Vitrectomy alone or Vitrectomy Combined with Scleral Buckle in the Management of Giant Retinal Tears

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ABSTRACT

The aim of this study was to compare as to which treatment achieves better outcomes in the management of giant retinal tears (GRTs) — pars plana vitrectomy (PPV) alone or combined with scleral buckle (SB)? The Web of Science, PubMed, and Cochrane Library databases were searched from January 1, 1950 to October 1, 2020. Pooled odds ratios (ORs), 95% confidence intervals (CIs), heterogeneity, and publication bias were determined with Review Manager software. PPV combined with SB significantly decreased the risk of recurrent retinal detachment (RRD, OR = 0.39, 95% CI = 0.20-0.77, $I^2 = 35\%$, $p = 0.006$) in GRT management compared with PPV alone. However, the final anatomical success (OR = 0.74, 95% CI = 0.23-2.39, $I^2 = 0\%$, $p = 0.61$), final visual acuity (OR = 1.11, 95% CI = 0.48-2.58, $I^2 = 13\%$, $p = 0.81$), and risk factors of GRT $\geq 180^\circ$ (OR = 0.43, 95% CI = 0.15-1.22, $I^2 = 0\%$, $p = 0.11$) were not significantly different between the two approaches.

According to the final anatomical success, final visual acuity, and risk factors of GRT $\geq 180^\circ$, there were no significant differences between PPV combined with SB and PPV alone for the management of GRT in the current study, except in decreasing the risk of RRD.

Key Words: Giant retinal tear, Pars plana vitrectomy, Scleral buckling, Recurrent retinal detachment.

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INTRODUCTION

The standard management of giant retinal tears (GRTs) has posed a great challenge to vitreoretinal ophthalmologists. Rarely, GRTs are due to giant rhegmatogenous retinal detachment, and these patients may have a poor prognosis. Rapidly developing and usually extensive retinal detachments commonly occurred with GRTs. One study estimated that the incidence of GRT is 0.05/100,000 among the general population per year or 0.5-8.3% of all patients with rhegmatogenous retinal detachment,¹ according to retrospective, single centre, hospital-based study reported, when it is the case with regard to other characteristics of harboring GRTs. There are many risk factors involved in GRT, such as Marfan syndrome, high myopia and trauma.²

Pars plana vitrectomy (PPV) was initially adopted as an adjunctive surgical step for GRT management and was subsequently accepted as the principle manoeuvre, in combination with a high posterior encircling buckle to prevent re-detachment due to anterior proliferative vitreoretinopathy (PVR).

Due to a higher success rate than previously used surgical treatments, PPV has become the standard first-line treatment of GRT,³ but some surgeons prefer to perform an encircling scleral buckle or a scleral buckle for a portion of the circumference. To prevent concomitant scleral buckling (SB), some researchers suggested that an encircling buckle may provide vitreous base support, particularly in cases with anterior PVR.² However, one group demonstrated that encircling buckles did not provide additional benefit for patients GRTs; but instead resulted in potential complications such as tear fishmouthing, choroidal haemorrhage, and anterior retinal folds, facilitating tear slippage.⁴ Despite advances in surgical techniques and endotamponade agents, GRTs pose significant challenge due to their complex anatomy, the risk of retinal slippage, and a high incidence of PVR. The use of an SB combined with PPV for GRT management has been a point of contention.

The aim of this meta-analysis was to identify as to which approach would be to treat GRTs—PPV alone or PPV combined with SB.

METHODOLOGY

Ethical approval and patient consent were not required, since all analyses were based on previously published studies. The systemic literature review and meta-analysis were performed following the preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement.⁵

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A systematic search was performed on the Web of Science, PubMed and Cochrane Library databases from January 1, 1950 to October 1, 2020. Articles written in English, French, German, Japanese, and Korean were included. Various combinations of the terms 'giant retinal tear (giant retinal tears), GRT, and giant rhegmatogenous retinal detachment (giant rhegmatogenous retinal detachments)' were fed into the search engines. References cited in the identified articles were also reviewed to find related studies.

Two independent reviewers (HFZ and QYL) judged the articles on the principle of fairness and justice. Discrepancies were resolved through the discussion with a third-party reviewer (QZ) to avoid bias. To confirm some detailed data in the selection studies, a final confirmation was obtained by asking all authors to contribute any related information and statistics. The reference lists from original and review articles were also manually reviewed to identify appropriate studies. Articles were assessed for quality to determine inclusion in the meta-analysis after initially screening the titles and abstracts.

