Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Inferential Analysis of Success Rates of Conventional Scleral Buckling Surgery

Abdul Hannan
Al-Shifa Trust Eye Hospital
Khadija Hussain
khadija.hussainn@gmail.com
Al-Shifa Trust Eye Hospital
Tehreem Tanveer
Al-Shifa Trust Eye Hospital
Fiza Shaheen
Al-Shifa Trust Eye Hospital
Aziz Jan Bashir
Al-Shifa Trust Eye Hospital
Shama Khan
Al-Shifa Trust Eye Hospital

Research Article

Keywords: Scleral buckling, rhegmatogenous retinal detachment, retinal surgery, anatomical success, visual outcome

Posted Date: May 27th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9586485/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Purpose:

To evaluate the anatomical and visual outcomes of conventional scleral buckling (SB) surgery in patients with uncomplicated rhegmatogenous retinal detachment (RRD), and to identify factors associated with surgical success.

Methods:

This retrospective cross-sectional study was conducted at the Vitreoretina Department of Al-Shifa Trust Eye Hospital, Rawalpindi. A total of 269 eyes that underwent scleral buckling surgery between April 2019 and March 2024, performed by a single vitreoretinal surgeon, were included. Eyes with prior vitreoretinal surgery, combined procedures, or incomplete records were excluded. Data collected included demographic characteristics, RRD features, intraoperative details, and postoperative outcomes. Primary anatomical success was defined as complete retinal attachment at 3 months. Final attachment was assessed after secondary intervention where required. Visual acuity was recorded in logMAR units. Statistical analysis was performed using SPSS version 21, with $p < 0.05$ considered significant.

Results:

The mean age of patients was 35.75 ± 19.5 years, with a male predominance (68.8%). Most eyes were phakic (76.2%) and macula-off at presentation (88.5%). The primary retinal reattachment rate was 74.4%. Among eyes with primary failure, secondary pars plana vitrectomy resulted in successful attachment in 57.6% of cases. Sponge explants demonstrated the highest primary success rate (78.4%, $p = 0.01$). Eyes with round holes had better outcomes compared to horseshoe tears (79% vs. 65.7%, $p = 0.006$). Phakic eyes showed significantly higher success rates than pseudophakic and aphakic eyes ($p = 0.02$). There was no significant difference between segmental and encircling buckles ($p = 0.9$). The overall complication rate was 7%, with elevated intraocular pressure being the most common. Mean visual acuity improved significantly from 1.62 ± 0.3 to 0.40 ± 0.22 logMAR ($p < 0.001$).

Conclusion:

Scleral buckling remains an effective and cost-efficient primary treatment for uncomplicated RRD, particularly in younger and phakic patients. It provides favorable anatomical and visual outcomes with a low complication rate. Careful case selection and early intervention are key to optimizing surgical success.

Introduction

Rhegmatogenous retinal detachment (RRD) is a commonly encountered condition in the vitreoretinal outpatient department and requires prompt surgical intervention to achieve optimal visual rehabilitation [1]. Several surgical options are available for the management of RRD, including pneumatic retinopexy, pars plana vitrectomy (PPV), scleral buckling (SB), or a combination of these techniques [2–5]. The choice of procedure depends on factors such as the type and location of retinal breaks, lens status, patient age, and macular involvement.

Although scleral buckling has become less frequently performed in modern surgical setups, it remains the preferred treatment modality in selected cases, particularly in younger patients [6]. Reported success rates for this extraocular tamponade procedure range from 75% to 90% [7]. First introduced by Custodis in the 1950s, scleral buckling revolutionized retinal detachment surgery by enabling external indentation of the sclera to support retinal breaks [5]. The buckle creates a chorioretinal adhesion, effectively re-establishing the attachment between the neurosensory retina and retinal pigment epithelium [8].

Scleral buckling remains an effective technique for managing retinal tears and lattice degeneration [9]. This study aims to evaluate scleral buckling as a primary treatment modality for uncomplicated RRD and analyze factors influencing its success.

Materials and methods

This **retrospective cross-sectional study** was conducted at the Vitreoretina Department of Al-Shifa Trust Eye Hospital, Rawalpindi, after obtaining approval from the Ethical Review Committee (ERC) of the Al-Shifa Research Center.

