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Surgical Approaches in Primary Rhegmatogenous Retinal Detachment: A Systematic Review and Meta-Analysis Comparing Vitrectomy vs. Vitrectomy Combined with Scleral Buckling, Lens-Sparing vs. Phako Procedures

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Abstract

Aim: This study aimed to assess and compare the functional and anatomical results of pars plana vitrectomy (PPV) alone versus PPV combined with scleral buckling (SB), and lens-sparing versus phaco-procedures for treating rhegmatogenous retinal detachment. **Methods:** A comprehensive literature search was performed using the Web of Science, MEDLINE, EMBASE, and Cochrane Library databases to retrieve comparative studies. The main objective was to assess the BCVA, while reattachment rates and ocular adverse events were considered secondary measures. Rev Manager software was used for statistical analysis. **Results:** The literature search identified 10 articles comprising 1518 eyes, with 682 eyes in the PPV group, 193 eyes in the lens-sparing versus phaco-procedure group, and 643 eyes in the combined PPV and SB surgery group. Quality assessment revealed a low risk of bias in most domains. The meta-analysis results revealed a significant difference in postoperative BCVA between the PPV and PPV combined with SB groups (WMD = −0.17, 95% CI [0.27, 0.07], p = 0.001). The primary reattachment rates were 82.80% for PPV alone and 87.52% for PPV combined with SB (p = 0.34). The final reattachment rates did not differ significantly between PPV and PPV combined with SB (99% vs. 99.8%; RR = 1.00, 95% CI [1.01, 0.99], p = 0.96). PPV alone demonstrated a significantly reduced risk of macular edema compared to PPV combined with scleral buckling (9.9% vs. 23%; p = 0.006). The incidences of macular hole development (p = 0.46), recurrent retinal detachment (p = 0.27), proliferative vitreoretinopathy development (p = 0.48), epiretinal membrane proliferation (p = 0.77), and limited choroidal hemorrhage (p = 0.69) were not significantly different between the two groups. **Conclusions:** These findings suggest that PPV alone may be a more effective treatment option in terms of visual acuity (VA) improvement, lower risk of macular edema and cataract development. However, there was no significant difference in VA improvement or complication rates between the lens-sparing and phaco-procedure groups.

Keywords

Lens-Sparing, Phaco-Procedure, Pars Plana Vitrectomy, Rhegmatogenous Retinal Detachment, Scleral Buckle

1. Introduction

Rhegmatogenous retinal detachment (RRD) is a vision-threatening condition that affects 1 in 10,000 people per year, with the highest frequency in males [1] [2]. This occurs when the vitreoretinal interface experiences the mechanical forces that cause retinal tears. This tear allows fluid to flow into the subretinal space, which separates the retina from the retinal pigment epithelium (RPE) and the choroid [1]. Giant retinal tears (GRTs) are a severe form of RRD, accounting for approximately 0.5% to 8.3% of all RRD cases [3] [4] [5]. GRTs involve tears extending circumferentially around the retina for three or more clock hours (90 or more) in the presence of a posteriorly detached vitreous, which can make surgical repair challenging [6] [7].

There is ongoing debate among retinal surgeons regarding the most favorable and effective technique for repairing RRD. Numerous surgical options are available, such as scleral buckling (SB), pars plana vitrectomy (PPV), pneumatic retinopexy (PnR), lens-sparing techniques, phaco-procedures, the combination of PPV with SB, and any of these interventions [8] [9]. However, the choice of method often varies depending on individual surgeon preferences or institutional practices rather than solely based on evidence-based outcomes [10]. According to the recommendations of the 2013 European Vitreo-Retinal Society (EVRS) Retinal Detachment Study, surgeons should carefully consider the risks associated with vitrectomy and SB and consider that vitrectomy may yield higher reattachment rates for uncomplicated pseudophakic RRD when performed as a single surgery. It has also been highlighted that adding supplemental buckles during vitrectomy may not provide additional benefits [11].

The debate regarding the relative effectiveness of combined vitrectomy with

SB versus vitrectomy alone for repairing RRD remains controversial [10]. The primary anatomical success rates for vitrectomy in two large comparative randomized studies conducted by Heimann *et al.* [12] (against SB) and Hillier *et al.* [13] (against PnR) were 72% and 93%, respectively. SB has a primary anatomical success rate ranging from 53% to 83% [12] [14]. Lee *et al.* [15] found that after a minimum follow-up period of 6 months, 85% of patients who underwent PPV achieved anatomical success, and 40% of them had a visual acuity (VA) of 20/40 or better. Notably, all patients underwent PPV, and 70.3% of patients with GRT and RRD underwent additional SB surgery [15]. A study by Goezinne *et al.* [16] suggested that retinal tears larger than three disc diameters are associated with higher rates of surgical failure. Therefore, patients with such tears should undergo primary PPV.

There has been a recent shift toward lens-sparing procedures such as PnR and SB with cryotherapy, which aim to preserve the natural lens of the eye whenever possible [17]. One reason for this shift is the potential complications associated with vitrectomy and SB, such as cataracts, glaucoma, and vision loss [18] [19] [20]. Lens-sparing techniques aim to preserve the natural lens while treating RRD, whereas lensectomy/phaco-procedures involve removal of the natural lens and replacement with an intraocular lens (IOL) implant [21]. Studies have shown that lens-sparing techniques have comparable success rates to lensectomy/phaco-procedures, with lower rates of cataract formation and other complications [22] [23].

In recent years, there has been increasing interest in comparing the outcomes of PPV alone with vitrectomy combined with SB and lens-sparing versus lensectomy/phaco-procedures for RRD. However, a consensus on the superior approach is lacking, and the factors influencing the surgical choice are unclear. This systematic review and meta-analysis aimed to compare the outcomes of vitrectomy alone versus vitrectomy combined with SB and to explore the impact of lens-sparing versus lensectomy/phaco-procedures in the treatment of primary RRD. Additionally, the factors influencing the choice of the surgical, reattachment rates, ocular adverse events, and incidence of complications were examined. This study provides valuable insights into the optimal surgical management of RRD, informs clinical decision-making for ophthalmologists, and potentially improves patient outcomes.

2. Methodology

2.1. Search Strategy

This systematic review and meta-analysis was conducted according to the Preferred Reporting Items of Systematic Reviews (PRISMA) guidelines [24] [25]. A comprehensive literature search was conducted in electronic databases, including Web of Science, PubMed, Medline, EMBASE, and Cochrane Library, using a combination of Medical Subject Headings (MeSH) terms and keywords related to RRD, GRT, vitrectomy, SB, lens-sparing, lensectomy, and phaco-procedures. The last search was conducted on June 18, 2023, and additional searches were performed using Google Scholar to identify the reference lists of the originally identified articles. Detailed keywords and search strategies are listed in Table S1.

2.2. Study Selection

Screening studies were conducted using the online screening tool Covidence.org. After removing duplicates, all retrieved articles underwent title and abstract screening, followed by full-text screening by two independent reviewers (MAQR and EAQG). Any discrepancy in screening was resolved by consensus with input from another author (VLG).

Studies that met the following predefined inclusion criteria were included in this systematic review and subsequent meta-analysis:

1) **Comparative Study Designs**: Comparative randomized controlled trials (RCTs) and observational studies were conducted. However, upon careful assessment, it was noted that the studies primarily had nonrandomized prospective and retrospective designs, thus acknowledging the limitations of the study's design diversity.

2) **Peer-Reviewed Full-Text Articles:** Only peer-reviewed full-text articles were incorporated into the study to ensure the credibility and rigor of the selected literature.

3) **Language and Publication:** The scope was limited to studies published in English.

4) **Patient Population:** This study focused on patients diagnosed with RRD, including various subtypes, such as single or multiple retinal breaks, presence of choroidal detachment, giant retinal break, proliferative vitreoretinopathy, and ocular trauma.

5) **Treatment Modalities:** The selected studies covered the spectrum of treatment modalities, including PPV alone, PPV combined with SB, and lens-sparing and phaco-combined procedures.

6) **Outcome Reporting:** To ensure data integrity, studies were required to report at least one set of efficacy and/or safety outcomes for each treatment arm.