To eliminate the interference from other factors, studies consistent with the following criteria were included: (1) subjects ages ranging from 3 to 83 years; (2) study samples ≥ 15 ; (3) large-circumferential retinal tears measuring $\geq 90^\circ$, or ≥ 3 contiguous clock hours (4) surgical techniques including PPV and PPV+SB with other procedures such as perfluorocarbon liquids (PFCLs) and silicone oil; (5) GRT with or without PVR; (6) comparison of PPV alone or with SB; and (7) at least two of the following experimental results of anatomical success, final visual acuity, and recurrent retinal detachment (RRD). Studies that did not meet these inclusion criteria were excluded during the initial or final review.

Data were extracted by two independent reviewers (HFZ and QYL) from all eligible studies. Another reviewer (QZ) solved any divergent issues by consulting with the respective authors on original manuscripts. The following data are shown in the table for each included article: first author name, publication year, gender, age (mean $\pm$ SD), mean follow-up time, number of GRT, surgical aspect, anatomical success, final visual acuity, RRD, and risk factors.

Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated to estimate the outcomes.⁶ Due to the low or high levels of heterogeneity in different studies, a fixed-effects or random-effects model was used for analyses. I^2 statistics were used to evaluate the degree of heterogeneity; 25%, 50% and 75% were considered as low, moderate, and high scores, respectively.⁷ To assess the outcomes of the two different procedures (PPV or PPV combined with SB) to treat GRT, a subgroup analysis was performed to investigate the sensitivities of and relationship between the two treatment methods. Using summary estimates from the individual studies with a random-effect models,⁸ study results were statistically analysed and displayed as forest plots. Funnel plots were generated to assess potential publication bias.⁹ Probability values <0.05 were defined as statistically significant. All data analyses were performed with Review Manager software, version 5.3.

RESULTS

The electronic search identified 1,272 studies, and 1,218 (95.8%) articles were excluded through the abstract and title review. For the remaining 54 papers, 49 did not meet the criteria, and five manuscripts¹⁰⁻¹⁴ were eventually chosen for this analysis (Figure 1). The characteristics of these studies are demonstrated in Table I. The analysis comprised 256 eyes from five studies. Among these individuals, all the patients underwent PPV, including 169 eyes combined with SB and others without SB. Among the five included studies, three included almost all data, while two studies contained several important outcomes such as final visual acuity and RRD. The evaluation of outcomes showed results associated with PPV combined with SB and PPV alone, but the statistical methods, descriptions, and analyses of all studies varied and focused on different aspects.

Five studies were identified, which included 256 eyes to compare the effects of PPV with or without SB in GRT management.¹⁰⁻¹⁴ Although several studies did not report baseline characteristics, the main information of the articles was used. Since low heterogeneity was observed between the studies ($I^2 = 35\%$), a fixed-effect model was applied. Compared with PPV alone, PPV with SB significantly decreased the risk of RRD (OR = 0.39, 95% CI = 0.20-0.77, $I^2 = 35\%$, $p = 0.006$) in GRT management (Figure 2). However, the final anatomical success (OR = 0.74, 95% CI = 0.23-2.39, $I^2 = 0\%$, $p = 0.61$) in four studies,^{10,12-14} final visual acuity (OR = 1.11, 95% CI = 0.48-2.58, $I^2 = 13\%$, $P = 0.81$) of three studies,^{10,12-14} and risk factors of GRT $\geq 180^\circ$ (OR = 0.43, 95% CI = 0.15-1.22, $I^2 = 0\%$, $p = 0.11$) of three studies,^{10,12,14} revealed no significant differences between the two groups. In three studies, gender ($Z = 1.15$, $p = 0.25$), age ($Z = 0.63$, $p = 0.53$), the number of GRT ($<150^\circ/\geq 150^\circ$) ($Z = 0.98$, $p = 0.33$), and mean follow-up time ($Z = 0.90$, $p = 0.37$) were also not significantly different between the two groups in three studies.^{10,12,14}

One study was excluded from the meta-analysis, owing to the small sample size for sensibility analysis.¹⁴ However, analysis of the other four studies,¹⁰⁻¹³ revealed that PPV with SB was associated with a beneficial outcome (OR = 0.36, 95% CI = 0.18-0.72, $I^2 = 44\%$, $p = 0.004$), which is almost consistent with the analysis using all five studies,¹⁰⁻¹⁴ where PPV with SB decreased the risk of RRD in GRT management (Figure 3). However, there was no difference in final anatomical success (OR = 0.75, 95% CI = 0.21-2.71, $I^2 = 0\%$, $p = 0.44$) or final visual acuity (OR = 1.03, 95% CI = 0.27-3.93, $I^2 = 55\%$, $p = 0.96$) between the two groups (Figures 4, 5).

Despite the limited number of studies, they had low heterogeneity, and the funnel plot asymmetry suggested that there was no significant publication bias among the studies in the management of GRT comparing PPV+SB and PPV alone (Figure 6).

Table I: Population characteristics of 5 GRT studies included in the meta-analysis.