All patients who underwent scleral buckle surgery between **April 1, 2019, and March 31, 2024**, performed by a single vitreoretinal surgeon (AH), were identified using the electronic medical record (EMR) system.

Inclusion Criteria

- Eyes undergoing scleral buckle surgery within the study period
- Procedures performed by the same surgeon (AH)

Exclusion Criteria

- History of prior vitreoretinal surgery
- Combined procedures with intraocular gas injection
- Incomplete or missing EMR data

Data Collection

The following variables were recorded:

- Demographics: age, gender
- Ocular factors: laterality, lens status, macular status
- RRD characteristics: type, extent, and number of breaks
- Intraoperative details
- Postoperative complications

Outcome Measures

- **Primary attachment**: complete retinal attachment at 3 months
- **Final attachment**: attachment after secondary intervention
- **Raised IOP**: intraocular pressure > 21 mmHg at any postoperative visit

Visual acuity was recorded preoperatively and at 3 months postoperatively. Snellen visual acuity was converted to logMAR for analysis.

Surgical Technique

A 360° conjunctival peritomy was performed, followed by isolation of the recti muscles using 4 − 0 silk sutures. Retinal breaks were localized using scleral depression. Subretinal fluid drainage was performed using a bent 27-gauge needle. Cryotherapy was applied to seal retinal breaks.

The type and configuration of the scleral buckle were selected based on case characteristics. The buckle was secured using 5 − 0 Ethibond sutures. Conjunctival closure was done with 7 − 0 Vicryl, followed by subconjunctival dexamethasone and gentamicin injection.

Statistical Analysis

Data were analyzed using **SPSS version 21**.

- Qualitative variables: frequencies and percentages
- Quantitative variables: mean ± standard deviation
- Statistical tests: Chi-square and one-way ANOVA
- Significance level: **$p < 0.05$**

Results

A total of 269 eyes met the inclusion criteria. The mean age of patients was 35.75 ± 19.5 years. There was a predominance of right-eye involvement (n = 149, 55.4%) and male patients (n = 185, 68.8%). Most

eyes were phakic (n = 205, 76.2%), with total rhegmatogenous retinal detachment (RRD) observed in 34.2% (n = 92), and macula-off status noted in 88.5% (n = 238). Additional preoperative characteristics are summarized in Table I.

Table I. Preoperative Characteristics of Operated Eyes (n = 269)

Feature	Frequency (n)	Percentage (%)
Lens Status		
Phakic	205	76.2
Pseudophakic	51	19.0
Aphakic	13	4.8
Clock Hours of RRD		
1–3	21	7.8
1–6	89	33.1
1–9	67	24.9
1–12	92	34.2
Macular Status		
On	31	11.5
Off	238	88.5
Type of Break		
Round hole	63	23.4
Horseshoe tear (HST)	110	40.9
Dialysis	20	7.4
Mixed	24	8.9
None	39	14.5
Not Available (NA)	13	4.8
Number of Breaks		
No Break	52	19.3
Single	109	40.5
2–5	96	35.7
6–10	7	2.6
> 10	5	1.9

Lens status showed that the majority were phakic (76.2%), followed by pseudophakic (19%) and aphakic eyes (4.8%). Clock hours of RRD ranged widely, with the most common being 1–12 hours (34.2%). Macular status was off in 88.5% of eyes. Types of retinal breaks were predominantly horseshoe tears

(40.9%) followed by round holes (23.4%). Break multiplicity was most commonly single (40.5%) or between 2–5 (35.7%). Intraoperatively, the majority of eyes underwent 360-degree encircling buckle (cerclage) placement (n = 176, 65.4%), with the 4 – 2 band being the most commonly used implant (n = 117, 43.5%). Full intraoperative details are provided in Table II.