7) **Minimum Sample Size:** Studies were included if they encompassed more than five eyes per treatment arm, aiming to ensure a minimum level of statistical power.

2.3. Data Extraction

Two reviewers (MAQR and EAQG) independently completed data extraction, and a third reviewer (VLG) resolved any discrepancies through consensus. Data from eligible studies were collected by referring to the manuscript and supplementary files. In the case of missing data, an effort was made to reach the author twice, with each attempt at least one week apart. Instead of estimating the missing data, they were explicitly identified as unavailable in the collection tables. The following data were collected: 1) study identifiers (title, authors, year of publication, country of origin); 2) baseline demographics (number of eyes in each group, age, sex, indication for treatment, type of intervention, type of endotamponade used, baseline best-corrected visual acuity (BCVA), and intraocular pressure (IOP)); and 3) outcome data (postoperative BCVA and IOP, final refractive error, incidence of macular hole (MH) development, and intraoperative and postoperative complications). Although central subfield thickness (CSFT) was an outcome of interest, none of the analyzed articles included this information. For the proportion of patients with an elevated postoperative IOP, the threshold IOP was defined by the authors of the original study.

2.4. Quality Assessment

The Cochrane Risk of Bias in Nonrandomized Studies of Interventions (ROBINS-I) tool, as described by Sterne *et al.* [26], was used for nonrandomized comparative studies. The ROBINS-I tool evaluates bias based on various factors, including the study question, study population, enrollment of eligible participants, sample size, clear description of interventions and outcome measures, validity and reliability, blinding of outcome assessors, follow-up rate, statistical analyses, multiple outcome measures, and efforts made at both the group and individual levels. Studies that exhibited a high risk of bias across all assessment categories were excluded from analysis. The quality of the reported outcomes was assessed using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) tool [27].

3. Meta-Analysis

A meta-analysis was conducted to determine the weighted mean differences (WMDs) and standard deviations (SDs) for continuous variables and risk ratios (RRs) for binary outcomes. Ninety-five percent confidence intervals (CIs) were calculated and presented. The inverse variance method was used for the meta-analysis of continuous data, whereas the Mantel-Haenszel method was used for categorical variables. Throughout the study, statistical significance was defined as a p value of <0.05. To assess statistical heterogeneity, two measures were computed: the I^2 statistic, which determines the percentage of variance attributable to heterogeneity, and the chi-square statistic, with a significance level of $p < 0.05$, indicating significant heterogeneity. Statistical analyses were performed using Review Manager software (RevMan version 5.3).

4. Result

4.1. Literature Search Results and Baseline Demographic Information

The initial search yielded 3086 articles, of which 10 involved 1518 eyes. These eyes were distributed among three groups: 682 eyes in the PPV group, 193 eyes in the lens-sparing versus phaco-procedure group, and 643 eyes in the combined SB and PPV surgery group (**Figure 1**). Among the included articles, two were prospective studies, and eight were retrospective comparative studies. One study by Kim *et al.* [28] consisted of two parts that compared phaco-procedures with lens-sparing techniques. Studies that compared PPV alone and PPV combined with SB have been published [10] [29]-[36], and their details can be found in **Table S2a** and **Table S2b** in the supplementary file. In five studies [28] [30] [31] [33] [36], each patient contributed to one eye, one study [34] included both eyes

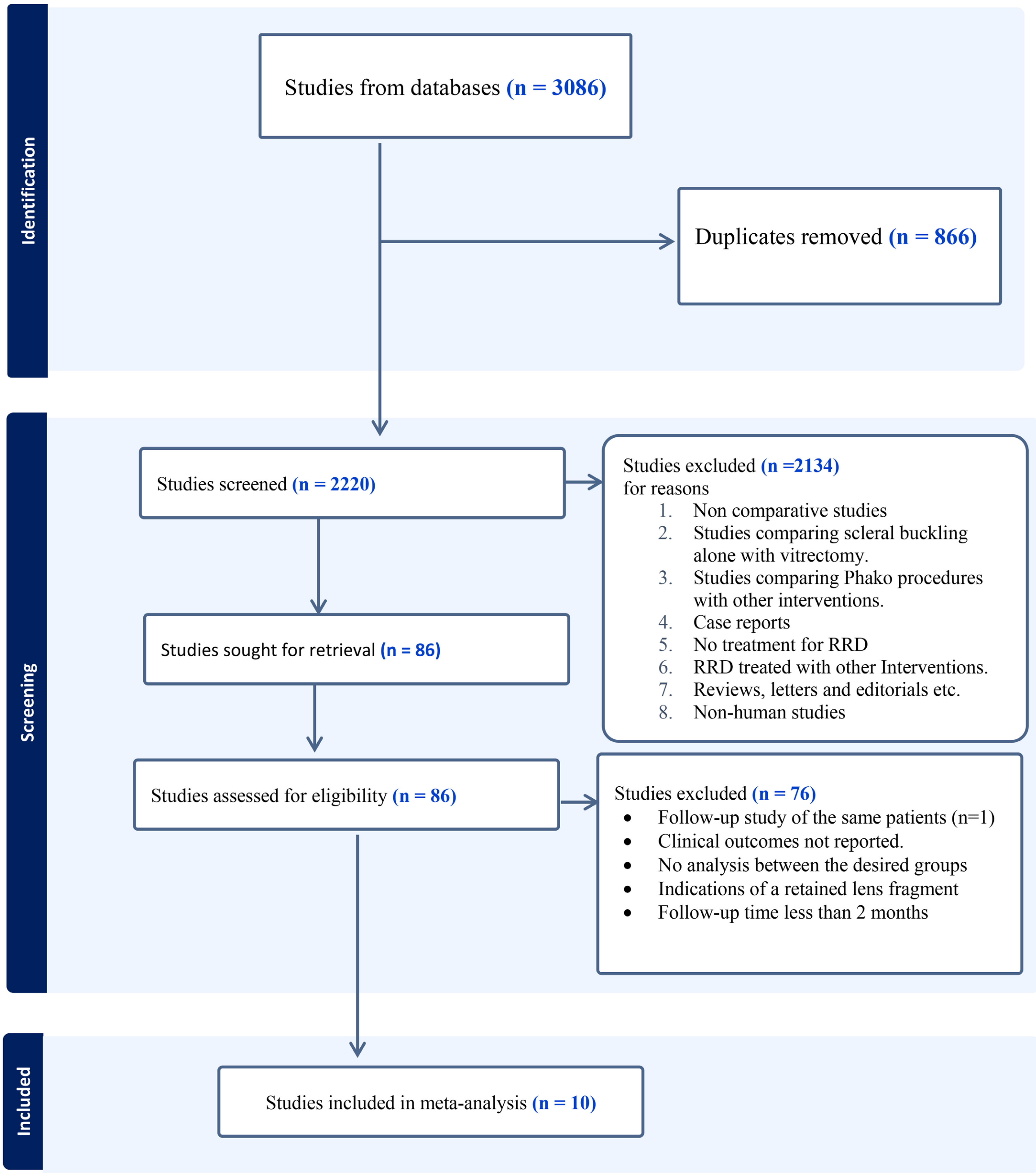

Figure 1. The PRISMA flow chart depicts the retrieved studies and studies included after screening.

of the same patient, and one study [10] [29] included both eyes of some patients. The average age of the patients in all the included studies was 59.34 ± 4.88 years. BCVA was measured using LogMAR in three studies [28] [34] [36] and Snellen chart in five studies [10] [29] [30] [31] [33] [35], and the method of measurement was unknown in one study [32].

4.2. Quality Assessment

All the included studies were nonrandomized, and the risk of bias was low for most domains. This trial had a high risk of bias in masking outcome assessors, random sequence generation, and an unclear risk of allocation concealment (see **Table S3** in the supplementary file). Five of the 10 comparative and observational studies [29] [31] [33] [34] [36] showed a poor risk of confounding bias, whereas 2 studies [32] [35] showed a high risk of confounding bias because the treatment groups were not distributed randomly, and no statistical adjustments were performed to account for confounding variables. The risk of bias in other categories was low [10] [28] [30] (see **Table S3** in the supplementary file). In terms of statistical analysis, three studies [29] [30] [32] did not report improvement, and three studies (20%) did not report this information. The quality of evidence for all reported efficacy and safety outcomes was assessed using the GRADE tool (**Table S4** in the supplementary file). The quality of evidence for the final BCVA and incidence of macular edema, recurrent RD, and epiretinal membrane proliferation (ERM) were low, while the incidence of IOP elevation and proliferative vitreoretinopathy (PVR) was moderate, and the primary and final reattachment rate quality of evidence was low. Issues related to heterogeneity and imprecision of measured estimates affect the quality of the observed evidence.