	Gender (No M/F)		Age (mean $\pm$ SD) (years)		Mean follow-up time (M $\pm$ SD)		GRT degrees (No <150°/≥150°)		Surgical Aspect (No)	
	VT	VT+SB	VT	VT+SB	VT	VT+SB	VT	VT+SB	VT	VT+SB
Kumar <i>et al.</i> (2018) ¹⁴	9/1	7/0	35.00 $\pm$ 22.63	14.71 $\pm$ 9.60	10.60 $\pm$ 2.80	9.57 $\pm$ 2.99	5/5	3/4	10	7
Goezinne <i>et al.</i> (2008) ¹²	6/3	20/1	56.33 $\pm$ 13.07	51.90 $\pm$ 10.13	46.89 $\pm$ 30.27	49.95 $\pm$ 26.26	7/2	17/4	9	21
Pitcher <i>et al.</i> (2015) ¹³	NA	NA	NA	NA	NA	NA	NA	NA	28	30
Verstraeten <i>et al.</i> (1995) ¹⁰	18/2	12/2	33.65 $\pm$ 16.63	42.07 $\pm$ 17.15	18.55 $\pm$ 14.80	15.71 $\pm$ 6.81	5/15	7/7	20	14
Al-Khairi <i>et al.</i> (2008) ¹¹	NA	NA	NA	NA	NA	NA	NA	NA	20	97

	Anatomical Success (%)		FVA (No $\leq$ 0.1/ $>$ 0.1)		RRD (%)		Risk factors		GRT $\geq$ 180°	
	VT	VT+SB	VT	VT+SB	VT	VT+SB	HM VT VT+SB	PVR	VT	VT+SB
Kumar <i>et al.</i> (2018)	90%	85.7%	4/6	3/4	10%	14.3%	3/10 3/7	17/100%	5/10	2/7
Goezinne <i>et al.</i> (2008)	100%	95.2%	NA	NA	66.7%	14.3%	NA	All A or B (100%)	1/9	3/21
Pitcher <i>et al.</i> (2015)	89.3%	86.7%	NA	NA	10.7%	13.3%	NA	C (17%)	NA	NA
Verstraeten <i>et al.</i> (1995)	100%	100%	4/16	5/9	45%	14.3%	8/20 7/14	NA	10/20	3/14
Al-Khairi <i>et al.</i> (2008)	NA	NA	12/8	44/53	35%	18.60%	NA	0 (0%)	NA	NA

M/F: Male/Female; SD: Standard deviation; VT: Vitrectomy; No: Number of.; FVA: Final visual acuity; RRD: Recurrent retinal detachment; HM: High myopia; NA: Not available.

Figure 1: Flow diagram of the literature search according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines. **Figure 2: RRD following PPV + SB and PPV alone in the treatment of GRT.** **Figure 3: Sensitivity analysis of RRD between PPV+SB and PPV alone in the treatment of GRT.** **Figure 4: Sensitivity analysis of final anatomical success between PPV+SB and PPV alone in the treatment of GRT.** **Figure 5: Sensitivity analysis of final visual acuity between PPV+SB and PPV alone in the treatment of GRT.** **Figure 6: Funnel plot of studies comparing PPV+SB and PPV alone.**

DISCUSSION

Effective treatment of GRT (a circumferential tear $\geq 90^\circ$), is very important for patient visual quality of life and is a great challenge to ophthalmologists due to technical treatment difficulties and the high risk of surgical complications. The incidence of GRT in the general United Kingdom population (0.09-0.11 per 100,000) indicates that it may occur more commonly than previously thought (0.05/100000 yearly).¹⁵ GRT carries a variety of risk factors: A posterior radial exten-

sion at the ends of the tear, an inverted retinal flap, and high rates of PVR and foveal detachment.¹⁶⁻¹⁸ These complex cases may be technically difficult to manage surgically. However, the prognosis of GRT can be poor if patients are not promptly treated.¹⁹

Although GRTs pose several surgical challenges including flap manipulation, extensive PVR membranes, tear extension, flap slippage, and subretinal posterior PFCL or silicone oil, their management has been substantially more successful with modern surgical techniques. SB and PPV are very suitable for the treatment of phakic and pseudophakic eyes in GRT cases, respectively.²⁰ However, there is a greater proportion of RRD among eyes without concomitant SB, and further surgery is required for these cases (45% RRD rate in PPV alone vs. 14.3% in PPV + SB).¹⁰ Goezinne *et al.* demonstrated that the absence of SB was a risk factor for RRD in GRT management,¹² which is consistent with another study.²¹ Another report concluded that encircling SB and silicone oil tamponade would decrease the risk of RRD.¹¹ The current study indicated that the most common method of repairing GRT-induced retinal detachment is a combination of PPV/SB and PFCLs, which obtains reasonable and generally favourable anatomical and visual results.²² Conversely, two groups recommended meticulous vitreous base trimming with deep scleral indentations and demonstrated that the GRT (with an appropriate tamponade) in cases with no significant PVR could be treated without SB placement.^{3,23,24} Some authors reported that successful treatment of GRT with initial micro-incision vitrectomy surgery (MIVS) does not need to be combined with an encircling SB,^{25,26} which was confirmed by other investigators.^{18,27} A high rate of anatomical success is proposed²⁸ and improvement of final visual acuity¹⁴ was achieved with PPV alone compared to PPV and SB. For surgeons, who routinely placed encircling buckles, the reoperation rate was 27%-50%, compared to 6%-21% for those who never placed encircling buckles.

