (IOP = 3 mm Hg) while none developed pre-phthical changes.

**Table 1: Demographics, clinical characteristics and outcomes of all eyes included in the study**

Age	Sex	Primary Diagnosis	Predisposing Factor	Primary Surgery	Tamponade in situ	No. of Previous Surg	Preop BCVA	Preop IOP	PVR Grade	Complication	SOR timing	BCVA at 6m	Retina at 6m	Lens at 6m
27	M	RD	Myopia	SB	Nil	2	1.3	16	CA-6, type 3,4	None	6	1.5	ON	Cataract
12	M	RD	Trauma	SB	Nil	1	2	11	CA-8, type 4	Tear	5	0.8	ON	PCIOL
53	F	ERM	Nil	Vit	Oil	2	2	2	CA-6, type 3,4	None	6	1.8	ON	Aphakia
49	M	RD	Nil	Vit	Oil	2	1.7	14	CA-4, type 4	Tear	6	1.8	ON	PCIOL
34	M	RD	Nil	Vit	Oil	2	2	9	CA-7, type 4	None	5	1.5	ON, pale disc	Aphakia
71	M	RD	PDR	Vit	Oil	2	1.8	10	CA-5, type 4	None	No	1.5	ON	PCIOL
21	M	RD	Myopia	Vit	Nil	2	2	21	CA-8, type 4	None	No	0.8	ON	Aphakia
60	M	RD	Nil	SB	Gas	2	1.8	3	CA-6, type 4	None	5	1.0	ON, pale disc	PCIOL
42	M	RD	Myopia	Vit	Oil	2	2	11	CA-5, type 4	Tear	5	1.5	ON, ERM	Aphakia
42	M	VH	Nil	Vit	Oil	2	2	4	CA-8, type 3,4	None	No	1.5	ON, macular scar	PCIOL
9	M	RD	Myopia	SB	Nil	1	2	7	CA-6, type 4	None	No	1.0	ON	Aphakia

PVR: Proliferative vitreoretinopathy as per Updated Retina Society classification 1991, Grade C, A: Anterior, Type 3: subretinal, Type 4: circumferential, BCVA: Best corrected visual acuity in logarithm of minimal angle of resolution (logMAR), 6m: 6 months, M: Male, F: Female, ERM: Epiretinal membrane, VH: Vitreous haemorrhage, PDR: Proliferative diabetic retinopathy, SB: Scleral Buckle, Vit: Vitrectomy

## Discussion

Retinal reattachment surgery in eyes with RRD and advanced grades of circumferential anterior PVR is extremely challenging with difficulty in relieving traction and making the peripheral retina mobile enough to reattach. Many maneuvers have been described to tackle this situation with mixed results<sup>[11-14]</sup> and most involve relieving the circumferential traction using relaxing retinotomies and retinectomies. We describe our initial results with the tug of war maneuver, a new bimanual technique of mechanical separation of the circumferential tractional elements of PVR using two forceps.

Previous studies have described variable success rates of retinal reattachment and visual recovery in eyes with advanced anterior PVR. Mancino *et al.*<sup>[13]</sup> showed good anatomical success rate with more than 90% eyes showing an attached retina after an inferior retinectomy. Similarly, Shalaby<sup>[16]</sup> reported success in 34 out of 38 eyes with retinal shortening using a combination of buckling, vitrectomy, peeling, relaxing retinotomy, and/or retinectomy. Ambiya *et al.*<sup>[17]</sup> studied 133 cases of RRD and found that PVR ≥ Grade C and multiple resurgeries are associated with a higher incidence of anatomical failure in RRD surgery. For cases with posterior PVR, Tabandeh described a bimanual technique, using two membrane scrappers bimanually.<sup>[18]</sup> The technique described makes it easier to visualize the posteriorly located membranes on the retinal surface and get a cleavage plane so that these membranes can be removed with forceps, while our technique mechanically divides anterior circumferential traction causing membranes. Tabandeh required performing peripheral retinectomy in 2 out of 7 eyes in their series while we propose our technique so that this can be completely avoided.

In the “Tug of War” technique, end-gripping forceps are used to release circumferential traction bimanually by grabbing the pre-retinal fibrous tissue and pulling it in opposite directions till the membranes are seen to visibly snap or separate due to stretching. There is a slight risk of causing iatrogenic retinal tears as the forces used to tear the membranes can be transmitted to the underlying retinal tissue, as seen in about 25% cases in our series. However, these tears are generally small and limited compared to large relaxing retinotomies. Most eyes in our series had an inferior RD making it relatively easier to approach membranes with forceps. We suspect that it may be more difficult to perform this maneuver in superior membranes, though most cases of RRD involve the inferior retina, where oil tamponade may have been inadequate. The possibility of intraoperative lens touch in phakic eyes would be one of the limitations of this technique. In our series though, the majority of our cases were either aphakic/pseudophakic or underwent combined surgery for the lens at the time of this maneuver.

Intraoperative complications of retinotomies include hemorrhage, subretinal migration of PFCLs and slippage of the retina during the air-fluid exchange.<sup>[11,19]</sup> Postoperative hypotony is an important complication that could occur after extensive retinectomies. Mechanical separation helped us relieve traction and avoid large relaxing retinotomies, which would otherwise have been required for reattachment of the retina in all our eyes. In our opinion, eyes with PVR



of grade CA with the circumferential component as per the updated Retina Society classification would benefit from the tug of war maneuver and this technique could also be used in primary cases, which fit the inclusion criteria.

## Conclusion

In conclusion, the tug of war maneuvers helped relieve circumferential traction in eyes with advanced anterior PVR and lead to good retinal reattachment in our cases. Importantly, it allowed us to avoid intraoperative and postoperative complications associated with large retinotomies. All our cases also had an encirclage band to take care of residual traction and intrinsic retinal contracture. We recommend the 'tug of war' maneuver in cases of Grade C anterior PVR with circumferential traction. A larger series would be required to confirm our findings and have a more widespread application of this technique. Additionally, though we suspect that it would be equally useful, the effectiveness of this technique in treatment naïve eyes with RD and advanced PVR needs to be studied further.

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## Conflicts of interest

There are no conflicts of interest.

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