4.3. Meta-Analysis of Efficacy Outcomes

In this meta-analysis, a comprehensive comparison was conducted to assess the efficacy of PPV alone versus PPV combined with SB, as well as lens-sparing techniques versus phaco-procedures in terms of postoperative visual acuity improvement. All available data were analyzed and are summarized in **Table S5** in the supplementary file. The results revealed a significant difference in postoperative BCVA between the PPV and PPV combined with SB groups (WMD = −0.17, 95% CI [0.27, 0.07], p = 0.001; GRADE: low certainty; **Figure 2a**), favoring the use of PPV alone. Conversely, no significant difference was observed between the lens-sparing techniques and phaco-procedures (WMD: −0.01, 95% CI [0.07, −0.09], p = 0.80; **Figure 2b**). Primary reattachment rates were 82.80% for PPV alone and 87.52% for PPV combined with SB. However, this difference was not statistically significant (RR = 0.97, 95% CI [1.03, 0.91], p = 0.34; GRADE: high certainty; **Figure 2c**).

Similarly, the final reattachment rates did not differ significantly between PPV and PPV combined with SB (99% vs. 99.8%; RR = 1.00, 95% CI [1.01, 0.99], p = 0.96; GRADE: high certainty; **Figure 2d**).

Similarly, no significant differences were observed in the primary reattachment rate (RR = 1.01, 95% CI [1.20, 0.85], p = 1.00; Figure 3a) and final reattachment rates (RR = 1.00, 95% CI [1.03 - 0.97], p = 1.00; Figure 3b) between the lens-sparing techniques and phaco-procedures. Insufficient postoperative data were available to conduct meta-analyses for outcomes, such as CSFT, operation

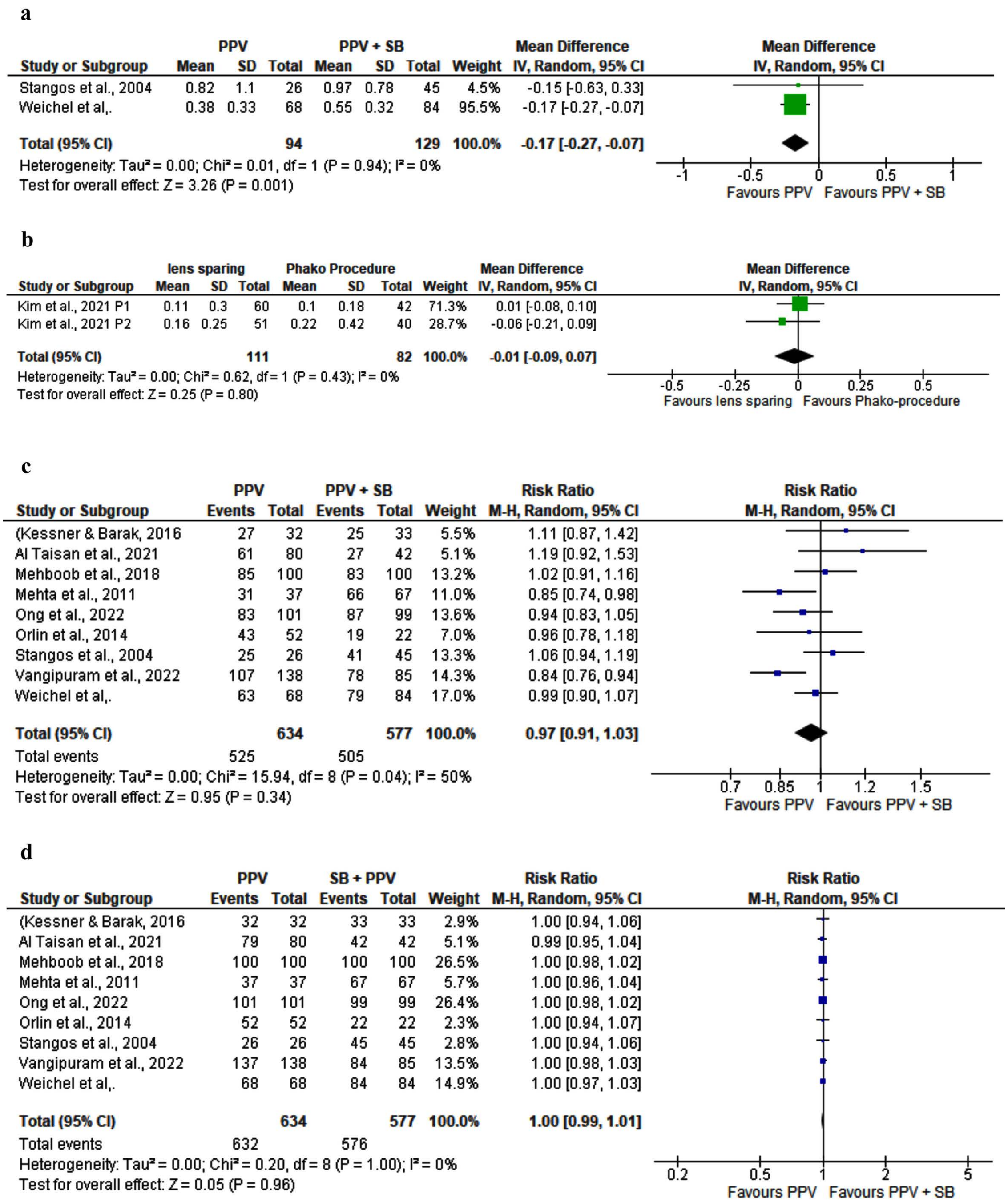

Figure 2. The figure illustrates various outcome measures in the study. (a) The figure represents the final best-corrected visual acuity (BCVA) outcomes. (b) This figure illustrates the results of the lens-sparing versus phaco-procedures comparison in terms of final best-corrected visual acuity (BCVA). (c) The figure depicts the primary reattachment rates. (d) The figure depicts the final reattachment rates.