Table II. Intraoperative Details

Feature	Frequency (n)	Percentage (%)
Type of Buckle Used		
4 – 1 Band	7	2.6
4 – 2 Band	117	43.5
Band with Sleeve	29	10.8
506 Sponge	94	34.9
277 Tire	9	3.3
Tire with Band	8	3.0
Tire, Band, and Sleeve	2	0.7
Sponge with Band	2	0.7
Configuration		
Cerclage (360° Buckle)	176	65.4
Segmental	90	33.5
Radial	3	1.1

The primary retinal reattachment rate was 74.4% (n = 192), excluding 11 eyes lost to follow-up. Of the 66 eyes with primary surgical failure (24.5%), 59 underwent secondary pars plana vitrectomy (PPV) with tamponade. This resulted in successful final attachment in 57.6% (n = 34). Details are presented in Table III.

Table III. Anatomical Outcomes and Additional Procedures

Outcome	Frequency (n)	Percentage (%)
Primary Retinal Attachment	192	74.4
Primary Failure	66	24.5
Status Unknown	11	4.1
Further Procedures		
Pars Plana Vitrectomy + Oil	59	21.9
Buckle Removal	2	0.7
Buckle Readjustment	1	0.4
Final Attachment (Post-PPV)	34	66.7

Subgroup analysis revealed that:

- Sponge buckles had the highest primary success rate (78.4%) (p = 0.01).
- Eyes with round holes showed the highest reattachment success (79%), while horseshoe tears had the lowest (65.7%) (p = 0.006).
- Segmental buckles and 360-degree buckles had comparable success rates (74.4% vs. 74.5%, p = 0.9).
- Phakic eyes showed a significantly higher attachment rate (76.5%) compared to pseudophakic (66.6%) and aphakic eyes (69.2%) (p = 0.02).

There was no statistically significant difference in primary success rates over consecutive years of the primary surgeon's performance (p = 0.6) (see Graph I).

Graph I. Primary Attachment Rate by Year of Surgeon's Experience

No statistically significant difference was observed in primary anatomical success across the years of surgical experience (p = 0.6), suggesting consistent surgical outcomes over time.

The overall perioperative and postoperative complication rate was 7% (n = 19). Raised intraocular pressure (IOP) was most commonly associated with the 4 − 2 band in 360-degree configuration (6.8%) (see Graph II).

Graph II. Complication Rate and Type

Overall complication rate was 7% (n = 19). The most common complication was raised intraocular pressure, particularly associated with the 4 − 2 band used in 360-degree configuration (6.8%).

Finally, there was a statistically significant improvement in mean visual acuity, from preoperative 1.62 ± 0.3 logMAR to postoperative 0.40 ± 0.22 logMAR ($p < 0.001$).

Discussion

This study evaluates scleral buckling as a primary treatment for RRD in a resource-limited setting. With increasing global incidence of RRD due to aging populations, myopia, and cataract surgery, the role of cost-effective surgical options remains highly relevant [10–12].

The observed **primary attachment rate of 74.4%** is comparable to international data, including the MUSTARD trial [14]. However, the **final attachment rate after secondary intervention was lower**, likely reflecting delayed presentations and a high proportion of macula-off detachments.

Outcomes were influenced by:

- **Age** (better in younger patients)
- **Lens status** (better in phakic eyes)
- **Break type** (better in round holes)

The study also demonstrated:

- No significant difference between **segmental vs. encircling buckles**
- **Sponge explants** showing better outcomes and fewer complications

The complication rate (7%) was low, with raised IOP being most common, particularly in 360° encircling procedures.

Conclusion

Scleral buckling remains an effective and economical primary treatment for uncomplicated RRD, particularly in resource-limited settings. It demonstrates satisfactory anatomical and functional outcomes with low complication rates.

Better outcomes were observed in:

- Younger patients
- Phakic eyes
- Early (macula-on) detachments

Despite advances in vitreoretinal surgery, scleral buckling continues to be a valuable technique. However, **prospective studies with longer follow-up and larger cohorts** are needed to further validate its long-term efficacy.

Declarations

Ethics Approval

The study was approved by the Ethical Review Committee of Al-Shifa Trust Eye Hospital, Rawalpindi, Pakistan, and was conducted in accordance with the tenets of the Declaration of Helsinki.

Consent to Participate

Due to the retrospective nature of the study, formal informed consent was waived by the Ethical Review Committee.

Consent for Publication

Not applicable.

Funding

No funding was received for this study.