The use of an SB combined with PPV for managing GRTs has been a point of controversy among researchers.^{12,16,18} In this meta-analysis of five studies with 256 eyes, it was found that PPV combined with SB was better than PPV alone with regard to decreasing the risk of RRD, but there was no significant difference in gender, age distribution, the extent of GRT, mean follow-up time, final anatomical success, final visual acuity, and risk of GRT $\geq 180^\circ$ between groups. Surgical techniques and treatments are constantly improved in GRT management. Intraoperative PFCL application dramatically increases reattachment rates after GRT surgery.² One study showed that the use of a "sandwich" of anterior silicone oil and PFCL was comfortable for patients undergoing laser surgery and created well-formed closed vitreous chamber that promoted continuous maintenance of retinal attachment in eyes with GRT.²⁹ Additionally, smaller-gauge vitrectomy has evolved over time and has several advantages including a high rate of anatomical success, lesser

vitreous traction, and good PVR management.³⁰⁻³² Other recent technical advancements such as MIVS, wide viewing systems, and chandelier illumination have also greatly improved GRT treatment (primary reattachment rate $>90\%$).^{18,25,28} Zhang *et al.* also reported that the 27-gauge PPV combined with temporary PFCL application could be safe and effective for GRT management.³³

There are no precise guidelines regarding intraoperative procedures of PPV for GRT; for example whether to use lensectomy, PFCL application, and 360° endophotocoagulation. Advanced PPV techniques have significantly increased the rate of anatomical success in GRT treatment.¹⁷ Patient age, gender, extent of GRT ($<150^\circ/\geq 150^\circ$), final anatomical success, final visual acuity, risk factors of GRT $\geq 180^\circ$, and the mean follow-up time were not significantly different between the PPV alone and PPV + SB groups. Due to the larger sample size of one study,¹¹ heterogeneity increased when that study¹⁴ was excluded. It should also be noted that a GRT-associated detachment should be treated as any other rhegmatogenous retinal detachment, and adjuvant SB should only be considered in certain high-risk cases.^{18,34} Consequently, SB was performed at the discretion of the surgeon based on the therapeutic strategy of GRTs, which is appropriate for patients with persistent retinal contraction, advanced-grade PVR, extensive inferior pathology within a detached area. Furthermore, SB could create an inward indentation in the sclera and choroid, which would promote retinal reattachment, weaken traction of the vitreous around the retinal tear, and possibly reduce the risk of RRD by pre-emptively neutralising subsequent traction.²⁰ Placement of an SB prior to the vitrectomy may counterbalance vitreous base contraction and peripheral traction, which could also compensate for retinal surface shortening induced by membranes with PVR in complicated cases including GRT,^{18,28} by preventing liquid in the vitreous cavity from re-entering the subretinal cavity through pushing the pressurised substance to close the retinal tear and reduce the vitreous cavity. This promotes contact between the detached retinal neuroepithelial and pigmented epithelial layers. Therefore, PPV combined with SB could enhance retina reattachment and effectively eliminate or reduce the effect of peripheral forces on residual traction, which can significantly decrease the risk of RRD. However, we should be aware that the recurrence rate of GRTs is relatively low in the clinic. The addition of SB can increase pain and the risks factor of high intraocular pressure and refractive system abnormalities.

CONCLUSION

The current analysis found no difference between PPV with or without SB with regard to the degree of GRT, mean follow-up time, final anatomical success, final visual acuity, or risk factors of GRT $\geq 180^\circ$; however, the addition of SB did decrease the risk of RRD. It is hoped that these findings provide some guidance for the treatment of GRT and improve patient quality of life.

More detailed comparisons and larger studies are needed to verify the findings of this study.

DATA AVAILABILITY:

The meta-analysis data, used to support the findings of this study, are available from the corresponding author upon request.

CONFLICT OF INTEREST:

The authors declared no conflict of interest.

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AUTHORS' CONTRIBUTION:

AX: Concept, design and writing – original draft.

HZ: Acquisition, analysis, or interpretation of data.

QL: Methodology, Software and Statistical analysis.

YS: Statistical analysis and writing review and editing.

QZ: Supervision and writing review and editing.

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