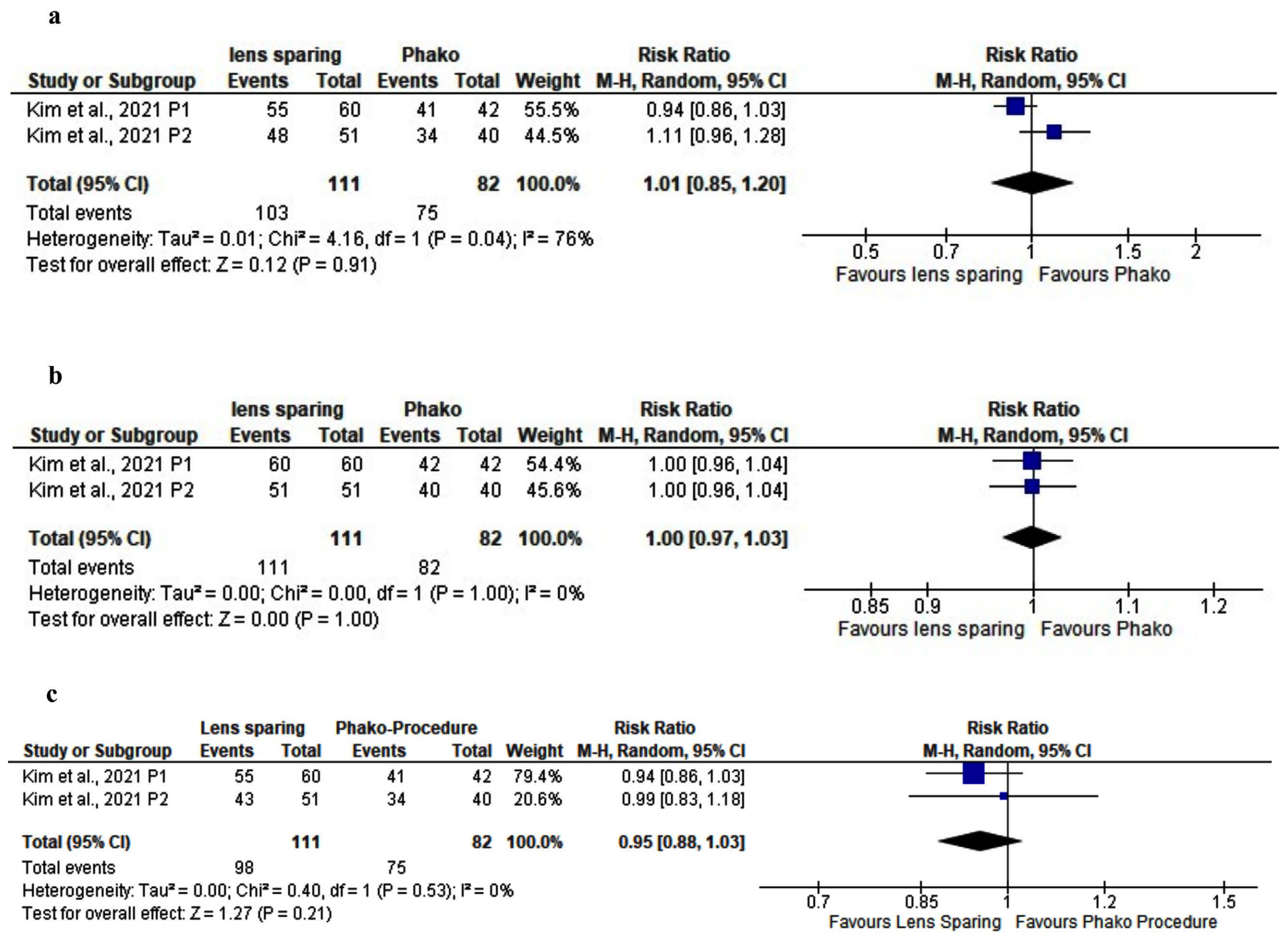

Figure 3. The figure illustrates various outcome measures in the study. (a) The figure represents the primary reattachment rate. (b) The figure represents the final reattachment rate. (c) Figure shows the anatomic success rate in treating RRD between pars plan vitrectomy (PPV) and PPV with scleral buckling (SB).

time, and number of interventions. However, anatomical success rates were reported for lens-sparing techniques versus phaco-procedures, showing no significant differences (RR = 0.95, CI [1.03, 0.88]; p = 0.21; Figure 3c), whereas these rates were not reported for PPV versus PPV combined with SB. Furthermore, elevated IOP was reported for PPV alone versus PPV with SB (RR = 0.66, 95% CI [1.82, 0.24], p = 0.43; GRADE: medium certainty) but not for lens-sparing techniques and phaco-procedures.

4.4. Meta-Analysis of Postoperative Complications

When evaluating the occurrence of complications, PPV alone demonstrated a significantly reduced risk of macular edema compared to PPV combined with SB (9.9% vs. 23%; RR = 0.36, 95% CI [0.74, 0.18], p = 0.006; GRADE: high certainty; Figure 4a). A detailed summary is presented in the Supplementary File (Table S6). Additionally, the incidence of cataract development or progression was lower in the PPV alone group than in the PPV + SB group (24.44% vs. 41.5%; RR = 0.70; 95% CI [0.52, 0.94]; p = 0.02; GRADE: moderate certainty; Figure 4b).

However, the incidence of MH development (RR = 1.79; 95% CI [0.38, 8.34]; p = 0.46; GRADE score: low; Figure 4c), recurrent RD (RR = 0.71; 95% CI [0.39, 1.30]; p = 0.27; Figure 4d), PVR development or progression (RR = 1.18; 95% CI [0.74, 1.90]; p = 0.48; Figure 5a), elevated IOP (p = 0.78; GRADE: moderate certainty; Figure 5b), and ERM proliferation (RR = 0.91; 95% CI [0.50, 1.66]; p = 0.77; Figure 5c) and limited choroidal hemorrhage (RR = 0.62; 95% CI: [0.06, 6.67]; p = 0.69; Figure 5d) were not significantly different between the two groups.

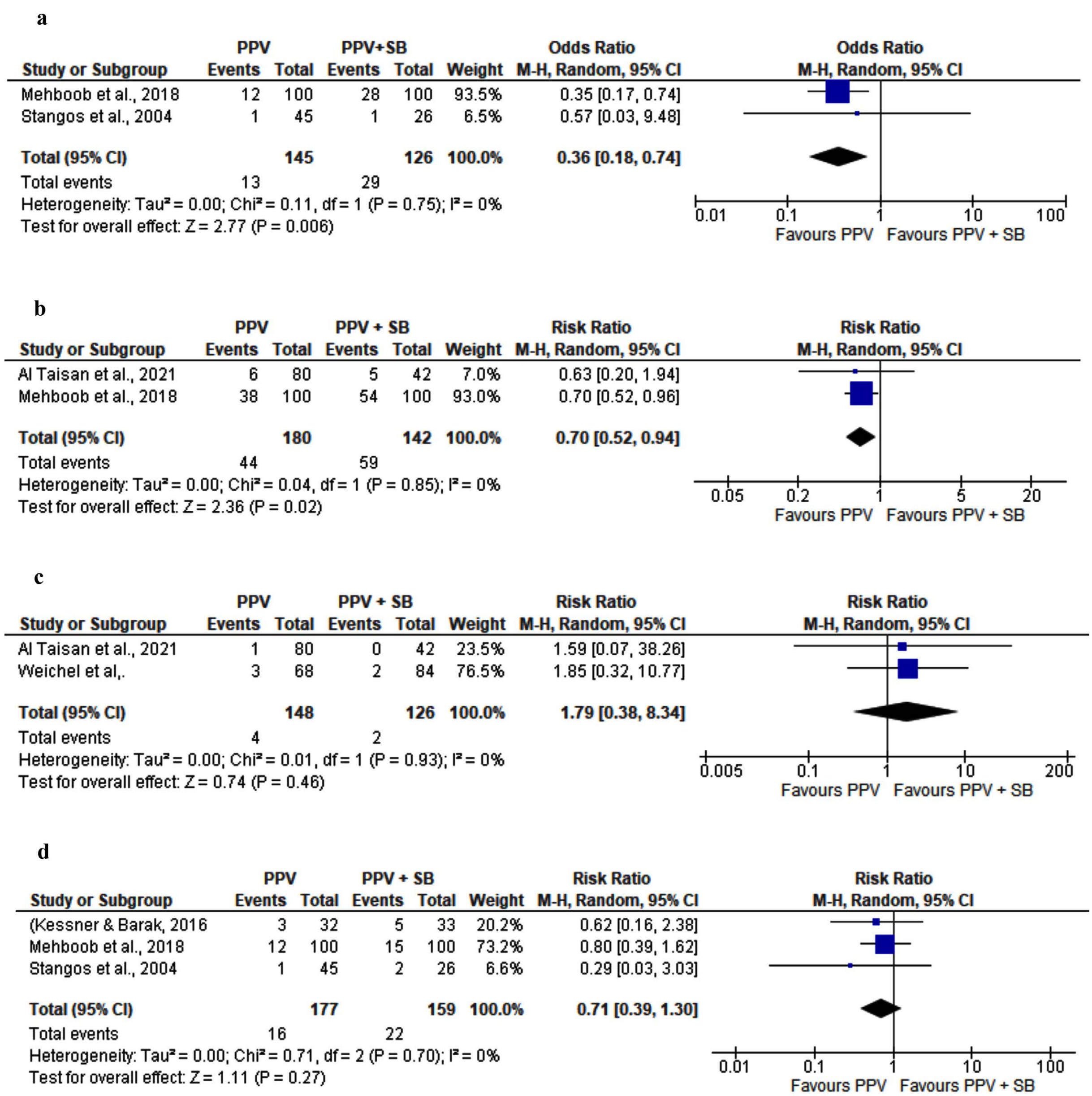

Figure 4. The figure illustrates various outcome measures in the study. (a) The figure shows the incidence of macular edema between the two studied techniques. (b) Comparative analysis of cataract development or progression in PPV compared with PPV and SB. (c) The figure represents the occurrence of macular holes in both groups. (d) This figure represents the occurrence of recurrent RD in the two studied groups.