Competing Interests

The authors declare that they have no competing interests.

Author Contribution

A.H conceptualized the study, performed all surgical procedures, and supervised the project. K.H contributed to study design, data collection and drafted the manuscript. T.T assisted in data collection, statistical analysis, and literature review. F.S contributed to all data collection, statistical analysis of all data, data input, prepared all figures and manuscript editing. A.J.B provided critical input in study design, data interpretation, and manuscript revision for important intellectual content. S.K assisted in data collection, literature review, and final manuscript proofreading.All authors read and approved the final manuscript and agree to be accountable for all aspects of the work.

References

1. Kohli P, Tripathy K. Scleral Buckling. [Updated 2023 Aug 25]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK580486/
2. Sodhi A, Leung LS, Do DV, Gower EW, Schein OD, Handa JT. Recent trends in the management of rhegmatogenous retinal detachment. Surv Ophthalmol. 2008 Jan-Feb;53(1):50-67. [PubMed]

3. Heimann H, Bartz-Schmidt KU, Bornfeld N, Weiss C, Hilgers RD, Foerster MH., Scleral Buckling versus Primary Vitrectomy in Rhegmatogenous Retinal Detachment Study Group. Scleral buckling versus primary vitrectomy in rhegmatogenous retinal detachment: a prospective randomized multicenter clinical study. Ophthalmology. 2007 Dec;114(12):2142-54. [PubMed]
4. Heimann H, Hellmich M, Bornfeld N, Bartz-Schmidt KU, Hilgers RD, Foerster MH. Scleral buckling versus primary vitrectomy in rhegmatogenous retinal detachment (SPR Study): design issues and implications. SPR Study report no. 1. Graefes Arch Clin Exp Ophthalmol. 2001 Aug;239(8):567-74. [PubMed]
5. Saw SM, Gazzard G, Wagle AM, Lim J, Au Eong KG. An evidence-based analysis of surgical interventions for uncomplicated rhegmatogenous retinal detachment. Acta Ophthalmol Scand. 2006 Oct;84(5):606-12. [PubMed]
6. Cruz-Pimentel, M., Huang, C. Y., & Wu, L. (2022). Scleral Buckling: A Look at the Past, Present, and Future in View of Recent Findings on the Importance of Photoreceptor Re-Alignment Following Retinal Re-Attachment. *Clinical Ophthalmology*, *16*, 1971–1984.
7. Papakostas TD, Vavvas D. Postoperative complications of scleral buckling. InSeminars in Ophthalmology 2018 Jan 2 (Vol. 33, No. 1, pp. 70-74). Taylor & Francis.
8. Braimah IZ, Akafo S, Chhablani J. Scleral buckle surgery in Ghana: a decade comparison of the anatomic and visual outcome. *Clin Ophthalmol*. 2018;12:2509-2517
9. Fallico M, Alosi P, Reibaldi M, Longo A, Bonfiglio V, Avitabile T, Russo A. Scleral buckling: a review of clinical aspects and current concepts. Journal of Clinical Medicine. 2022 Jan 9;11(2):314.
10. Shanmugam PM, Ramanjulu R, Mishra KD, Sagar P. Novel techniques in scleral buckling. Indian journal of ophthalmology. 2018 Jul 1;66(7):909-15.
11. Nielsen BR, Alberti M, Bjerrum SS, la Cour M. The incidence of rhegmatogenous retinal detachment is increasing. *Acta Ophthalmol*. 2020;98(6):603–606. doi:10.1111/aos.14380
12. Park JY, Byun SJ, Woo SJ, et al. Increasing trend in rhegmatogenous retinal detachment in Korea from 2004 to 2015. *BMC Ophthalmol*. 2021;21(1):406. doi:10.1186/s12886-021-02157-1
13. Dayani PN, Blinder KJ, Shah GK, Holekamp NM, Joseph DP, Wilson B, Thomas MA, Grand MG. Surgical outcome of scleral buckling compared with scleral buckling with vitrectomy for treatment of macula-off retinal detachment. Ophthalmic Surg Lasers Imaging. 2009 Nov-Dec;40(6):539-47. doi: 10.3928/15428877-20091030-02. PMID: 19928718.
14. Thelen U, Amler S, Osada N, Gerding H. Outcome of surgery after macula-off retinal detachment - results from MUSTARD, one of the largest databases on buckling surgery in Europe. Acta Ophthalmol. 2012 Aug;90(5):481-6. doi: 10.1111/j.1755-3768.2010.01939.x. Epub 2010 Jun 1. PMID: 20529077.
15. Pastor J. C., Fernandez I., de la Rodriguez R. E., et al. Surgical outcomes for primary rhegmatogenous retinal detachments in phakic and pseudophakic patients: the Retina 1 Project-report 2. *British Journal of Ophthalmology.* 2008;92(3):378–382. doi: 10.1136/bjo.2007.129437.