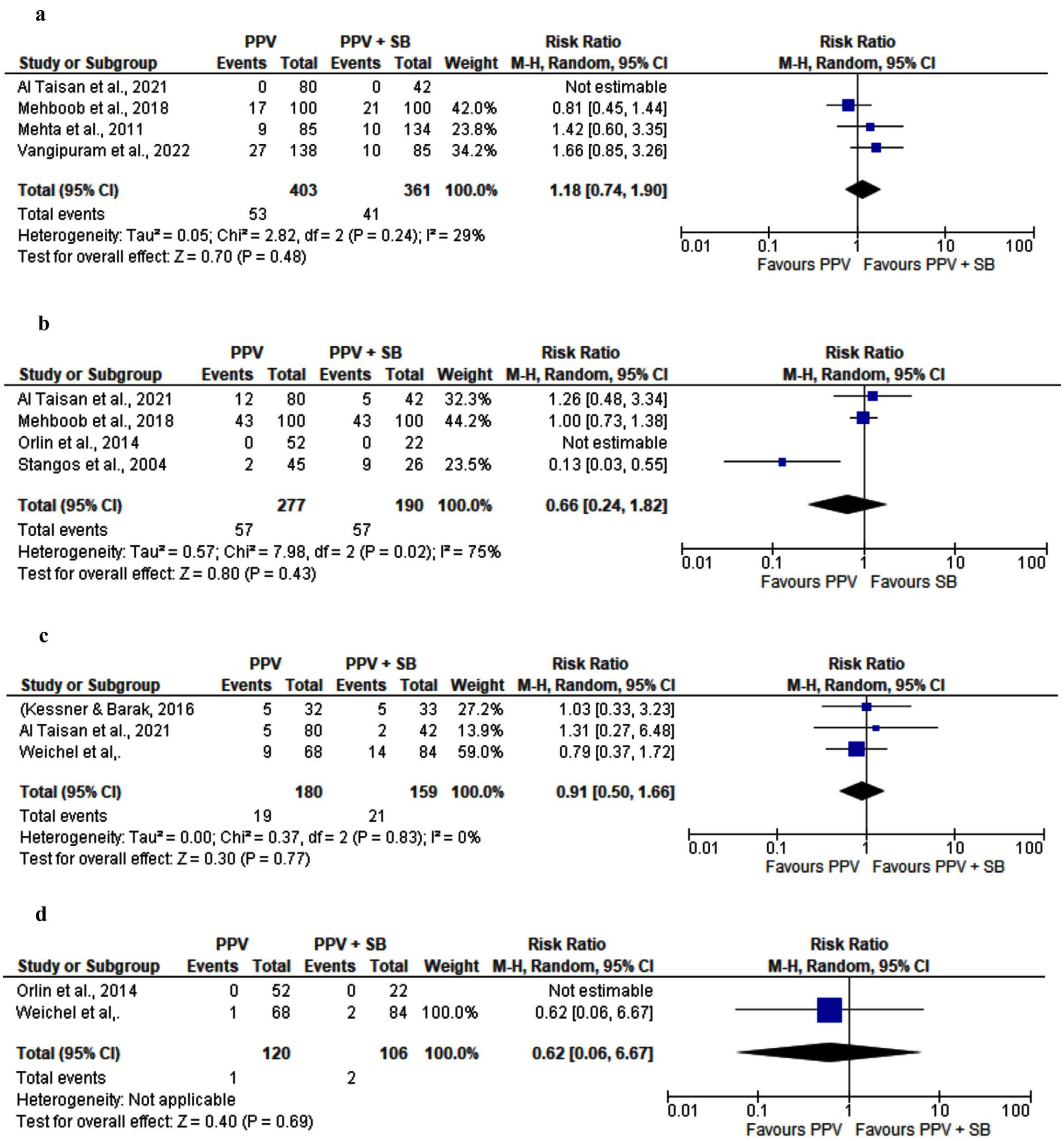

Figure 5. This figure illustrates various outcome measures in the study. (a) The figure represents the comparative development or progression of proliferative vitreoretinopathy in the two studied groups. (b) The figure depicts the comparative elevated intraocular pressure studied in the two groups. (c) This figure depicts the comparative occurrence of epiretinal membrane in PPV compared to PPV with SB. (d) This figure represents the limited choroidal hemorrhage occurrence in both groups.

5. Discussion

This systematic review and meta-analysis evaluated the results of 1518 eyes with RRD that underwent PPV or PPV combined with SB and lens-sparing or phaco-procedures. This study demonstrated that PPV alone or PPV combined with SB and lens-sparing versus phaco-procedures may be efficacious and safe for the treatment of RRD. Despite the growing preference of some ophthalmologists for PPV, owing to its safety and potentially comparable effectiveness with reduced operative time, there is still no consensus on the preferred surgical approach [12] [37] [38] [39]. In this context, there have been debates regarding the use of SB, which involves manipulation and dissection of extraocular tissues, making it invasive; it is relatively less invasive than PPV in terms of intraocular risk [40]. SB is commonly used as a treatment modality in younger patients, whereas PPV is used more frequently in middle-aged patients [41] [42]. To mitigate the need for subsequent cataract surgery and alleviate patient burden, RRD can be effectively managed through a phaco-procedure that combines vitrectomy with phacoemulsification [43] and lens-sparing PPV used in the management of some phakic RRD [44]. However, phaco-procedures demonstrate a reasonable success rate and potential complications associated with IOL stability, including myopic shift, IOL iris capture, and IOL decentration [41]. Given the distinct advantages and disadvantages associated with each technique, this meta-analysis aimed to consolidate relevant comparative studies to examine the efficacy and safety of PPV versus PPV in combination with SB and phaco-procedures in comparison with lens-sparing techniques.

In the efficacy analysis, there was a significant postoperative BCVA improvement in favor of PPV compared with PPV with SB. According to Escoffery *et al.* [20], vitrectomy alone is an effective and satisfactory approach for repairing RRD. This study involved the use of vitrectomy in eyes with different conditions, including aphakic, phakic, and pseudophakic, resulting in a success rate of 79%. Another study conducted by Colyer *et al.* [45] revealed that PPV is a superior treatment modality for primary RRD compared with alternative techniques. Furthermore, Chong and Fuller [38] reported that PPV is an effective and preferred technique for the primary repair of RRD. Based on these findings, PPV was found to be user-friendly and yielded improved visual outcomes compared with other methods, such as SB or a combination of SB and PPV, which aligns with the findings of our study.

In the current systematic review and meta-analysis, Mehta *et al.* [31] reported that combined PPV and SB resulted in a significantly better single-surgery anatomical success rate than did PPV alone. Additionally, another study by Mehboob *et al.* [30] achieved 84% success in the PPV group in one surgery and 82% success in the PPV and SB groups. This is supported by Lindsell *et al.* [46], who reported that PPV combined with SB and PPV alone was equally effective in achieving successful anatomical outcomes in primary RRD repair through a single surgical procedure. The success rates were comparable, with PPV demonstrating an 85% success rate and SB achieving a PPV of 83% [46]. Moreover, there was no significant difference in the primary reattachment rate in the eyes treated with PPV alone or PPV combined with SB. The final reattachment rates were similarly high in both surgical groups, with a higher rate of reattachment in PPV combined with SB (99.8%) than in PPV alone (99%).

This study aimed to investigate the occurrence of postoperative complications using different surgical approaches in the treatment of primary RRD. The incidence rates were determined as follows: 29.6% in the PPV alone group, 39% in the PPV combined with SB group, 19.8% in the lens-sparing group, and 26.8% in the phacoemulsification (phaco) group. Among the complications observed, the highest reported incidence in the PPV group was an IOP of 8.3%, and cataract formation was 6.4%. Conversely, in the PPV and SB groups, the highest incidence rates were observed for cataract formation (9%), increased IOP (8.8%) and PVR (8.2%). Notably, lens-sparing and phaco-procedures exhibited the highest RD recurrence rates, accounting for 7.2% and 8.5%, respectively. However, owing to the limited availability of data comparing phaco-procedures with lens-sparing procedures, drawing definitive conclusions is impractical.