16. Kovacevic I., Radosavljevic A. Stefanovic I., et al. Anatomical and functional factors influencing the results of sclera buckling procedure for macula-off rhegmatogenous retinal detachments. *Vojnosanitetski pregled.* 2017;74(3):212–218. doi: 10.2298/vsp141001175k.
17. Shah R, Byanju R, Pradhan S, Ranabhat S. Factors Affecting the Outcome of Scleral Buckling Surgery for Primary Rhegmatogenous Retinal Detachment. J Ophthalmol. 2018 Nov 13;2018:9016302. doi: 10.1155/2018/9016302. PMID: 30538859; PMCID: PMC6260553.
18. Banaee T, Hosseini SM, Ghooshkhanei H, Moosavi M, Khayyatzadeh-Kakhki S. Anatomical and visual outcomes of three different scleral buckling techniques. Journal of ophthalmic & vision research. 2009 Apr;4(2):90.
19. Veckeneer M, Van Overdam K, Bouwens D, et al. A randomized clinical trial of cryotherapy versus laser photocoagulation for retinopexy in conventional retinal detachment surgery. Am J Ophthalmol. 2001;132(3):343–347.
20. Goezinne F, La Heij EC, Berendschot TT, et al. Incidence of redetachment 6 months after scleral buckling surgery. Acta Ophthalmol. 2010;88(2):199–206.