In terms of cataract development, the present findings are consistent with previous literature regarding elevated susceptibility to cataract development in vitrectomized eyes. Furthermore, Park *et al.* [47] supported the recommendation of SB as the preferred treatment over PPV for younger patients owing to a reduced likelihood of accommodation impairment. Nevertheless, the included studies exhibited inconsistencies in the specific utilization of endotamponades, laser retinopexy, and cryopexy. In addition, the findings of this study are in accordance with those of previous studies that documented a higher incidence of IOP elevation in eyes that underwent vitrectomy. According to Mansukhani *et al.* [48] and Han *et al.* [49], this elevation of IOP is typically temporary but also poses a potential long-term risk for glaucoma development. IOP elevation after retinal surgery is likely caused by the use of intraocular tamponade agents (such as gas or silicone oil) and their respective expansion- or overfilling-associated properties [40].

The incidence of macular edema was significantly reduced in cases where PPV alone was employed compared to cases where SB was combined with PPV. Cystoid macular edema (CME) is a well-documented complication observed after ERM using PPV and PPV combined with SB, with reported incidence rates ranging from 1.7% to 2.7% post-PPV and from 3.2% to 5.1% post-PPV with SB. The risk of CME resulting from RRD repair remains uncertain due to variations in study design, surgical approaches, and inconsistent and nonstandardized reporting of this complication across studies [47] [50]. Implementing preoperative and postoperative measures, such as the administration of anti-inflammatory medications [51], surgical techniques including inner limiting membrane peeling [52] [53], and utilizing advancements in optical coherence tomography for monitoring CME development [50], may contribute to the prevention, diagnosis, and management of CME following RRD repair. Furthermore, the lack of available baseline and postoperative CSFT data poses challenges in calculating mean retinal thickness differences over time.

6. Limitations

The limitations inherent in the examined studies that compared PPV alone with PPV combined with SB for RRD treatment encompass several key aspects. These limitations include the absence of essential baseline and outcome data, nonstandardized reporting of data and outcomes, differences in baseline characteristics between the PPV and PPV combined with SB groups, potential confounding due to supplementary interventions following primary surgery failure, restricted availability of conclusive visual acuity data, variations in data representation formats, altered significance in sensitivity analyses, incomplete documentation of RRD repair-related complications, subjective selection of surgical approaches, and skewed study distribution. Moreover, the comparison groups demonstrated discrepancies in the proportion of RRD surgical cases in the combined group, possibly influencing outcomes, such as postoperative complications. Variations across study sites, resources, surgeons, follow-up durations, and outcome assessment methodologies introduce heterogeneity that could obscure potential effects. Inadequate sample sizes might hinder the identification of infrequent complications such as vitreous hemorrhage. Additionally, findings from older studies might lack direct applicability to contemporary practices owing to advancements in surgical techniques and equipment. Despite these limitations, it is pivotal to acknowledge that the analysis serves as a hypothesis-generating exploration pertinent to populations rather than to individual patients. Notably, the inclusion of observational studies carries the inherent risks of confounding and selection biases. Given these constraints and the decline in research on SB due to surgeon preference, this study underscores the viability of using primary SB for RRD treatment. Addressing these limitations requires further investigation, including well-designed RCTs and comprehensive complication reporting, to yield more robust evidence to guide RRD management decisions.

7. Conclusion

In conclusion, this systematic review and meta-analysis provides evidence regarding the efficacy and safety of different surgical approaches for RRD treatment. PPV alone and PPV combined with SB demonstrated comparably high rates of primary and final reattachments. PPV alone showed superior postoperative BCVA improvement compared with PPV combined with SB. Lens-sparing and phaco-procedures were effective in managing RRD, although further research is needed to draw definitive conclusions on their comparative effectiveness. Regarding complications, cataract formation was a common occurrence in both the PPV alone and PPV combined with SB groups, with higher rates in the latter. Increased IOP was observed in both groups but was more prevalent in the PPV-alone group. The recurrence rates of RD were higher in the lens-sparing and phaco-sparing groups. The incidence of macular edema was reduced in cases where PPV alone was performed compared to PPV combined with SB. The incidence of MH development, recurrent RD, PVR development or progression, ERM proliferation, and limited choroidal hemorrhage was not significantly different between the two groups. These findings suggest that PPV alone may be the preferred surgical approach because of its superior BCVA improvement and lower rates of certain complications, such as cataract formation. However, the choice of surgical technique should be tailored to individual patients by considering factors such as age, lens status, and associated risk factors.

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Authors' Contribution

MAQR, study conception, manuscript writing, dataset interpretation, statistical analysis interpretation, final revision, conclusions; EAQG, figures artwork, tables, photographic material compilation; MAQG, graphics; VLG, statistical analysis, and final revision. All the authors have approved the manuscript for submission.

Ethics Approval

This study was conducted in the Retina Department of the Oftalmologia Integral ABC Institution in Mexico City. The institutional review board approved the study according to the institutional guidelines, and no reference number was provided for review studies by this institution.

Data Availability Statement

The datasets used in this study have been included in the main text. Photographs and figures from this study may be released via a written application to the Photographic Laboratory and Clinical Archives Department of the Retina Specialists Unit at Oftalmologia Integral ABC, Medical and Surgical Assistance Institution (Nonprofit Organization), Av. Paseo de las Palmas 735 suite 303, Lomas de Chapultepec, Mexico City 11000, Mexico and the corresponding author upon request. All analysis files, tables, and figures (PDF) can be found in the supplementary file.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Supplementary File (List of Tables)

Table S1. Search strategy.

Web of science

#	Searches	Results
1.	"Retinal detachment," OR "Rhegmatogenous retinal detachment," OR Retinal Detachment/su, th [Surgery, Therapy]	17,817
2.	All = (Giant retinal tear OR giant retinal tears OR GRT OR giant rhegmatogenous retinal detachment OR giant rhegmatogenous retinal detachments)	3344
3.	**1 OR 2**	20,879
4.	ALL = (vitrectomy OR Vitreoretinal Surgery OR pars plana vitrectomy)	22,979
5.	ALL = ("Vitrectomy," OR "Vitreoretinal Surgery" OR "Pars plana vitrectomy," OR "Phacoemulsification," OR "Phacoemulsification," OR "Vitreoretinal surgery," OR "Phacovitrectomy," OR "combined phacovitrectomy." OR "Retinal Detachment/surgery" OR Vitreous Body)	*35,907*
6.	**4 OR 5**	35,886
7.	"Exp Scleral Buckling"	1589
8.	"Scleral Band" OR "Buckle Procedure" OR "Scleral Implant" OR "Choroidal Detachment" OR "Sub Retinal Fluid" OR "Scleral Depressor"	1113
9.	**7 OR 8**	3340
10.	*Lens-sparing techniques OR Lens-Sparing*	256
11.	*Lens Preservation OR Lens-sparing techniques*	854
12.	***10 OR 11***	1041
13.	*Lensectomy OR Phaco Procedures OR Phako procedures*	1378
14.	*phacoemulsification, OR cataract surgery, OR intraocular lens implantation, OR small incision cataract surgery, OR lens extraction, OR artificial intraocular lens (IOL), natural lens removal*	44,600
15.	**13 OR 14**	45,081
16.	**3 AND 6**	7518
17.	**3 AND 9**	2004
18.	**16 OR 17**	8083
19.	**3 AND 12**	120
20.	**3 AND 15**	2547
21.	**19 OR 20**	2614
22.	**18 AND 21**	1888
	6/18/2023	

Medline

#	Searches	Results
1	Retinal detachment OR Rhegmatogenous retinal detachment OR Retinal Detachment	29,585
2	Giant retinal tear OR giant retinal tears OR GRT OR giant rhegmatogenous retinal detachment OR giant rhegmatogenous retinal detachments OR Schwartz-Matsuo syndrome	*819*
3	1 or 2	*30,070*
4.	vitrectomy OR Vitreoretinal Surgery OR pars plana vitrectomy	24,302
5.	(vitrectomy OR (Vitreoretinal Surgery) OR (pars plana vitrectomy OR Vitrectom* or vitreoretinal surger*).mp. [mp = title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	24,302
6.	4 OR 5	24,302
7.	Exp Scleral Buckling	*3118*
8.	"Scleral Band" OR "Buckle Procedure" OR "Scleral Implant" OR "Choroidal Detachment" OR "Sub Retinal Fluid" OR "Scleral Depressor" OR scleral buckling combined with vitrectomy	*1546*
9.	7 OR 8	*4549*
10.	*Lens-sparing techniques OR Lens-Sparing*	182
11.	*Lens Preservation OR Lens-sparing techniques*	12
12.	***10 OR 11***	187
13.	*Lensectomy OR Phaco Procedures OR Phako procedures*	1187
14.	*phacoemulsification, OR cataract surgery, OR intraocular lens implantation, OR small incision cataract surgery, OR lens extraction, OR artificial intraocular lens (IOL), natural lens removal*	39,053
15.	**13 OR 14**	39,826
16.	**3 AND 6**	8219
17.	**3 AND 9**	3251
18.	**16 AND 17**	1423
19.	**3 AND 12**	85
20.	**3 AND 15**	2313
21.	**19 AND 20**	28
22.	**18 AND 21**	1383

6/18/2023

Table S2. (a) Baseline Demographic and Clinical Characteristics - Vitrectomy vs SB combined withvitrectomy. (b) Baseline Demographic and Clinical Characteristics - Lens-Sparing versus Phako-procedures.

a

Study	Number of Eyes	Design	Intervention	Age years (mean ± SD)	Phakic %	Pseudo Phakic %	Average clock hours detached	Gender (male) %	Pre-Operative BCVA (logMAR; mean ± SD)	Post-operative BCVA (logMAR; mean ± SD)	IOP (mmHg; mean ± SD)	Duration of Symptoms (days; mean ± SD)	Macula off (%)	Macula on (%)	Lattice degeneration, %	Inferior detachment 4:00-8:00 (%)	No of breaks ($\mu \pm \sigma$)	Any PVR (%)	Post operative complication (%)	Follow Up, months
Weichel *et al.* [1]	68	Retrospective	PPV	65.8 ± 13.5	-	-	5.44	-	0.82 ± 0.49	0.38 ± 0.33	-	10.9	45		23.5	60		17.64	19.1	10.93
Comparison Arm	84		SB + PPV	66.1 ± 11.9	-	-	5.73	-	1.03 ± 0.58	0.55 ± 0.32	-	11.1	63		19	62		16.6	32.1	8.60
Mehta *et al.* [2]	85	Retrospective	PPV	*58.45 ± 3.327*	43.5	35.82		63.5%	-	-		15.5	41.2		31.8	16.5	1.6	9	-	13.2
Comparison Arm	134		SB + PPV	*57.5 ± 13.65*	50.74	48.17		64.2%	-	-		17.6	51.5		30.6	25.4	1.6	10	-	13.2 months
Kessner and Barak, [3]	32	Retrospective	PPV	64.938	-	32	-	56.3	0.992 (20/196.350)	0.486 (20/61.239)	13.586	18	-		-	42.4	-	-	21.9 %	<2
Comparison Arm	33		SB + PPV	65.303	-	33	-	78.8	0.992 (20/196.350)	0.580 (20/76.038)	12.938	22	-		-	35.5	-	-	45.5 %	<2
Al Taisan *et al.* [4]	80	Retrospective	PPV	10.2 ± 5.3	86.3	13.8	-	70	-	-	12		92.5	6 (7.5)	-	-	-	93.8	31%	19.2 ± 11
Comparison Arm	42		SB + PPV	10.9 ± 4.8	92.9	7.1	-	71.4	-	-	5		95.2	2 (4.8)	-	-	-	92.9	32.5%	18.2 ± 11
Mehboob *et al.* [5]	100	Retrospective	PPV	54.80 ± 5.64	41	59		82			43		52	48 (48%)	6	14		8		27.94 ± 2.11
Comparison Arm	100		SB + PPV	55.60 ± 4.51	61	49		63			43		73	27 (27%)	19	57		40		31.93 ± 1.26
Stangos *et al.* [6]	26	Prospective	PPV	65.7 ± 10.32				70.42	1.23 ± 1.09	0.82 ± 1.10	11.26		35.55		9.85			20		12.45 ± 5.23
Comparison Arm	45		SB + PPV						1.3 ± 8.4	0.97 ± 0.78			34.61					8.88		12.45 ± 5.23
Orlin *et al.*, [7]	52	Prospective	PPV	54.49	65	35		50	0.903 (20/159.83)	0.418 (20/52.39)			61		31	17			0	406.73 days
Comparison Arm	22		SB + PPV	55.68	41	59		59.09	0.890 (20/155.29)	0.479 (20/60.37)			68		32	54			0	502.14 days
Ong *et al.*, [8]	101	Retrospective	PPV															70.4		6
Comparison Arm	99		SB + PPV															93.8		6
Vangipuram *et al.* [9]	138	Retrospective	PPV	61.9						1.26								19.5		6
Comparison Arm	85		SB + PPV	60.2						2.12								11.7		6

*PPV = pars plana vitrectomy; SB = scleral buckle; BCVA = Best corrected visual acuity; logMAR = logarithm of the minimum angle of resolution; SD = standard deviation; IOP = intraocular pressure; PVR = proliferative vitreoretinopathy.

b

Study	Number of Eyes	Design	Intervention	Age years (mean ± SD)	Phakic %	Pseudo Phakic %	Axial Length	Gender (male) %	Pre-operative BCVA (logMAR; mean ± SD)	Post-operative BCVA (logMAR; mean ± SD)	IOP (mmHg; mean ± SD)	Macula off (%)	Anatomic success	Recurrence of RD (%)	Inferior tear %	Reattachment with a single operation (%)	VH %	Any PVR (%)	Complications (%)	Follow up months
Kim *et al.* Part 1 (10)	60	Retrospective	Lens-sparing	49.3 ± 11.8			25.39 ± 1.79	65	0.79 ± 0.86	0.11 ± 0.30	11.7	55	91.7% (55)	8.3	10.0	91.7	0	4	2.4	27.3 ± 16.3
Comparison Arm	42	Retrospective	Phaco-procedure	61.8 ± 8.3			24.39 ± 1.24	57.1	0.96 ± 0.93	0.10 ± 0.18	7.1	50	97.6% (41)	2.4	9.5	97.6	0	1		25.8 ± 15.3
Kim *et al.* part 2 (10)	51	Retrospective	Lens-sparing	48.8 ± 10.8			26.20 ± 2.00	51	0.98 ± 0.97	0.16 ± 0.25	15.7	62.7	85% (43)	5.9	19.6	94.1	2	1	10	26.6 ± 15.6
Comparison Arm	40	Retrospective	Phaco-procedure	60.8 ± 8.1			24.40 ± 1.22	42.5	1.05 ± 0.92	0.22 ± 0.42	7.5	72.5	85% (34)	15	25	85	0	4		24.8 ± 16.1

Table S3. Non-randomized Studies: ROBINS-I Risk of Bias Assessment.

Author	Study question	Study population	All eligible participants enrolled.	Sample size	Intervention clearly described	Outcome measures valid and reliable	Blinding of outcome assessors	Follow-up rate	Statistical analyses	Missing data	Group-level interventions outcome efforts	Quality rating
Weichel *et al.* [1]	N	Y	Y	N	Y	Y	N	N	Y	Y	NA	POOR
Mehta *et al.* [2]	N	Y	Y	N	Y	Y	N	CD	N	N	NR	POOR
Kessner and Barak [3]	N	Y	CD	N	Y	Y	N	Y	Y	N	N	FAIR
Al Taisan*et al.* [4]	N	Y	Y	N	Y	N	N	Y	N	N	NR	POOR
Mehboob *et al.* [5]	N	Y	CD	N	Y	Y	N	Y	Y	N	NA	FAIR
Stangos *et al.* [6]	N	Y	CD	N	Y	Y	N	CD	N	N	NR	POOR
Orlin *et al.* [7]	N	Y	Y	N	Y	Y	N	N	Y	N	NR	POOR
Ong *et al.* [8]	Y	Y	Y	N	Y	Y	N	CD	Y	Y	NR	HIGH
Kim *et al.*, part 2 [10]	N	Y	Y	N	Y	N	N	CD	N	N	NA	FAIR
Kim *et al.*, Part 1 [10]	N	Y	Y	N	Y	N	N	CD	N	N	NA	FAIR
Vangipuram *et al.* [9]	N	Y	CD	N	Y	N	N	Y	Y	Y	CD	HIGH

Y = Yes; N = No; CD = cannot determine; NA = not applicable; NR = not recorded.