Figures

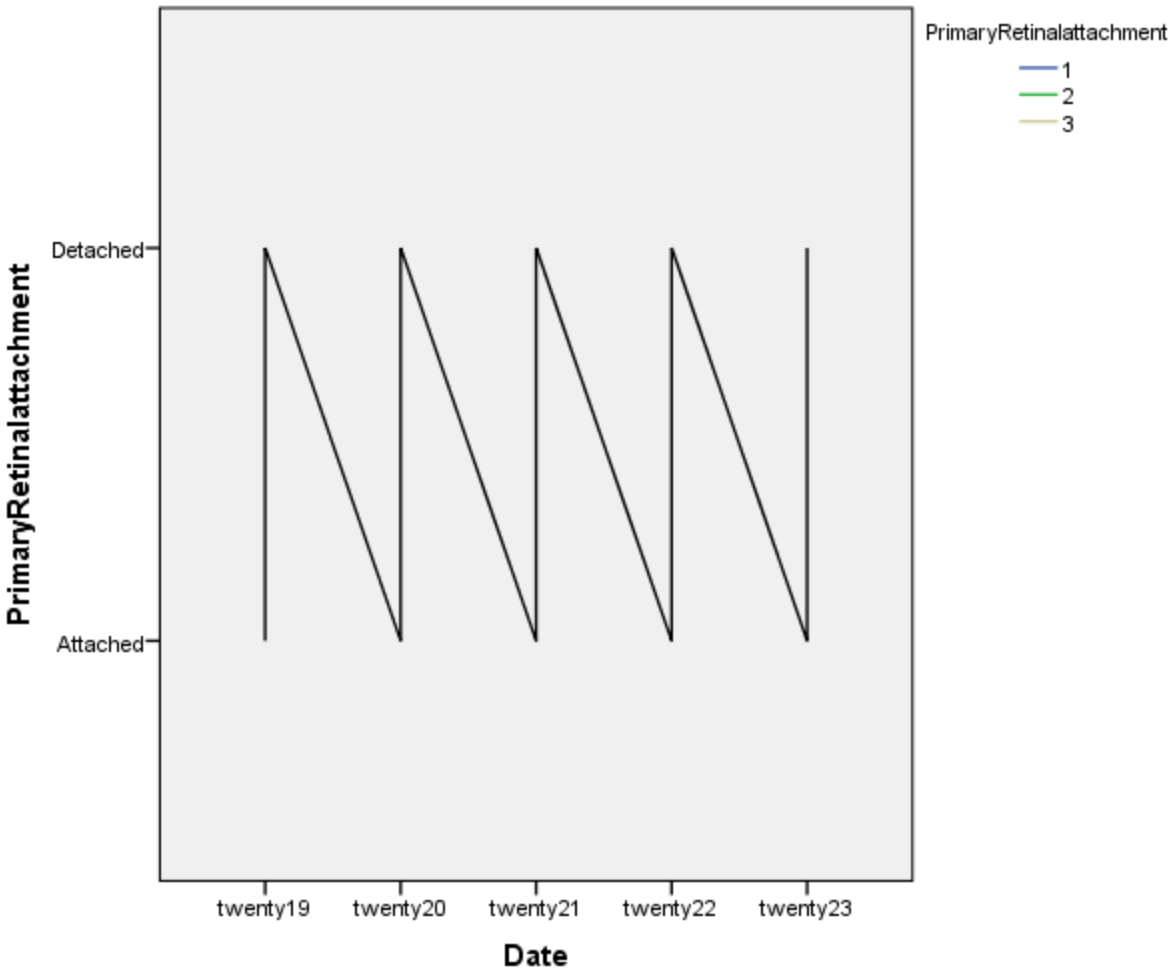


Figure 1

Graph I. Primary Attachment Rate by Year of Surgeon's Experience

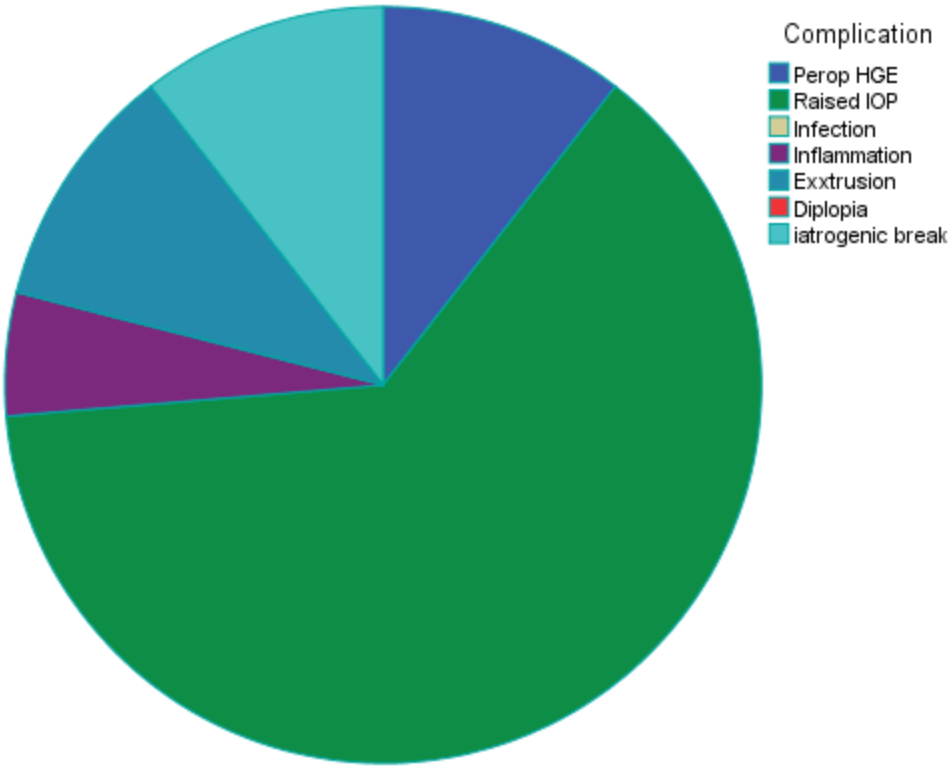


Figure 2

Graph II. Complication Rate and Type