Table S4. Grading of Recommendations, Assessment, Development and Evaluation (GRADE) Summary of Findings Table – Pars Plana Vitrectomy + Scleral Buckle versus Pars Plana Vitrectomy.

Population: Patients receiving pars plana vitrectomy alone and PPV combine with scleral buckle for rhegmatogenous retinal detachment
Setting: Postoperative clinic-based environment
Intervention: Pars plana vitrectomy and scleral buckle
Comparison: Pars plana vitrectomy

Outcomes	Relative effect: RR (95% CI)	Number of studies	Certainty of the evidence (GRADE)†	Rationale
Final BCVA	WMD = −0.17, 95% CI = [0.27, 0.07], p = 0.001	2	⊕⊕⊖⊖ Low	1. Low sample size 2. Few diversities of studies 3. No heterogeneity 4. Low-to-moderate study risk of bias 5. The included studies are Prospective and retrospective. 6. Significant difference Missing statistical analysis
Macular edema	RR = 0.36, 95% CI = [0.74, 0.18], p = 0.006	4	⊕⊕⊖⊖ Low	1. Low sample size 2. Few diversities of studies 3. No heterogeneity 4. Low-to-moderate study risk of bias 5. The included studies are Prospective and retrospective. 6. Significant difference Missing statistical analysis
Proliferative vitreoretinopathy	RR = 1.18, 95% CI = [1.90, 0.74], p = 0.48	4	⊕⊕⊕⊖ Medium	1. High sample size 2. Moderate diversity of studies 3. Low heterogeneity 4. Low-to-moderate study risk of bias 5. All included studies are retrospective. 6. Non-significant difference No inconsistency, indirectness, imprecision, major study limitations or publication bias

Continued

Recurrent RD	RR = 0.71, 95% CI = [1.30, 0.39], p = 0.27	3	⊕⊕⊖⊖ Low	1. Low sample size 2. Few diversities of studies 3. No heterogeneity 4. Low-to-moderate study risk of bias 5. The included studies are Prospective and retrospective. 6. Non-Significant difference No inconsistency, indirectness, imprecision, major study limitations or publication bias
Elevated IOP	RR = 0.66, 95% CI = [0.24,1.82], p = 0.43	4	⊕⊕⊕⊖ Medium	1. High sample size 2. Moderate diversity of studies 3. high heterogeneity 4. Low-to-moderate study risk of bias 5. All included studies are retrospectiveand prospective. 6. Non-significant difference No inconsistency, indirectness, imprecision, major study limitations or publication bias
Primary reattachment rate	RR = 0.97, 95% CI = [1.03, 0.91], p = 0.34	9	⊕⊕⊕⊕ High	1. High sample size 2. High diversity of studies 3. Moderate heterogeneity 4. Low-to-moderate study risk of bias 5. All included studies are Retrospective and prospective. 6. Non-significant difference No inconsistency, indirectness, imprecision, major study limitations or publication bias
Final reattachment rate	RR = 1.00, 95% CI = [1.01, 0.99], p = 0.96	9	⊕⊕⊕⊕ High	1. High sample size 2. High diversity of studies 3. Low heterogeneity 4. Low-to-moderate study risk of bias 5. All included studies are Retrospective and prospective. 6. Non-significant difference No inconsistency, indirectness, imprecision, major study limitations or publication bias
ERM	RR = 0.91, 95% CI = [0.50, 1.66], p = 0.77	3	⊕⊕⊖⊖ Low	1. Low sample size 2. Low diversity of studies 3. Low heterogeneity 4. Low-to-moderate study risk of bias 5. All included studies are retrospective. 6. Moderate effect size No inconsistency, indirectness, imprecision, major study limitations or publication bias

95% CI: 95% confidence interval; WMD: weighted mean difference; PPV: pars plana vitrectomy; SB: scleral buckle; CDVA: corrected distance visual acuity. High = This research provides a very good indication of the likely effect. The likelihood that the effect will be substantially different‡ is low. Moderate = This research provides a good indication of the likely effect. The likelihood that the effect will be substantially different‡ is moderate. Low = This research provides some indication of the likely effect. However, the likelihood that it will be substantially different‡ is high. Very low = This research does not provide a reliable indication of the likely effect. The likelihood that the effect will be substantially different‡ is very high. ‡Substantially different = a large enough difference that it might affect a decision.

Table S5. Included studies Efficacy endpoint data:

Study ID	Surgery	Final BCVA	Primary re-attachment Event	Final re-attachment rate	Operation time, min ($\mu \pm \sigma$)	Number of operations to anatomic success ($\mu \pm \sigma$)	Target F/U, months
Weichel*et al.* [1]	PPV	0.38±0.33	63	100%	-	-	10.93
Comparison Arm	SB + PPV	0.55±0.32	79	100%	-	-	8.60
Mehta*et al.* [2]	PPV	0.2758	31	100%	-	-	13.2
Comparison Arm	SB + PPV	0.2518	66	100%	-	-	13.2 months
Kessner and Barak, [3]	PPV	0.486 (20/ 61.239)	27	100%			<2
Comparison Arm	SB + PPV	0.580 (20/76.038)	25	100%		--	<2
Al Taisan*et al.* [4]	PPV	-	61	98.7%	-	-	19.2 ± 11
Comparison Arm	SB + PPV	-	27	100%	-	-	18.2 ± 11
Mehboob *et al.* [5]	PPV	-	85	100%			27.94 ± 2.11
Comparison Arm	SB + PPV	-	83	100%			31.93 ± 1.26
Stangos *et al.* [6]	PPV	0.82 ±1.10	25	100			12.45 ± 5.23
Comparison Arm	SB + PPV	0.97 ±0.78	41	100			12.45 ± 5.23
Orlin *et al.* [7]	PPV	0.418	43	100%			406.73 days
Comparison Arm	SB + PPV	0.479	19	100%			502.14 days
Ong *et al.* [8]	PPV	-	83	100			6
Comparison Arm	SB + PPV	-	87	100			6
Vangipuram *et al.* [9]	PPV	2.12	107	137 (99.27%)			6
Comparison Arm	SB + PPV	1.26	78	84 (98.8%)			6
Kim *et al.* Part 1 [10]	Lens-sparing	0.11 ± 0.30	55 (91.7)	60 (100)	55.8 ± 15.0	-	27.3 ± 16.3
Comparison Arm	Phaco-procedure	0.10 ± 0.18	41(97.6)	42 (100)	62.7 ± 12.9	-	25.8 ± 15.3
Kim *et al.*Part 2 [10]	Lens-sparing	0.16 ± 0.25	48 (94.1)	51 (100)	103.9 ± 41.3	-	26.6 ± 15.6
Comparison Arm	Phaco-procedure	0.22 ± 0.42	34 (85)	40 (100)	128.0 ± 54.5	-	24.8 ± 16.1

Table S6. Post Operative complication and incidence rate.

Outcome	Events		Number of eyes (number of studies)	Events		Number of eyes (number of studies)
	Pars Plana Vitrectomy alone	Pars Plana Vitrectomy combined with Scleral Buckle Group		Lens sparing	Phako-procedure	
ERM	19	21	339 (3)	-	-	-
Limited choroidal hemorrhage	10	6	352 (2)	-	-	-
Macular edema	12	33	352 (2)	0	5	193 (1)
Increased IOP	57	57	467 (4)	7	3	193 (1)
VH	-	-	-	1	0	193 (1)
PVR	41	53	764 (3)	5	5	193 (1)
Recurrence of RD	15	20	265 (2)	8	7	193 (1)
Macular hole	4	2	284 (2)	1	2	193 (1)
Cataract	44	59	322 (2)	-	-	-

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